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e-EarlyCare-T

TRAINING AND SPECIALISATION IN EARLY INTERVENTION: USE OF TECHNOLOGICAL RESOURCES AND ARTIFICIAL INTELLIGENCE





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e-EarlyCare-T

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Acknowledgments:

To the early childhood professionals for their vocation and dedication

To the families of children in need of early intervention:
without them, progress in this field would not be possible

To Begoña Prieto Moreno, Vice-rector of Teaching and Digital Education at the University of Burgos for supporting this training project from the beginning, without her support this work would not have been possible

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PROLOGUE SCIENTIST

To paraphrase Ebbinghaus, "Early Childhood Care" (ECC) has a long past but a short history. In this case, it is also the case that in the framework of ECC, different areas of knowledge and disciplines at different stages of development converge. This situation implies to some extent different methodological and conceptual approaches that we must integrate under an eclectic philosophy (Alcantud-Marin, 2012).

Over the last eighty years, the ECI model has evolved from a rehabilitative model focused almost exclusively on the individual deficit, to a model centred on the person-family and the social context. In the first period, it was defined as "Early Stimulation" (ES) and included all the actions undertaken on the child to facilitate his or her development trying to reach the maximum of his or her potential capacities (Gutiérrez, 2005; Gutiérrez & Ruiz, 2012). The term ES soon began to be replaced by the term "Early Childhood Care" (ECC), since the former was understood, and in fact continues to be used in some fields, as the acceleration of normal developmental and learning processes (Arizcun-Pineda, 1991). In parallel, in the Anglo-Saxon world Dunst (1985), defines Early Intervention as a general term used to describe programmes aimed at children who present some problem in their development. It is important to realise that the term "Early Intervention" in Spain is not equivalent to the Anglo-Saxon term "Early Intervention". The latter refers to early intervention in its broadest sense, and in its field it has generated numerous different intervention models and programmes. Whereas the Spanish concept of Early Intervention implies the action of a multidisciplinary team around the figure of the EIC (Early Intervention Centre) or the CDEI (Child Development and Early Intervention Centre), financed by the corresponding autonomous community and, consequently, free of charge for families. Consequently, the EICs and CDEIs develop more or less what in Anglo-Saxon terms is called "community early intervention".

In historical-political terms, the approval in 1959 of the United Nations Declaration of the Rights of the Child Act, in all member countries, encouraged the development of actions aimed at caring for children in the early stages (Pérez-López & Brito de la Nuez, 2004). At the international level, the publication in the USA of the Economic Opportunity Act in 1964 is recognised as a significant milestone (Milla-Romero, 2019). However, as is always the case, legal initiatives (Millá-Romero, 2005) are preceded by the development of scientific knowledge and social pressure (Casado, 2005).

In particular, stimulation or early care services emerged first as a health need to care for children born preterm (Arizcun-Pineda, 1991; Casado, 2005). Perinatology and paediatrics services began to concern themselves with the care of children who developed some kind of impairment or were at risk of doing so. Therefore, the birth of early childhood care took place in the healthcare field (Casado-Pérez, 2006). From a technical and scientific point of view, in the 1950s and 1960s, developmental psychologists discovered that, contrary to previously held beliefs, children are extraordinarily competent and complex beings, who process information and take an active part in their own development (Appleton, 1975). The term intervention, although introduced by way of clinical-therapeutic application and initially inheriting the medical-epidemiological model, quickly evolved into a systemic psycho-social model (Genovard, 1980), especially thanks to the development and application of General Systems Theory (Ludwig von Bertalanffy †1901-1972). As a consequence, the child is no longer the sole epicentre of the intervention activity but is considered as a being immersed in a system, with the capacity to receive stimuli and to act on his or her environment (Gutiérrez, 2005). Child-centred models were a novelty for their time and represented a breakthrough for their development (Linares von Schmiterlöw & Rodríguez, 2005). Thus, when research reports indicated that through education and training the long-term prognosis of children with developmental disorders could be significantly modified, this was seen as confirmatory evidence of both the importance of this intervention and the malleability of the brain during early childhood development (Hunt, 1961).

The evidence of the improvements produced by Early Intervention programmes for children with neurodevelopmental disorders when implemented before the age of three is overwhelming (Barnett, 1995; Reynolds, Temple, Robertson, & Mann, 2001). Nowadays, we understand that child development is a con-

sequence of the interaction between the organism and the environment, which is why EICs and CDEIs intervention programmes have been broadening the focus of their action to include the family and the child's context. The aim of this change is to prevent socio-familial maladjustments, to increase the appropriate interaction between the child and his or her family by improving family functioning, to accompany and assist in the adjustment to the new situation and to provide the necessary support and competencies (Blackman, 2003; Peterander, Speck, Pithon, & Terrisse, 1999).

However, the interacting systems (individual, family, socio-community, educational, etc.) involve a large amount of information that sometimes exceeds the human capacity for analysis, generating in turn a challenge in the development and application of data analysis techniques. The use of medical records is essential for the management of a CAT or CDIAT, for decision making in each case or for the evaluation of the results of the programmes. Electronic medical records have been in use for years (Dick, Steen, & Detmer, 1997) and their use in health care has been standardised. However, they are not common in EICs and CDEIs. Due to the burden of care, most professionals are reluctant to use database systems to record their actions. When appropriate instruments are available, a large amount of information is generated which requires specific techniques for its processing. The lack of training of EICs and CDEIs technicians in these tasks means that their use and exploitation is considered an overload.

The book prologue here is the result of years of direct experience in the activity of EICs in the Community of Castilla-León and has been developed as training and updating material for CAT technicians in the framework of a programme co-financed by the EU. It is composed of eight modules with a different number of topics. The first module presents the concept of Early Intervention and Care from a preventive intervention perspective. The second module conceptualises normative early neurodevelopment and then introduces in the third module the most frequent pathologies in early childhood. Module four presents the techniques and tools for the collection and storage of large masses of data and the corresponding exploitation based on data mining and Artificial Intelligence. Particular emphasis is placed on standardised observation and assessment tools such as the Portage Guide. In modules five and six, the topics of language development, cognitive, motor, autonomy, etc. are specifically developed, and the penultimate module presents the latest developments in Artificial Intelligence applied to early intervention. All the modules maintain a similar structure, providing bibliographies, web resources and questions to confirm the understanding of the main ideas expressed in the text, thus making it an excellent tool to support the training and updating of EIC centre technicians.

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PROLOGUE INSTITUTIONAL

The book, in open edition, "Training and specialisation in early intervention: use of technological resources and artificial intelligence", coordinated by the professors of the Faculty of Health Sciences of the University of Burgos María Consuelo Sáiz Manzanares and Montserrat Santamaría Vázquez, constitutes a difficult and relevant challenge of the innovative project co-funded by the European Union "Specialized and updated training on supporting advance technologies for early childhood education and care professionals and graduates" and coordinated by the University of Burgos.

The effective coordination has allowed the collaboration of three universities (University of Burgos, University of Roma Tre and Faculty of Medicine of the University of Rijeka) from three countries (Spain, Italy and Croatia) together with the collaboration of the technological SME Gestionet and the consultancy specialised in Research, Development and Innovation Kveloce for the achievement of innovative results absolutely necessary at a time when technology and artificial intelligence have burst suddenly and continuously to also benefit human behaviour when they are applied in a reflexive way after a rigorous observation.

This is the paradigmatic case of this project.

It represents an important boost in training and specialisation in early care in all its areas - training, research, transfer and services - through the sharing of different experiences and the analysis of the achievements that will ultimately lead to a transfer of knowledge from which society as a whole will benefit.

As Vice Chancellor of the University of Burgos, I would like to express my congratulations and recognition to the coordinators, the participating universities and the authors, whom I encourage to continue working on this project, which will promote cooperation and improvement in our institutions.

Begoña Prieto Moreno

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MODULE I. INTRODUCTION TO THE CONCEPT OF EARLY INTERVENTION AND INTERVENTION IN DIFFERENT CONTEXTS

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I. INTRODUCTION

Child development is a dynamic, complex process, based on biological, psychological and social development. The first years of life are a critical stage, in which perceptual, motor, cognitive, linguistic, affective and social skills are shaped. These skills will enable balanced interaction with the environment (Gómez Artiga y Viguer Seguí, 2007; Grupo de Atención Temprana-GAT, 2005).

Early Care (EC), based on the scientific principles of Paediatrics, Neurology, Psychology, Psychiatry, Pedagogy, Physiotherapy, Linguistics, etc., aims to offer children with deficits or who are at risk a set of optimizing and compensating actions. These actions will facilitate proper maturation in all areas and will allow children to reach the highest level of personal development and social integration. In this sense, Early Intervention is part of a comprehensive process whose objective is the harmonious development of children integrated into their environment. (GAT, 2005; Serra Desfilis, 2007).

We know that the first years of life are crucial for proper biological, psychological and social development (Alonso, 1997; San Salvador, 1998). Hence, the importance of understanding development at this stage, especially when there are signs of congenital, metabolic, maturational or other disorders or possible risk of them. In fact, early care and intervention improves the chances of biopsychosocial development. It is essential to work from a multidisciplinary perspective, with the belief that children with any type of deficit can develop a useful life and integrate into society (Candel, 2005; Pons, 2007; Robles-Bello & Sánchez-Teruel, 2013)

Since TA is based on prevention, we can relate it to primary, secondary and tertiary prevention (which will be analyzed in depth in the following sections):

- **Primary prevention** in EC acts on subjects at "high risk" of suffering from a deficit, even though they have not yet shown symptoms or have not been diagnosed. These &are universal measures, aimed at the entire population to protect health.
- **Secondary prevention**, acts to avoid what may cause the appearance of a disorder or deficit, reducing its progression and duration or mitigating its effects. The ultimate goal is reducing a disease in the population. EC attempts to detect diseases, disorders or risk situations early (Robles-Bello and Sánchez-Teruel, 2013).
- **Tertiary prevention** aims to reduce the incidence of chronic disabilities in a population, trying to minimize disability caused by disease. EC directs its actions to minimize the consequences of a deficit or disease once diagnosed. In addition, it tries to reduce the consequences of children's metabolic, neurological, genetic or developmental disorders or pathologies (Robles-Bello and Sánchez-Teruel, 2013).

Consequently, EC is an effective strategy for preventing or compensating for the effects of any type of deficit (developmental, biological or social) early in a child's life. (Robles-Bello & Sánchez-Teruel, 2013).

II. OBJETIVES

Understand the general characteristics of early care and its application to different fields of action, as well as to different groups.

III. THEME-SPECIFIC CONTENT

1. The concept of early stimulation

According to the White Paper on Early Intervention (Group of Early Intervention-GAT, 2005, p. 14): *Early Attention is understood as the set of interventions aimed at the child population aged 0-6, the family and the environment, which aim to respond as soon as possible to the temporary or permanent needs presented by children with disorders in their development or who are at risk of developing them. These interventions, which must consider the child as a whole, must be planned by a team of professionals with an interdisciplinary or transdisciplinary orientation.* (Robles-Bello & Sánchez-Teruel, 2013).

In the 1990s, the current concept of Early Intervention emerged, agreed by different professionals and reflected in the work of GAT (2005). This work is a reference for all sectors involved in EC: associations, professionals, institutions, researchers and family members, among others (Gómez Artiga & Viguer Seguí, 2007; Robles-Bello & Sánchez-Teruel, 2013).

According to Candel (2005), EC should not be understood as a treatment aimed at children, but as a series of actions aimed at children, the family and the community in general. Given the cerebral plasticity of the nervous system (GAT, 2005), the maturation process of the brain does not end with birth, but continues to develop for a while, and is also susceptible to modification (Gútiez, 2005; Robles-Bello & Sánchez-Teruel, 2013).

1.1. Child development

Child development in early years is characterized by the progressive acquisition of such important functions as postural control, movement autonomy, communication, verbal language, and social interaction. This development is linked to the maturation process of the nervous system, already initiated in utero, and to emotional and mental organization. It requires adequate genetic structure and satisfaction of the basic human needs at a biological and psycho-affective level. (GAT, 2005; Serra Desfilis, 2007).

Child development is the result of the interaction between genetic factors and environmental factors:

- **The genetic base**, specific to each person, establishes their own development capacities and so far, impossible to modify.
- **Environmental factors** modulate and even determine the possibility of expression or latency of some of the genetic characteristics. These factors are *biological, psychological and social*: A) *Biological environmental factors*: maintenance of homeostasis, health status, absence of factors of aggression to the Nervous System (NS)... Necessary conditions for adequate maturation. B) *Environmental factors of a psychological and social order*: children's interaction with their environment, emotional bonds, the perception of everything around them (people, images, sounds, movement...). These conditions, which are basic needs of human beings, are decisive in emotional development, communicative functions, adaptive behaviors and in attitudes towards learning (GAT, 2005; Serra Desfilis, 2007).

In early childhood, the nervous system is in a stage of maturation and notable plasticity. Because it is maturing, there is greater vulnerability to adverse environmental conditions and harms. Therefore, anything affecting the acquisition of the first developmental milestones can endanger subsequent development. However, plasticity also gives the Nervous System greater capacity for recovery and organic and functional reorganization, which decreases in later years (GAT, 2005; Serra Desfilis, 2007).

The progression of children with alterations in their development will depend to a large extent on the date of detection and the point when Early Intervention begins. The shorter the stimulus deprivation time,

the better the brain plasticity and the shorter the delay. In this process, family involvement is crucial for affective and emotional interaction, as well as for effective treatments (GAT, 2005; Serra Desfilis, 2007).

1.2. Developmental disorders

Development is the dynamic process of interaction between the organism and the environment that results in the organic and functional maturation of the nervous system, the development of psychological function and structuring personality. Developmental disorder is a significant deviation from the normal course of development resulting from health or relationship events that compromise biological, psychological or social development. Some developmental delays can be compensated for or neutralized spontaneously, and it is often the intervention that determines the transience of the disorder (GAT, 2005; Serra Desfilis, 2007).

The main risks are biological and social. Children who, during pre, peri or postnatal periods, or during early development, have been subjected to situations that could affect their maturation process, such as prematurity, low birth weight or anoxia at birth, are considered to be at biological risk. Children at *Psychosocial risk* are those who live in unfavorable social conditions, such as lack of care or inadequate interactions with parents and family, mistreatment, neglect, or abuse, which can affect their maturation (GAT, 2005; Serra Desfilis, 2007).

2. Objectives of early stimulation

The main objective of EC is to promote children and their family's development and well-being, enabling their integration into the family, school and social environment, as well as personal autonomy (Candel, 2005). Consequently, it works on areas such as cognitive, autonomy, language or communication, and motor skills (Federación Estatal de Asociaciones de Profesionales de Atención Temprana –FEAPAPT-, 2008; GAT, 2005; Robles-Bello & Sánchez-Teruel, 2013).

Early Attention must reach all children who present any type of disorder or alteration in their development, be it physical, mental or sensory, or who are in a situation of biological or social risk. All actions and interventions in early care must consider not only the child, but also the family and their environment (GAT, 2005; Gómez Artiga & Viguer Seguí, 2007; Serra Desfilis, 2007; Viger Seguí & Gómez Artiga, 2007).

he following set of objectives specific to Early Intervention emerges from this framework: 1. Reduce the effects of a deficiency or deficit on the overall development of the child; 2. Optimize, as much as possible, the course of the child's development; 3. Introduce any required compensation mechanisms, eliminate barriers and adapt to specific needs; 4. Avoid or reduce the appearance of secondary or associated effects or deficits produced by a high-risk disorder or situation; 5. Meet the needs and requirements of the family and the environment the child lives in; 6. Consider the child as an active subject of the intervention (GAT, 2005).

3. Application of early stimulation in interdisciplinary contexts (fields of action)

When planning the intervention, the point in the child's development and their needs must be considered in all areas, not only the deficit or disability that may present. In Early Intervention, the child must be considered as a whole, taking into account intrapersonal, biological, psychosocial and educational aspects specific to each individual, as well as the interpersonal aspects related to their own environment, family, school, culture and social context (GAT, 2005; iger Seguí & Gómez Artiga, 2007).

Consequently, intervention covers a set of actions aimed at the population from 0 to 6 years old, but also at the family and the community. There are numerous scientific disciplines that support the theoretical basis of EC, such as Neurology, Developmental and Learning Psychology, Pediatrics, Psychiatry, Pedagogy, Physiotherapy, Speech Therapy, among others (De Linares & Rodríguez, 2004; Robles-Bello & Sánchez-Teruel, 2013; Viger Seguí & Gómez Artiga, 2007).

The effectiveness of EC programs is based on the earliness of the intervention, which depends on early diagnosis of problems. This diagnosis allows children to start work early, and the earlier, the more effective that work will be, since the ability to assimilate and integrate new experiences is much greater in early stages of development (Pérez-López & Brito, 2004). The disciplines on which EC is based provide children—suffering from deficits or at risk of suffering from deficits—with a set of organized and planned actions that facilitate their maturation in all areas, allowing them to reach the highest level of development and social integration (Quirós, 2009; Robles-Bello & Sánchez-Teruel, 2013).

The main objectives of intervention are: preventive measures, early detection, and intervention focused on maximum development of physical, mental and social faculties in diagnosed children (Robles-Bello & Sánchez-Teruel, 2013).

3.1. Intervention levels

The biopsychosocial model of Early Intervention leads to the need to establish relationships with the programs and services that act in the context of children and their families. There are three levels on which this collaboration should be based (GAT, 2005; Gómez Artiga & Viguer Seguí, 2007): primary, secondary and tertiary prevention in EC.

3.1.1. Primary Prevention in Early Care

Primary prevention in health are the actions and health protection aimed at the well-being of children and their families. They are universal measures for the entire population, including rights such as health care, maternity leave and fostering or adoption. At this level Early Intervention is responsible for identifying and communicating to social institutions, circumstances that may be relevant to creating norms or universal rights in the promotion and protection of child development. A primary prevention measure of Early Intervention is that it is universal, free, and early (GAT, 2005; Gómez Artiga & Viguer Seguí, 2007).

Primary prevention of child development disorders aims to prevent conditions that can lead to deficiencies or disorders in child development. The competent services in these actions are primarily Health, Social Services and Education (GAT, 2005, 2011):

- *Health services are responsible for:* family planning programs, care of pregnant women, maternal and child health, detection of metabolic disorders and vaccinations, information on risk factors and their prevention, primary pediatric care and hospital and healthcare actions in general. Pediatric services in Primary Care—used by the entire child population from birth to 14 or 18 years of age—are important in the prevention of developmental disorders. Child Mental Health services are important in primary prevention, collaborating with health and family planning teams in maternal and child programs, to avoid high-risk situations. (GAT, 2005; Gómez Artiga & Viguer Seguí, 2007; Serra Desfilis, 2007; Viger Seguí & Gómez Artiga, 2007).
- *Social services are responsible for:* interventions aimed at preventing situations of social risk and child abuse. Social Services activity is part of the task of caring for the family. Social Services also intervene in the prevention of child developmental disorders, through programs aimed at high-risk groups due to social conditions, such as teenage mothers, or migrant populations, etc. (GAT, 2005; Gómez Artiga & Viguer Seguí, 2007; Serra Desfilis, 2007; Viger Seguí & Gómez Artiga, 2007).
- *Educational services are responsible for:* actions to support the child and the family from Infant schools. These schools do essential work in the prevention of developmental disorders for high-risk populations. They offer a stable and stimulating environment to a sector of the child population that often suffers from adverse conditions in the family (GAT, 2005; Gómez Artiga & Viguer Seguí, 2007; Serra Desfilis, 2007; Viger Seguí & Gómez Artiga, 2007).

3.1.2. Secondary Prevention in Early Care

Secondary prevention in health is based on the early detection of diseases, disorders, or high-risk situations. It is implemented through special programs aimed at groups identified as being at risk, such as

premature infants born at less than 32 weeks or less than 1,500 grams; family units with adolescent pregnancies under 18 years of age, at risk of relational dysfunction; family units with pregnancies from the age of 35, with risk of chromosomal abnormalities; children with spastic tetraplegia and risk of hip dislocation (GAT, 2005; Gómez Artiga & Viguer Seguí, 2007).

3.1.2.1. Detection

Detecting possible alterations in child development is a fundamental aspect of Early Intervention insofar as it enables community action mechanisms to be implemented. The sooner detection is achieved, the greater the assurance of preventing additional pathologies, achieving functional improvements, and enabling more adaptive adjustment for children and their environment (GAT, 2005; Serra Desfilis, 2007).

Early detection of disorders in child development is essential for diagnosis and therapeutic care. Early detection is essential to influence a stage in which the plasticity of the nervous system is at its heigh, and the therapeutic possibilities demonstrate greatest efficacy. Children's developmental disorders need to be detected at the point the first telltale signs appear (GAT, 2005; Gómez Artiga & Viguer Seguí, 2007; Serra Desfilis, 2007).

In the detection of developmental disorders or risk situations we can consider various stages and agents (GAT, 2005):

a) **Prenatal Stage Obstetrics Services.** Secondary prevention of child development disorders should start in Obstetrics services, with care for pregnant women by health professionals (obstetricians and midwives). These professionals are responsible for detecting risk situations and providing information, support, and guidance for mothers-to-be (GAT, 2005; Gómez Artiga GAT, 2005 Viguer Seguí, 2007; Serra Desfilis, 2007).

b) **Perinatal stage Neonatology Services.** Children at high risk of presenting deficiencies, disorders or alterations in development due to certain genetic conditions and adverse situations in the biological or organic sphere receive care in Neonatology units or services: intrauterine infections, low weight, hypoxia, cerebral hemorrhages, postnatal infections. When there are signs compatible with a developmental disorder, appropriate therapeutic measures are put in place, always tailored to the child's situation (GAT, 2005; Gómez Artiga GAT, 2005 Viguer Seguí, 2007; Serra Desfilis, 2007).

c) **Postnatal stage Pediatric Services.** The pediatric team is the main agent of early detection through regular visits to the child in the first years of life and healthy child control programs. Direct observation of children and information provided by parents allows confirmation of normal child development or suspected deviation from it. This level of detection is essential, since children with serious developmental problems often have a history of pre- or perinatal pathology and there are often specific follow-up programs that they should attend. Detection in these cases should be within the framework of regular pediatric consultation (GAT, 2005; Gómez Artiga & Viguer Seguí, 2007; Serra Desfilis, 2007; Saiz Manzanares & Escolar-Llamazares, 2013; Saiz Manzanares et al., 2019; Sarriá Sanchez, 2010).

d) **Educational services.** Nursery school, teachers and educators are important agents of detection. At this stage, problems can be seen in the basic abilities and behaviors for learning: motor skills, socialization, language, attentional and perceptive difficulties and cognitive or emotional limitations, which have not been detected previously. The conditions of the Nursery School and the interactions that occur in the school context, differ from those in the family environment, and reveal the presence of deviations in the developmental process, imbalances in children's psycho-affective development or alterations in behavior. These deviations can easily go unnoticed by parents and by health personnel and may not detected until the child accesses the educational context (GAT, 2005; Gómez Artiga GAT, 2005 Viguer Seguí, 2007; Serra Desfilis, 2007).

   When teachers detect a possible disorder, they communicate their concern to the family. Based on the data provided by the school and family environment, coordinated observation and *action*

guidelines should be established, along with referral to a pediatrician and the Early Care Center. The goal is to establish a complete diagnosis and initiate appropriate therapeutic intervention (GAT, 2005; Sarriá Sánchez & Brioso Díez, 2010; Saiz Manzanares & Escolar-Llamazares, 2013; Saiz Manzanares et al., 2019; Sarriá Sanchez, 2010).

e) **The family environment.** The family environment is an important means of detection, since it is often the parents, in daily interaction in their natural context, who notice deviations between their child's and other children's behavior. Greater care and information for parents would facilitate early detection of developmental disorders (GAT, 2005; Gómez Artiga & Viguer Seguí, 2007; Serra Desfilis, 2007).

f) **Social Services.** Due to their relationship with families with psycho-social problems and with the community in general, they are in a very good position to detect social risk factors in child development, such as situations of very low family income, teenage mothers, drug addiction, social marginalization of the family etc. (GAT, 2005).

3.1.2.2. Diagnosis

Diagnosis consists of finding evidence of an alteration in development, as well as the knowledge of its causes, allowing the beginning of appropriate therapeutic intervention. Given the suspicion of a disorder in child development, it is essential to propose a broad diagnosis, which considers different areas and levels. The problem in most cases is not confined to a single aspect. It usually affects different areas and has a multifactorial origin: interaction of genetic factors, health aspects, psycho-affective care and environmental conditions in general (GAT, 2005; Viger Seguí & Gómez Artiga, 2007).

Diagnosis in Early Intervention must address the biological, psychological, social and educational fields, requiring collaboration of professionals from various disciplines: medicine, psychology, pedagogy and social sciences.

Diagnosis of developmental disorders considers three diagnostic levels: functional, syndromic and etiological:

1. *Functional diagnosis.* Qualitatively and quantitatively determine disorders or dysfunctions. It constitutes the basic information for understanding the child's problems, considering family interaction and that of their cultural environment, their capacities and the possibility of developing them. A functional diagnosis is essential for producing intervention objectives and strategies.
2. *Syndromic diagnosis.* This is a set of signs and symptoms that define a certain pathological entity. The identification of a syndrome allows us to determine the structures (neurological, psychic or social) responsible for the disorder and provides guidance on its etiology. Syndromic diagnosis guides us towards the areas where we need more nformation to establish the etiological diagnosis. It also helps to establish whether it is a stable, transitory or evolutionary pathology, with a predominantly organic or environmental basis.
3. *Etiological diagnosis* reports on the causes—of a biological or psycho-social nature—of the functional disorders or of the identified syndrome (GAT, 2005; Viger Seguí and Gómez Artiga, 2007).

In all cases, an attempt is made to establish the etiology of the different disorders identified, always considering their probable multifactorial nature. It is a broad approach that considers biological, psychological, educational and environmental aspects in general (GAT, 2005).

One important issue in Early Intervention is the communication of diagnostic information to parents in a risk situation, or in the probable presence of a developmental disorder in their child. This information produces an emotional shock in the parents, with anxiety and anguish, fear, feelings of rejection, and denial. It can often start family arguments. Care is needed throughout this process of giving information and how it is done. Good information makes it easier for the family to understand and assimilate the reality of their child and to adapt their environment to the child's needs (GAT, 2005; iger Seguí & Gómez Artiga, 2007).

The information about the diagnosis of a disorder should always be accompanied by information for the family about therapeutic, social, educational, and economic resources, among other things. Similarly, it is important that parents know how to access resources, as well as the existence of support groups. It is vital to ensure coordination between professionals and institutions and offer support throughout the referral process (GAT, 2005; Serra Desfilis, 2007; Viger Seguí and Gómez Artiga, 2007).

3.1.3. Tertiary Prevention

Tertiary prevention in health, corresponds to actions aimed at remedying situations of biopsychosocial crisis. Examples are the birth of a child with a disability or the appearance of a developmental disorder. EC is responsible for activating a reorganization process, working with children, families, and the environment in which they live. The complexity of these situations requires the intervention of a multidisciplinary team (GAT, 2005; Gómez Artiga & Viguer Seguí, 2007).

Tertiary prevention in Early Intervention groups all the activities directed towards children and their environment to improve their developmental conditions. It addresses children, their families, and their environment. It aims to mitigate or overcome developmental disorders or dysfunctions, prevent secondary disorders, and modify risk factors in the child's immediate environment (GAT, 2005; Serra Desfilis, 2007; Viger Seguí & Gómez Artiga, 2007.)

Another fundamental objective of intervention is to ensure that the family knows and understands their child's reality, their abilities, and their limitations. In this way, families can act as agents who improve children's development, modifying their environment to their physical, mental, and social needs, ensuring their well-being, and facilitating their social integration. Intervention needs global, interdisciplinary planning, considering children's abilities and difficulties in the different areas of development and their history and developmental processes. It must also consider the possibilities and needs of the other family members along with the resources available and knowledge and action in the social environment (GAT, 2005; Serra Desfilis, 2007; Viger Seguí & Gómez Artiga, 2007).

3.2. Main areas of action

3.2.1. Child Development and Early Care Centers (CDIAT)

CDIATs are autonomous services whose objective is to care for children aged 0-6 who have or are at risk of developmental disorde. Its main objective is to provide the care required by all children who present disorders or dysfunctions in their development, or who are in a situation of biological, psychological, or social risk. The CDIAT model mainly covers the care of children with various pathologies or dysfunctions in their development (GAT, 2005; Gómez Artiga & Viguer Seguí, 2007).

The CDIAT team will be multi-professional, interdisciplinary and holistically oriented, considering that interventions cover *intrapersonal*, biological, psychological, social, and educational aspects that are specific to each individual, along with *interpersonal aspects* related to their own environment, such as family, school and culture. The team will be made up of specialists in Early Intervention from the medical, psychological, educational, and social fields (GAT, 2005; Gómez Artiga & Viguer Seguí, 2007; Viger Seguí & Gómez Artiga, 2007).

3.2.1.1. Primary and Secondary Prevention

The functions of a CDIAT include awareness, prevention, and detection. The Early Intervention Center will collaborate with institutions, patient groups and other professionals in the development of awareness programs for the general population in prevention aspects related to child development (GAT, 2005; Gómez Artiga & Viguer Seguí, 2007; Viger Seguí & Gómez Artiga, 2007).

3.2.1.2. Tertiary Prevention

Interventions will be planned and programmed individually, considering the needs and possibilities of each child in each area of development, the situation, and the possibilities of their family and those of the

school environment. The program must include the timing of the objectives, the methodological modality and the evaluation of the proposed objectives or the result of the application of the program. Intervention at the Early Intervention Center begins when a request is received from the family or from any other professional or institution. This intervention consists of different moments: initial assessment, therapeutic intervention, follow-up and control, and referral (GAT, 2005; Gómez Artiga Viguer Seguí, 2007; Viger Seguí & Gómez Artiga, 2007):

A. ***Initial Assessment Process***. This involves a comprehensive, in-depth study of the child's development, their individual and family history, and their environment. This requires the collaboration of professionals from different disciplines, as well as the collaboration and coordination of the institutions that originated the case. There are four steps in the initial assessment: 1) Collection of information, 2) Evaluation of the child and their environment, 3) Create diagnostic hypotheses and intervention plan and 4) Return interview with the family (GAT, 2005; Gómez Artiga & Viguer Seguí, 2007; Viger Seguí & Gómez Artiga, 2007).

A.1. Information collection. Proper collection of information is the most important element of the diagnostic process and is the instrument that guides the subsequent steps in the evaluation process. Information is gathered through reception, **systematic collection of information,** and the contributions of other professionals (Saiz Manzanares, & Escolar-Llamazares, 2013; Saiz Manzanares et al., 2019; Sarriá Sanchez, 2010).

A.1.1. *Reception* is the first contact with the family, in which the professional listens to and collects parents' concerns, memories, projects, expectations, and difficulties about their child. This welcome interview, in addition to being an important initial assessment tool, establishes the first guidelines for the design of the intervention (GAT, 2005; Gómez Artiga & Viguer Seguí, 2007; Serra Desfilis, 2007; Viger Seguí & Gómez Artiga, 2007).

A.1.2. *Systematic collection of information.* Based on the information from the reception interview, this is the collection of data that the family has not spontaneously provided, but which necessary for proper understanding of the child's development and point in their development, as well as possible causes of the alteration (GAT, 2005; Saiz Manzanares & Escolar-Llamazares, 2013; Saiz Manzanares et al., 2019; Sarriá Sanchez, 2010).

A.1.3. *Information from other professionals.* Information is obtained from other professionals—such as pediatricians, school psychologists, educators, social workers, etc.—through written reports or interviews. The data will be organized into a common history (GAT, 2005; Gómez Artiga & Viguer Seguí, 2007; Serra Desfilis, 2007; Viger Seguí & Gómez Artiga, 2007).

A.2. Assessment of the child and their environment. There are various instruments for assessing children and their environments which are used differently for each child, based on the initial hypotheses based on their history: – **Observation of spontaneous and reactive behavior** to certain presented situations and stimuli; - Relationship with parents and the professional performing the evaluation; – Relationship with other children and with the educator when the child is in school; – Physical examination and neurological and functional assessment of the child; – Standardized tests; – **Observation at home**; – Complementary exams, specialized consultations. These techniques provide information on the child's general and specific functioning at a physical and emotional level. This information will indicate the possible limitations and deficits presented by the child, along with their abilities and potential (GAT, 2005; Gómez Artiga and Viguer Seguí, 2007; Saiz Manzanares and Escolar-Llamazares, 2013; Saiz Manzanares et al., 2019; Sarria Sanchez, 2010).

A.3. Development of diagnostic hypotheses and intervention plan. Once the information collection stage has concluded, each professional will provide the data and conclusions from their evaluations in order to jointly establish—taking into account all the bio-psycho-social factors—diagnoses or diagnostic hypotheses on three levels: functional, syndromic and etiological. The needs of the child and the family, and existing resources in the community will be established. It is important to establish action priorities, and possible short-, medium- and long-term forecasts. The objectives of the therapeutic intervention will be specified, prioritized, and timed, determining the professional

or professionals who will be responsible for each part (GAT, 2005; Gómez Artiga & Viguer Seguí, 2007; Serra Desfilis, 2007; Viger Seguí & Gómez Artiga, 2007).

A.4. Return interview. In the return interview we offer the parents the diagnostic information prepared by the team, using appropriate language they can understand. This information should allow them to understand their child's situation, possible future prospects, and the therapeutic means the center can provide (GAT, 2005; Gómez Artiga & Viguer Seguí, 2007; Serra Desfilis, 2007; Viger Seguí & Gómez Artiga, 2007).

B. *Therapeutic Intervention.* The intervention groups together all the activities aimed at the child and their environment to improve their development conditions. Action areas and the type of intervention will be established based on the child's age, characteristics and needs, the type and degree of disorder, the family, the team itself and possible collaboration with other community resources. The intervention will be planned and programmed globally and individually, with specific guidelines tailored to each child's needs and those of each family in each of the areas of development. The program must include timescales of the objectives, as well as evaluation and how to achieve them (GAT, 2005; Gómez Artiga & Viguer Seguí, 2007; Serra Desfilis, 2007; Viger Seguí & Gómez Artiga, 2007).

C. *Evaluation and Monitoring*. The evaluation must cover all aspects of the intervention and can be considered in two phases: a) Continuous evaluation, which will allow the program to be adjusted to needs and modified as required; b) Final evaluation, which determines if the objectives set at the beginning of the intervention have been met and that serves to specify whether it is considered complete or if a referral has to be made (GAT, 2005; Gómez Artiga & Viguer Seguí, 2007; Serra Desfilis, 2007; Viger Seguí & Gómez Artiga, 2007).

D. *Derivation.* The care period of a child in an Early Intervention service ends when they no longer need this Service or, for reasons of age or skills, must continue with care from another source. In both cases, the family has the right to receive information orally and a written report summarizing the child's progress and current situation, as well as the needs that are considered accurate (GAT, 2005; Gómez Artiga & Viguer Seguí, 2007; Serra Desfilis, 2007; Viger Seguí & Gómez Artiga, 2007).

3.2.2. Health Services

a) **Obstetric Services.** The preventive work of these professionals, basically in primary prevention, is through: Detection and diagnosis of risk factors prior to pregnancy; Care for pregnant women at high biological, psychological or social risk; Childbirth preparation consultations where the future parents are given information about the normal development of the child, as well as about possible warning signs; Detection of possible situations of risk in childbirth and appropriate care; In the case of prenatal diagnosis of deficiency, parents—especially mothers—need preventive psychological care from the beginning, due to potential effects on the mother-child bond (GAT, 2005; Serra Desfilis, 2007; Viger Seguí & Gómez Artiga, 2007).

b) **Neonatology Services.** In the perinatal environment, we often find children at high risk of presenting deficiencies, based on their immaturity, low birth weight or other hereditary or pre-perinatal factors. Between 10 and 12% of newborns go through a "neo-natal care unit", and between 3% and 5% of newborns are considered to be at psycho-neurosensorial risk. This reality makes Neonatology services an important tool for primary prevention. They also do important secondary prevention work by detecting and diagnosing pathological conditions, already established at birth, that are associated with developmental disorders (GAT, 2005; Serra Desfilis, 2007; Viger Seguí & Gómez Artiga, 2007).

c) **Pediatrics in Primary Care.** These are healthcare professionals who have regular contact with children and their families and are a point of reference for parents. Pediatricians are essential in order to properly detect and refer children for diagnosis, follow-up and to intervention centers. Primary prevention in Pediatrics is through the health controls of the healthy child program. *Detection* is child health examinations, applying objective screening methods and **observation methods** to de-

tect warning signs of developmental disorders. **Observation data offered by the family** should be assessed and given particular importance (GAT, 2005; Serra Desfilis, 2007; Saiz Manzanares & Escolar-Llamazares, 2013; Saiz Manzanares et al., 2019; Sarriá Sanchez, 2010).

d) **Neuropediatric Services.** Neuropadiatrics services intervene in Early Care in various areas: • They act together with Neonatal Unit professionals in terms of detection, diagnosis and therapeutic care required by at-risk newborns; • They participate in development monitoring programs as part of the team caring for children considered to be at high bio-psycho-social risk; • They detect warning signs and diagnose neurological disorders; Neuropediatricians establish functional, syndromic and etiological diagnoses of children with disorders in their development and specifically in organic-based processes (GAT, 2005; Gómez Artiga & Viguer Seguí, 2007; Serra Desfilis, 2007).

e) **Children's Rehabilitation Services.** Rehabilitation services in Spain have been linked to three types of experiences: 1. Hospital experience, predominated by physical therapeutic actions and treatment of "acute pathologies"; 2. Experience from social services, through personalized programs to respond to the needs of social integration and autonomy of people with disabilities (network of INSERSO Base Centers); 3. Experience from the patient-support-group movement that produced specialized centers for comprehensive, intensive treatment for certain pathologies. For children aged 0 to 6, the teams at the base centers have been a very important part of promoting the Early Stimulation and Early Care programs. Specific patient-support-group centers have often taken the place of centers for the care of children with disabilities, especially from early childhood (GAT, 2005; Serra Desfilis, 2007).

f) **Mental Health Services.** Professionals in Child Mental Health units are involved at all levels of Early Care. General primary prevention measures from Child Mental Health include: • Coordination and development of programs with other health, educational, social and judicial services; • Collaboration in preventive programs for the detection of psychological risk factors; • Participation in training and coordination programs with other primary care professionals.

Therapeutic intervention in child Mental Health units covers various basic modes of action: • Direct intervention with children individually or in small groups, in cases of severe early psychopathology, basically psychosis, autism, developmental disharmonies... ;• Family interventions in order to make it easier for them to understand children's disorders, difficulties and the importance of adapting the family environment to their needs; • Coordination activities with other related services and professionals (GAT, 2005; Gómez Artiga & Viguer Seguí, 2007; Serra Desfilis, 2007; Viger Seguí & Gómez Artiga, 2007).

3.2.3. Social services

Considering the importance of the social context and the surrounding conditions in the existence of a deficit in development or in the risk that it may occur, social services have a role and a responsibility both in prevention programs and in detection, diagnosis, and intervention. Social services and their professionals intervene at all levels of primary care. Their action in Early Care is vitally important and is carried out through the promotion of families' social welfare and through prevention and intervention programs (GAT, 2005; Gómez Artiga & Viguer Seguí, 2007).

a) **Promotion of the social welfare of families.** Early Intervention has contributed to recognizing how important factors such as the following are for child development: affective dedication; economic sufficiency; job stability; stability of family relationships; participation in social networks; and consistency of educational styles. The protection of the first relationships between parents and children must be a social priority. This means a need for more thorough measures that, based on respect for cultural diversity, encourage, train, and help parents in what they do and allow them to balance work and family life (GAT, 2005; Gómez Artiga & Viguer Seguí, 2007; Serra Desfilis, 2007; Viger Seguí & Gómez Artiga, 2007).

b) **Prevention programs.** Primary prevention can be carried out through interventions (individual or group support) aimed at contexts previously defined as "with social difficulty/risk" as well as through community projects aimed at promoting well-being and comprehensive health in early childhood. Based on social risk indicators, secondary prevention programs aim to detect family situations and

environmental and social factors that may influence the appearance of disorders in children's development or put it in at risk (GAT, 2005; Gómez Artiga & Viguer Seguí, 2007).

c) c). **Early intervention programs in the psychosocial field.** The objectives of these programs are: a. the reconstruction and reorganization of the family of origin; b. the protection and accompaniment of transits when there is a dissolution of family ties or the constitution of new ones; c. family reintegration, foster care or adoption; d. protection and accompaniment of institutionalized children without other options or family references; and e. Early treatment of any developmental disorder that can be detected (GAT, 2005; Gómez Artiga & Viguer Seguí, 2007).

3.2.4. Educational services

School is an important milestone in the process of children's integration and socialization, very significantly in those with developmental problems. Early childhood education is particularly important since the first years of life are key to children's harmonious physical and psychological development, as well as for the formation of their intellectual faculties and development of their personality. Education at these ages has a marked preventive and compensatory character, due to the importance of early intervention in avoiding problems in development both in the general population and especially in children who have special educational needs. Early childhood education establishes a series of general objectives in order for children to develop skills such as: knowing their own body, relating to others through different forms of expression and communication, acquiring a certain autonomy in their usual activities, and observing and exploring their environment, family, and social surroundings (GAT, 2005; Gómez Artiga & Viguer Seguí, 2007; Serra Desfilis, 2007; Viger Seguí & Gómez Artiga, 2007).

a) **Primary prevention.** It is important to highlight educational character as a mediator and facilitator of subsequent learning during this school period. Early childhood education should contribute to children's emotional, physical, social, and moral development (GAT, 2005; Gómez Artiga & Viguer Seguí, 2007; Serra Desfilis, 2007; Viger Seguí & Gómez Artiga, 2007).

b) **Secondary Prevention.** The detection of children's possible special educational needs while they are infants is one of classroom-teachers' functions, in collaboration with psychopedagogical teams. These teams will be in charge of assessing children's needs, as well as issues related to their schooling, curricular adaptations, and any technical aids they may need (GAT, 2005; Serra Desfilis, 2007; Viger Seguí & Gómez Artiga, 2007).

c) **Tertiary Prevention.** Within this stage of early childhood education, schooling for students with special educational needs should begin in a context that is as normal as possible in order to support and encourage development and the learning process. This means that, in practice, these students should be in ordinary schools. This means the curriculum being adapted to the needs of each student, leaving schooling in special education units or centers for situations where students need significant or extreme adaptations to the ordinary curriculum, as well as personal and material measures that are not common in ordinary schools (GAT, 2005; Serra Desfilis, 2007; Viger Seguí & Gómez Artiga, 2007).

4. Target group of early child care

EC is aimed at all children between zero and six years of age who show some type of deficiency and includes those children with at high biological, psychological, or social risk that may affect their development (Gútiez, 2005; Robles-Bello & Sánchez-Teruel, 2013).

The first group (*biological risk*) refers to children who suffer from documented alterations or disabilities (disorders in motor, cognitive, language, sensory, generalized development, behavioral, emotional, somatic expression, evolutionary disorders, etc.) The second group (*psychological risk*) refers to children who, during their pre, peri or postnatal period or during early development, have been subjected to situations that could alter their maturational process, such as prematurity, low weight, or anoxia at birth (GAT, 2005; Robles-Bello & Sánchez-Teruel, 2013).

Finally, children at *psychosocial risk* are those who live in unfavorable social conditions, such as lack of care, inadequate interactions with their parents and family, mistreatment, neglect, or abuse, which can alter their maturation process (GAT, 2011; Pineapple, 2007). Sometimes, these children's parents may exhibit attitudes that EC programs are responsible for reducing or modifying behaviors such as anxiety or lack of skills to take on responsibilities and meet their children's special needs. And so, we try to improve the development of the infant or, at least, ensure that there is no negative influence on their development (GAT, 2005; Gómez Artiga & Viguer Seguí, 2007; Robles-Bello & Sánchez-Teruel, 2013).

Currently, there are specific, agreed-upon, common diagnostic criteria within EC which allow epidemiological studies to be performed, research to be designed, preventive measures to be taken, forms of action to be contracted, and a common language to be established among the professionals involved in EC from the different disciplines. This is the Diagnostic Organization for Early Care (ODAT) (FEAPAT, 2004, 2008) which, based on previous international classifications, allows us to identify not only developmental disorders or difficulties, but also the etiological factors that cause them. whether biological, psychological and/or social (GAT, 2005; Robles-Bello & Sánchez-Teruel, 2013).

This classification system is organized into a series of axes that have been modeled to contain the lists of different aspects of a biological, psychological, and social nature, and also includes the continuum represented by detection, diagnosis and treatment.

The structure has three levels:

The first level describes the risk factors for developmental disorders in the different contexts, the child, the family, and the environment. It includes:

1. Biological risk factors.
2. Family risk factors.
3. Environmental risk factors.

The second level describes the type of disorders or dysfunctions that can be diagnosed in the child in interactions with the family and with the characteristics of the environment. It includes:

1. Developmental disorders.
2. Family.
3. Environment.

The third level includes the resources distributed in three axes referring to the child, the family and the environment. Treatment is carried out in Child Development and Early Care Centers, which in Andalusia are called Early Child Care Centers, which respond to this community need for a resource that promotes activities related to upbringing, education and socialization in all levels of prevention, although each service or sector will participate to varying levels and with varying responsibilities (Robles-Bello & Sánchez-Teruel, 2013; Serra Desfilis, 2007; Viger Seguí & Gómez Artiga, 2007).

1. Table 1
EARLY BIOLOGICAL RISK FACTORS

A. NEWBORN AT NEUROLOGICAL RISK	
✓ NB. with weight <P10 for gestational age or with weight < 1500grs or gestational age < 32 weeks (*). ✓ APGAR < 3 at 1 minute or < 7 at 5 minutes ✓ NB on mechanical ventilation for more than 24 hours ✓ Hyperbilirubinaemia leading to exchange transfusion ✓ Neonatal convulsions ✓ Sepsis, meningitis or neonatal encephalitis ✓ persistent neurological dysfunction (more than seven days)	✓ Brain damage as evidenced by ECHO or CT scan ✓ Central Nervous System deformations ✓ Neuro-metabolapathies ✓ chromosomopathies and other dysmorphic syndromes ✓ Brain damage as evidenced by ECHO or CT scan ✓ Central Nervous System deformations ✓ Neuro-metabolapathies ✓ Chromosomopathies and other dysmorphic syndromes ✓ Daughter of a mother with mental pathology and/or infections and/or drugs that may affect the foetus. ✓ NB with sibling with unclear neurological pathology or at risk of recurrence ✓ Twin, if the sibling is at neurological risk. ✓ Whenever the paediatrician considers it appropriate.

B. NEWBORN AT SENSORY-VISUAL RISK	
✓ Prolonged mechanical ventilation	✓ Cranial pathology detected by ECHO/CT scan
✓ Severe prematurity	✓ Malformative syndrome with visual compromise
✓ NB weighing < 1500 grams	✓ Postnatal Central Nervous System infections
✓ Hydrocephalus	✓ Severe asphyxia
✓ Congenital Central Nervous System Infections	
C. NeWBORN AT SENSORY RISK - AUDITORY	
✓ Hyperbilirubinaemia necessitating exchange transfusion	✓ Malformation syndromes with hearing impairment
✓ Severe prematurity	✓ Family history of hearing loss
✓ NB weighing < 1500 grams	✓ Postnatal Central Nervous System infections
✓ Congenital infections of the Central Nervous System	✓ Severe asphyxia
✓ Ingestion of aminoglycosides for a prolonged period or with elevated plasma levels during pregnancy	

Source: Robles-Bello and Sánchez-Teruel (2013)

Table 2
SOCIO-FAMILIAL RISK FACTORS

✓ Economic deprivation	✓ Prostitution
✓ Traumatic accidental pregnancy	✓ Delinquency/Incarceration
✓ Conflictual cohabitation in the family nucleus	✓ Teenage mothers
✓ Traumatic separation in the family nucleus	✓ Suspected abuse
✓ Parents with low IQ/unstimulating environment	✓ Children in children's homes
✓ Serious illness	✓ Families who repeatedly fail to complete health checks
✓ Alcoholism/Drug addiction	✓ Prostitution

Source: Robles-Bello and Sánchez-Teruel (2013)

5. Conclusions

There has been great progress made in the development of programs aimed at children, parents, and the community in matters of prevention, detection, treatment and information on EC. This progress is especially thanks to the parent groups for affected children and professionals from various fields who took care to investigate and get involved in the progress of these actions (Robles-Bello & Sánchez-Teruel, 2013; Serra Desfilis, 2007; Viger Seguí & Gómez Artiga, 2007).

According to the White Paper on Early Intervention (GAT, 2000, 2005, 2011), in its different editions, research is a necessity for the development of intervention programs. Research in the field of psychology of early childhood care will serve to increase knowledge about the characteristics of different disabilities and developmental disorders, their repercussions on family dynamics, and sources of stress, as well as to evaluate what intervention modalities are most effective. However, research in this clinical area of intervention in childhood is still to be done in Spain. For a long time, EC research has focused almost exclusively on demonstrating the efficacy of any intervention versus no intervention. Currently, there is a need to demonstrate which specific intervention approaches are most effective, which particular aspects of each form of intervention lead to better outcomes for children, which program features are most effective, and what child and family characteristics contribute to the best results (Robles-Bello & Sánchez-Teruel, 2013; Serra Desfilis, 2007; Viger Seguí & Gómez Artiga, 2007).

In this regard, it is essential to have interdisciplinary research that allows medium and long-term follow-up of children's development, the results of which are communicated to the services and intervention programs that initially meet the needs of children and their families in order to be able to assess the real impact of these resources and to promote improvements in the quality of all services (Robles-Bello & Sánchez-Teruel, 2013; Serra Desfilis, 2007; Viger Seguí & Gómez Artiga, 2007).

Evaluation of EC intervention programs has two objectives: understanding, on the one hand, children's capacities, and abilities and, on the other, how families live and organize themselves. With this knowledge, it will be possible to provide the most appropriate individual treatment program for each child within a family (Meisels & Shonkoff, 2000; Robles-Bello & Sánchez-Teruel, 2011, 2013).

Evaluations of EC programs in Spain have sought to determine how EC works in terms of the number of early care child development centers, working professionals, children served, form of referral and type of subsidy. They have not really proven the effectiveness of attending an EC program. Therefore, it would be extremely meaningful to understand how effective they are based on progress made in the development of children who are undergoing surgery (GAT, 2011; Robles-Bello & Sánchez-Teruel, 2013).

Similarly, there still needs to be better coordination between the different agents involved in EC treatmentEC, and better coordination between the different administrations involved (Robles-Bello & Sánchez-Teruel, 2013).

Resume

Early Attention (EA) aims to offer children with deficits or at risk of suffering from them a set of optimizing and compensatory actions that facilitate their proper maturation in all areas and that allows them to reach the highest level of personal development and of social integration (GAT, 2005; Serra Desfilis, 2007).

Child development in the early years is characterized by the progressive acquisition of functions as important as postural control, movement autonomy, communication, verbal language, and social interaction. This evolution is linked to the maturation process of the nervous system and to the emotional and mental organization. It requires an adequate genetic structure and the satisfaction of the basic requirements for the human being at a biological and psycho-affective level (GAT, 2005; Serra Desfilis, 2007). Development is the dynamic process of interaction between the organism and the environment that results in the organic and functional maturation of the nervous system, the development of mental functions, and the structuring of the personality.

A developmental disorder is considered a significant deviation from the course of development, because of health or relationship events that compromise biological, psychological, and social evolution. Some developmental delays can be spontaneously compensated or neutralized, often being the intervention that determines the transience of the disorder (GAT, 2005; Serra Desfilis, 2007).

The main objective of EA is to promote the development and well-being of the child and his family, enabling his integration into the family, school, and social environment, as well as his personal autonomy (Candel, 2005). Consequently, areas such as cognitive, autonomy, language or communication, and motor skills are worked on, in addition to advising, guiding, and intervening individually and/or in groups for families who have a child with a disability or at risk of suffering from it (State Federation of Associations of Early Care Professionals -FEAPAPT-, 2008; GAT, 2005; Robles-Bello and Sánchez-Teruel, 2013).

When planning the intervention, the evolutionary moment and the needs of the child must be considered in all areas and not only the deficit or disability that they may present. In Early Care, the child must be considered as a whole, considering the intrapersonal, biological, psychosocial and educational aspects, specific to each individual, and the interpersonal, related to their own environment, family, school, culture and social context (GAT, 2005; Viger Seguí and Gómez Artiga, 2007).

Consequently, a set of actions aimed at the population from 0 to 6 years of age, but also at the family and the community are contemplated. There are numerous scientific disciplines that support the theoretical basis of AT, such as Neurology, Developmental and Learning Psychology, Pediatrics, Psychiatry, Pedagogy, Physiotherapy, Speech Therapy, etc. (De Linares and Rodríguez, 2004; Robles-Bello and Sánchez-Teruel, 2013; Viger Seguí & Gómez Artiga, 2007).

Given that TA is largely based on prevention, we can relate it to primary, secondary, and tertiary prevention: - Primary prevention in TA acts on subjects at “high risk” of suffering from a deficiency, even if they have not yet shown symptoms or have not been diagnosed. These are universal measures, aimed at the entire population and with the intention of protecting health. - Secondary prevention acts to avoid what may lead to the appearance of a disorder or deficit, reducing its evolution and duration or mitigating its effects, all with the goal of reducing a disease in the population. In EA, an attempt is made to detect diseases, disorders, or risk situations early (Robles-Bello & Sánchez-Teruel, 2013). - Tertiary prevention aims to reduce the incidence of chronic disabilities in a population, trying to minimize the disability caused by a

disease. In TA, he directs his actions to minimize the consequences and sequelae of a deficit or disease, once diagnosed. An attempt is made to alleviate the consequences derived from metabolic, neurological, genetic or evolutionary disorders or pathologies of the child (Robles-Bello and Sánchez-Teruel, 2013).

The main areas of action are the Child Development and Early Care Centers (CDIAT), Health Services, Social Services and Educational Services.

The great progress produced in the development of programs aimed at both children, parents, and the community in matters of prevention, detection, treatment or information on EA should be noted. (Robles-Bello and Sánchez-Teruel, 2013; Serra Desfilis, 2007; Viger Seguí and Gómez Artiga, 2007). However, it is important to point out the importance of interdisciplinary research that allows for medium- and long-term follow-up of the child's development, the results of which are known by the services and intervention programs that initially met the needs of the child and/or their family in order to assess the real repercussions of these resources, as well as to promote improvements in the quality of all services (Robles-Bello and Sánchez-Teruel, 2013; Serra Desfilis, 2007; Viger Seguí and Gómez Artiga, 2007).

Glossary

Primary prevention: They are the set of health activities aimed mainly at the general population, aimed at preventing the onset or appearance of a disease. Its objective is to reduce the incidence of the disease.

Secondary prevention: It consists of detecting and applying treatment to diseases in very early stages. The intervention takes place at the beginning of the disease, its main objective being to prevent or delay its development.

Tertiary prevention: Seeks to reduce the degree of disability, sequelae, and premature death, in the event that recovery from the state prior to the disease has not been achieved.

Genetic Basis: Genetics is the study of heredity, the process in which a parent passes certain genes to his offspring.

Environmental factors: Each one of the elements of the environment that act directly on the living being (or at least on a phase of its life cycle). Environment is synonymous with natural surroundings but not with environment.

Biological risk: Possible exposure to microorganisms that may cause disease.

Risk of a social nature: Social risk is understood as the possibility that a person suffers damage that originates from a social cause. This means that the social risk depends on the conditions of the environment that surrounds the individual.

Direct observation: Systematic, valid, and reliable record of behaviors or overt behaviors. Through this technique the researcher can observe and collect data through his own observation.

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Comprehension questions

Answer (true answer is in bold)

Question 1. Early Warning is largely based on prevention, therefore:

a) **We can relate it to primary, secondary and tertiary prevention.**
b) We must focus especially on primary prevention.
c) We must focus especially on primary and secondary prevention.
d) We must focus especially on tertiary prevention.

Question 2. According to the White Paper on Early Intervention-GAT (2005), the concept of EC is assumed by consensus, understood as:

a) The set of interventions aimed specifically at the child population aged 0-6 years that aim to respond as soon as possible to the temporary or permanent needs presented by children with developmental disorders or who are at risk of suffering from them.

b) The set of interventions aimed at the child population aged 0-6 years, the family, and the environment, which aim to respond as soon as possible to the transitory or permanent needs presented by children with disorders in their development or who are at risk of developing them.

c) The set of interventions aimed at the child population aged 0-3 years, the family, and the environment, which aim to respond as soon as possible to the transitory or permanent needs presented by children with disorders in their development or who are at risk of suffering from them.

d) **The set of interventions aimed at the child population aged 0-6 years, the family, and the environment, which aim to respond as soon as possible to the transitory or permanent needs presented by children with disorders in their development or who are at risk of suffering from them.**

Question 3. According to Candel (2005):

a) Early Warning must be understood as a treatment aimed at a child.

b) **Early Warning should not be understood as a treatment aimed at a child, but rather as a series of actions aimed at children, their families, and the community in general.**

c) Early Warning should not be understood as a treatment aimed at a child, but as a series of actions aimed at children and their families.

d) All the previous answers are false.

Question 4. The main objective of Early Warning is:

a) Work on cognitive, motor and autonomy areas.

b) Reduce the incidence of chronic disabilities in a population, seeking to minimize the disability caused by a disease.

c) **Promote the development and well-being of the child and their family, enabling their integration into the family, school and social environment, as well as their personal autonomy.**

d) Promote the development and well-being of the child, enabling their integration into the school environment, as well as their personal autonomy.

Question 5. Mark the correct option.

a) Early detection of child development disorders is essential for diagnosis and therapeutic care.

b) Early detection is essential to influence a stage in which the plasticity of the nervous system is greater, and the therapeutic possibilities show their greatest efficacy.

c) It is necessary to detect child development disorders at the moment in which the first indicative signs of them appear.

d) **All the above answers are correct.**

Question 6. Indicate the correct option about the role of Educational Services in the early detection of childhood disorders.

a) Nursery school, teachers and educators are detection agents, although their role is not significant.

b) The interactions that occur in the school context are like those in the family environment, consequently, they can detect the presence of deviations in the evolutionary process to the same extent.

c) Deviations in a child's childhood development are usually detected in a similar way by parents, by health personnel and within the educational context.

d) **All the previous answers are false.**

MODULE II. EARLY NEURODEVELOPMENT

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I. INTRODUCTION

Neurodevelopment is the process of acquiring skills in relation to the brain maturation of the nervous system in the child, until reaching the adult stage. It is a process where biological and environmental aspects intervene that are in constantand interaction. In this chapter, the neurodevelopmental processes of the nervous system will be reviewed from an evolutionary point of view to understand the emergence of the mechanisms of mental activity and human behavior in the child.

II. OBJECTIVES

Know the phases of brain maturation and the stages of acquisition of the different skills and abilities that will allow the child to develop correctly within the neurodevelopment process.

III. SPECIFIC CONTENTS OF THE TOPIC

1. Brain development: Basic premises

With regard to brain development, the most widespread idea that exists today is that in the first years of life is when the complexity and functionality of the brain increases numerically. However, as Sebastian (2012) points out, a greater number of neurons and connections does not equate to better brain functioning.

As Ortiz (2018) expresses, this neurodevelopment will be a slow process that will last for several decades and will not have its parallelism with biological neurodevelopment. Brain development and maturation is characterized by long-lasting and heterochronic development**.** However, as brain structures develop, perceptual, motor, cognitive functions begin to be expressed in observable behaviors. Thus, structures that develop more quickly manifest their functions, rather than those functions that develop more slowly, such as the abilities controlled by the neocortex (frontal lobe) (Kolb and Whishaw, 2003., Coll, 2011).

Human beings are born with an immature brain devoid of a functional cognitive system and it is in fact that this immaturity will allow experience to shape this brain in a fundamental way.

And also, the different rates of maturation of the different cortical structures will be determined both by genetics and by specific stimulation mechanisms that are given to that developing brain.

In the first months of life, the cerebral cortex experiences a significant proliferation of synapses (neuronal communication) that will result in the formation of synaptogenesis, followed by a period of synaptic **pruning** (elimination of synapses, often due to lack of use).

Another element involved in brain development is related to the process of **myelination** of neurons, a process that consists of the axons of neurons being covered with a kind of "insulator" formed of white matter in order to have an adequate transmission of the signal.

And it is especially in this developing brain, the amount of myelin in a certain brain area will be a good indicator of the use that will be made of that area inducing the development of a certain cortical area with a certain involvement in a subsequent cognitive process.

As with *synaptogenesis processes and synaptic pruning processes,* myelination also *has different rates of formation depending on which areas of the brain are developing.* We would be talking, therefore, not only about how many neurons or synaptic connections exist, but also about how is the structure of white matter (axons and myelin), dendrites, as well as the neurochemical circuits that shape brain functioning.

Thus, it is presumed (Table 1) that both the **process of synaptic pruning** and that of **synaptogenesis** is determined by neurochemical mechanisms. The presence of certain molecules (specific brain areas) will enhance or slow down the appearance or disappearance of certain synapses, conditioned to the activity in neurons Sebastián Gallés, (2012).

Table 1. Some features of human brain development Excerpted from García Madruga and Herranz Ibarra, 2010.

Characteristics of human brain development	
Postnatal growth of the human brain	Brain mass quadruples between birth and adulthood. -Notable increase in the number and complexity of neurons. -Steady increase in the density of synaptic connections in various regions of the cerebral cortex. - Increase in the myelination process which will allow an improvement in the speed of transmission of information between neurons.
Loss or "synaptic pruning" of synaptic connections	A process involving selective loss in brain development, mainly observed in synaptic density. Pattern of initial increase and subsequent decrease or "pruning" of synaptic density that appears at different ages according to different cortical regions. The initial overproduction of synaptic connections and the subsequent "pruning" seems to be related to the special plasticity of the infant brain.
Brain plasticity	Plasticity as a fundamental property of the development of the cerebral cortex. The process of differentiation and specialization of the different areas of the cortex is strongly influenced by the neuronal activity itself, in addition to the inherent factors related to the automatic "ignition". (Childhood and adolescence, mainly)

1.1. Prenatal and postnatal brain development

All the complexity of the brain derives from the precise spatiotemporal process of the main processes of brain development. (Figure 1). Both for *brain regionalization*, neural migration, and *synapse formation* by neural cells during the periods, embryonic and perinatal.

The cells of the nervous system are formed from one of the three sheets into which the embryo, the ectoderm, divides during a process **called gastrulation.** The stem cells of the medial part of the ectoderm proliferate at an extremely high rate, modifying the morphology and size of this lamina and giving rise to the neural plate, forming the neural tube **(neurulation)**.

The precursor vesicles, around the fourth gestational week, will form the three main structures that will form the future brain.

In turn, neural tube stem cells will be *future neurons and glial cells.* The cells that will become neurons will therefore lose their ability to divide and will be specialized cells. In order to form the different regions of the nervous system, the still immature neurons will migrate from the place of birth to their definitive location in the nervous system and once there, unite with other neurons to form functional units (nuclei and cortical layers).

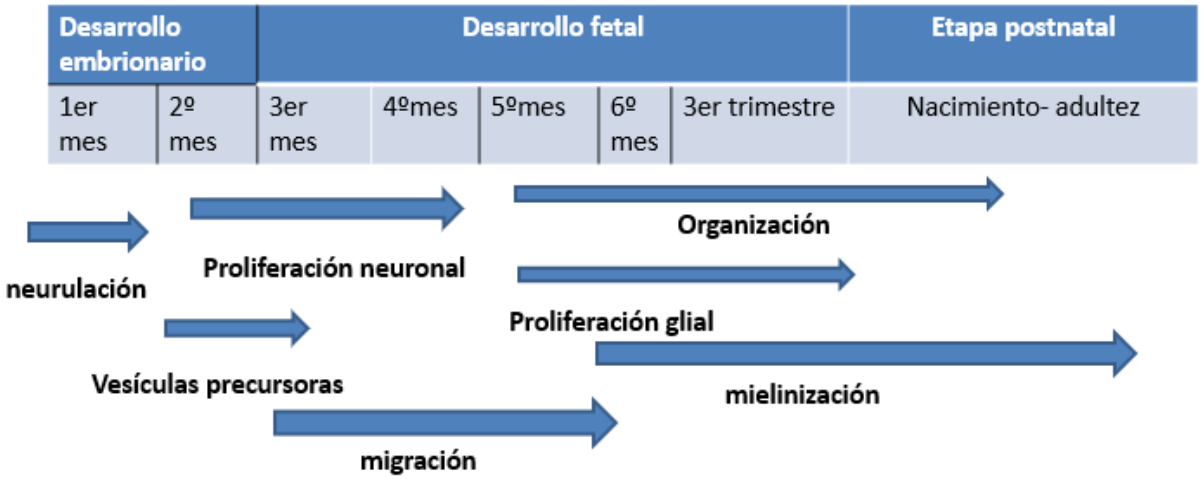

Figure 1. Temporary windows of the development of the nervous system. Enseñat et al, 2015.

With respect to **proliferation**, also called **neurogenesis**, a process that occurs between the third and fifth month of fetal development, which consists of the miotic division of stem cells in the neural tube to later produce neurons and glia.

Parallel to this process, **cell migration** also occurs, which are massive movements or displacements of nerve cells, or precursor cells in order to establish differentiated populations of nerve cells (layers of the cerebral cortex, subcortical nuclei). It seems that some supporting cells (glia) help guide this process of cell migration.

The formation of synaptic connections (inaptogenesis) takes place at various times throughout development. During the last months of intrauterine life and the first years of childhood, an extraordinary high number of synapses will be formed, but many of these neurons will disappear, while new synapses will be formed and the functioning of existing ones will be modified. This process is called **synaptic reorganization,** being key to the maturation of the brain and the consequent evolution of mental abilities. These synapses will depend to a large extent on the pattern of electrical activity of the neurons and this in turn will be related to the use made of these synapses.

In order for immature neurons to develop the functions that define them (processing of chemical and electrical signals) they must acquire specific electrophysiological and biochemical properties and establish synaptic contacts with other neurons. These immature neurons must be able to generate and conduct nerve impulses (**action potentials**) capable of releasing certain types of neurotransmitters (chemicals that serve to communicate and cause one effect or another) and to respond to messages emitted by other neurons.

Before the formation of these synaptic connections, it is necessary that the axon is formed, an extension that arises from the cell body and that increases its length until it reaches the region that contains the target neurons with which the synapses will be established. It is also necessary to form dendrites (neuronal extensions specialized in the reception of information).

At various moments of development and following (Coll, 2011) and very markedly in the perinatal stage, an apparently paradoxical process also takes place, which is **cell death or apoptosis**.

This process involves the death of many neurons that had been formed in previous stages as a result of the expression of genes that will activate programmed self-destruction. This process is most likely activated in those neurons that have not been able to establish functional synapses and in turn has not been nourished by neurotrophic factors (proteins that ensure the survival of these neurons) the formation of synaptic connections and synaptic plasticity.

Thus, during the development of the nervous system, a significant number of neurons will be generated, some of them selectively eliminated. A very large number of synapses will also be formed and will subsequently undergo a reorganization process.

These phenomena of **synaptic reorganization** and apoptosis will end up configuring the nervous tissue with fewer neurons and fewer synapses than those initially formed, but a more efficient functioning (Coll, 2011).

Postnatal development

In general, the development and maturation of the brain is characterized by being of long duration and by occurring at different times. Thus, various aspects of development will take place not only throughout childhood, but also during and even during adolescence. In general, regions related to more basic sensory, motor, and physiological functions mature first, while areas related to complex cognitive functions show a slower maturation process.

Also, maturation changes in brain tissue during childhood and adolescence show a reduction in gray matter volume and an increase in white matter volume. Gray matter consists of the parts of nerve tissue that are composed of neuronal bodies and dendrites, in addition to most synapses, while white matter is basically made up of nerve fibers (axons).

From the last months of gestation until approximately two years of life, there is a very notable increase in brain synapses, which will be reduced, reflecting a reduction in the volume occupied by the gray matter. This reduction is the product of synaptic reorganization processes that improve the efficiency of brain functioning. In turn, the increase in white matter volume is attributable to increased myelination of axons.

In some regions, especially in areas related to so-called executive functions (planning capacity, inhibition of irrelevant thoughts, management of emotions and monitoring), this myelination process takes place well into the third decade of life (Coll, 2011).

2. Anatomical neurodevelopment

As we have seen above, the development and maturation of the cerebral cortex and in turn of the CNS will be evaluated by means of different criteria: *myelination, axon* development (proliferation of axonal buttons) dendritic *arborization*, measurement of neurodensity (development of *dendrites and cell bodies) and measurement of the thickness of the cortical layers* (it will show us the degree of complexity, neural networks of the cerebral cortex) Fernández Guinea (2003).

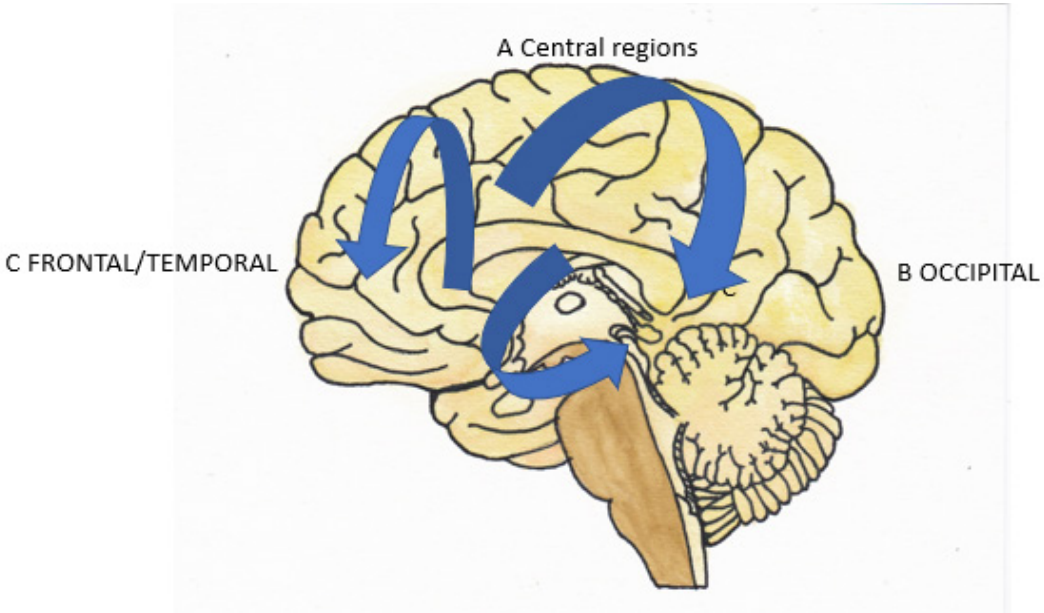

Figure 2. Cortical myelination patterns. Based on Enseñat et al., 2015.

As we are pointing out previously, the emergence of these cognitive functions will be given by the process of myelination (figure 2). First, the sensory and motor areas (parietal area) will be operational, then,

the development will continue towards visual areas, located in the occipital lobe, to finish, as we have been developing throughout this chapter, the coordinated executive functions in the prefrontal lobe. Thisprocess occurs in **a sequential and hierarchical manner,** following coordinated steps in the development of the following neuroanatomical structures.

1. **Brain stem and reticular formation**: In these brain structures are the centers that control wake-sleep rhythm, breathing movements, cough reflexes, sucking, swallowing, blood pressure, cardiac movements, and the primary autonomic functions of life. First structures to develop vital for survival.
2. **Thalamus**: The pulvinar nucleus grows rapidly between 16 and 37 weeks of gestation. Thalamic afferents can already be observed at 82-91 days towards the prefrontal and occipital cortex and later, between days 145-150 there is a relatively mature pattern of thalamus-cortex projections but whose branching is more extensive than in the adult.
3. **Basal ganglia:** These structures play an important role in controlling posture and voluntary movement. Theputamen develops at a faster rate than the caudate nucleus in the first four and a half months of gestation. The first synapses are already observed in the putamen at 60 days and at 65 days in the head of the caudate nucleus.

   These two structures, both the *putamen and the caudate nucleus*, are structures that make up the basal ganglia, fundamental structures along with the thalamus, cerebral cortex, and cerebellum, which are responsible for motor control. It should also be noted that the first afferents from the brainstem and the substantia nigra will arise around 40 days and those from the prefrontal cortex will appear around 70 days.
4. **Hippocampus:** The development of this brain structure begins around 38 days and is practically simultaneous in all areas. In the second half of hippocampal gestation, well-differentiated postsynaptic elements are already shown, and the established afferent pathways are already generated.
5. **Cerebellum**: At the beginning of the fifth month of gestation a six-layer cortex is observed in the area of the vermis and in the medial areas of the cerebellar hemispheres, with a slower development of the lateral faces of the same (about one and a half to two months). By six months all cerebellar areas have six layers, although the embryonic granular layers do not disappear completely until seven months or eight months after birth. Until the second year of life, the cerebellum grows rapidly to reach adult size between six and nine years of age.
6. **Primary motor and sensory areas: the** maturation of the layers of the motor cortex begins at birth and its development will allow reflex and spontaneous movements of the limbs, although it will still take longer until the baby can perform coordinated movements.
7. **Secondary motor and sensory areas: the maturation of** these areas may coincide with the maturation of the primary and tertiary areas, although the development of this area is slower and will end around the fifth year of life. With the maturation of the secondary areas, the process of lateralization of functions and the passage from the sensory-motor level to the perceptual motor begins. These regions are essential for learning during the first years of life.
8. **Tertiary and posterior areas of the cerebral cortex**: These are areas that correspond to an area of integration of stimuli of different sensory modalities and production of symbolic functional schemes. The maturation of these areas is key to the acquisition of school knowledge, highlighting the angular gyrus of the parietal lobes, essential for the acquisition of reading.
9. **Prefrontal cortex**: Part of the cortex that is to develop last. It will not be fully functional until four to seven years of age and will continue its development into adulthood. Also called neocortex.

The process of differentiation and specialization of the different areas of the cortex is strongly influenced by the neuronal activity itself, in addition to the inherent factors related to the automatic “ignition”.

3. Functional Cognitive Neurodevelopment

The development of the main cognitive functions depends on the maturation of the brain circuits that support it. Knowing the evolution and normal development of cognitive functions will be essential to identify and interpret possible alterations in this development. The study from the nEuropsychology focuses on the study of the main cognitive processes that will be established as the nervous system develops. We will talk about the maturational development of perception, memory, attention, language and in its entirety the development of executive functions. (Enseñat, Roig and García, 2015).

3.1. Visual perception

In general, it is accepted that during the first year of life the visual system undergoes important functional changes (both for oculomotor regulation and for visual acuity) showing functional changes that depend on the subcortical structures at first, and then move to the progressive domain of processing at the level of the cerebral cortex.

With respect to the two pathways responsible for the processing of movement, shape of objects, places and faces (ventral and dorsal pathways), the *ventral* way is responsible for the processing of shape, while the dorsal way, the processing of movement.

Integrated response to movement is considered to be earlier than integrated form processing. However, the first thing that will be processed are the faces, objects and places. Movement processing, however, will take longer to reach maturity and appears to be more susceptible to alteration (Enseñat et al., 2015).

One of the most studied visual processes in childhood has been the *recognition of faces*. All the evidence accumulated through research in this area leads us to conclude that already at the age of 5 years or perhaps earlier, maturity in the perception of faces is already reached, partly due to genetic mechanisms and innate contributions.

Therefore, it could be considered that in childhood, the adult mechanisms employed in the perception of faces are already present. This would include phenomena associated with the recognition of individuality and learning of new faces, global processing, as well as the acceptance of the absence of certain traits, but managing to recognize that previously coded face. (Enseñat et al., 2015).

In addition, it should not be forgotten that the maturation of other cognitive processes will also contribute to improving the recognition of faces beyond early childhood, as well as, for example, the recognition of faces will improve if we join the development of recognition of emotional expression, related to changes in the connections between neuroanatomical structures such as the fusiform gyrus and the structures of the limbic system (amygdala, hippocampus).

3.2. Memory

The age at which you reach mnesic maturity will depend on several factors. On the one hand, it will be mediated by the development of coding strategies dependent on the maturation of the prefrontal cortex, and by the development of the mnestic process associated with the maturation of the medial temporal lobe.

This will have as a consequence the increase in general knowledge that will necessarily improve the ability to memorize. As Enseñat et al. (2015) expose, another factor that influences is the development of basic cognitive functions such as processing speed, attention, working memory capacity and the effect of complex functions such as the ability to solve problems or metamemory (Enseñat, 2015, Ofen, 2012).

Episodic memory is considered to develop throughout childhood, but it is not clear whether maturity is reached at a certain age or, conversely, continues to develop throughout development until adolescence.

With regard to the development of coding strategies, in those cases in which the tasks involve greater complexity and require the use of certain strategies to obtain a free memory or greater involvement of a temporal order, they will entail a later development. (Frontal lobe vs occipital lobe).

On the other hand, if we consider the relevant role of the medial temporal lobe for memory processes and the scarce structural changes of this region from childhood, it could be considered that the processes involved in memory more related to the medial temporal lobe, such as associative memory, They would be the ones who would mature earlier (Ofen, 2012, Enseñat et al., 2015).

In its entirety, the evolution of episodic memory emerges from the development of a brain network that includes, at a minimum, the hippocampus, and the prefrontal cortex. The role of the parietal lobe in the development of episodic memory is not so clear and it is suggested that it can function as a mediator due to the involvement of attentional processes.

With regard to procedural memory, necessary for complex thinking, we know that, from an early age, children already acquire procedural skills that will later serve them in learning new skills. The age of acquisition will depend on the skill required, the times that what is memorized is repeated and the requirement of other cognitive functions to be able to carry it out. It is considered that procedural learning first goes through a more external phase, in which cognitive resources (short-term memory) are needed so that it can progressively convert this type of procedural memory into an implicit and automated memory in which this procedure guided by external data is reduced. However, it seems difficult to explain through this approach all procedural learning in children in whom the mechanisms of explicit learning and cognitive control have not yet been developed.

On the other hand, working memory refers to the ability to maintain and manipulate for a short period of time the information necessary to guide a certain behavior. In general, it is considered that this capacity experiences a significant increase at 11 years, as well as between 15 and 19 years, reaching maximum levels in adulthood. Its correct development has been related to the maturation of cortical areas such as the superior frontal cortex, the intraparietal cortex, as well as their connections.

The development of different types of memory provides the basis for the acquisition of skills and knowledge of the adult. Knowledge of milestones reached during childhood not only provides useful information for clinical evaluation but will also have important implications for education.

Considering that children's episodic memory is basically associative (at least until primary education) is essential to consider it necessary to instruct them in the use of specific strategies to improve memory performance in the classroom. Enseñat et al. (2015).

3.3. Language

With regard to language and its cognitive development in childhood, language acquisition, as well as the acquisition of other cognitive functions, will depend to a large extent on the level of environmental stimulation and correct brain maturation (Enseñat et al., 2015). The proper development of language systems depends on interaction with other functional networks responsible for ability, e.g., motor, or visuospatial skills, memory, attention, acoustic discrimination capacity and social and emotional skills.

A classic example to illustrate the existence of critical and sensitive periods is the study concerning language acquisition. It is important to note that not all aspects of language are acquired in the same time windows. We know, for example, that the critical period for learning phonemes will occur during the first year of life. Soon after birth, babies are already able to discriminate the phonetic contrasts of different languages, even those that contrasts not present in their native language. (Enseñat et al., 2015).

The exposure to a linguistic context during the first year of life will allow the specialization of this skill, achieving better capacity for the phonological contrasts of the languages present in their day to day. (Language period).

During the following months, the child learns an average of 10 words per month to exceed the figure of 50 words, later, about 18 months the explosion of that vocabulary is evident, and the child is already able to learn an average of 30 words per month. (Enseñat et al., 2015).

Around the second year of life, between 18 and 36 months of life, syntactic learning begins. The child is already able to make and combine words in simple grammatical structures (sentences with two

words) and later, around the age of five, children will increase the complexity of these grammatical structures that they use to add the use of negative questions and phrases.

The complexity of grammatical structures will not be dependent on the availability of lexical content and therefore will be related to the child's ability to increase their vocabulary.

From the age of five, children already begin to experiment with the uses of language, so that communication strategies and keys appear that will allow them to follow a conversation with another person, clarify misunderstandings of a speech, increase their level of understanding as well as narrative production. (Enseñat et al., 2015).

3.4. Executive functions

Executive functions (EF) refer to a set of cognitive functions that allowmaintaining a coherent and organized plan towards a specific end. These functions include the ability to plan and organize information, flexibility and planning, and the ability to control impulses (Roselli, 2002).

In general, it is considered that the most critical regions for the emergence of executive functions are located in the prefrontal cortex, in the most anterior part of the frontal lobe, in front of the motor areas. The prefrontal cortex and the connections that this region establishes with other brain areas undergo changes not only throughout childhood, but also, very markedly, during adolescence. Coll, 2011.

FEs include cold executive functions as well as hot executive functions. *The first refer to the ability to plan, organize, set goals, monitor behavior, solve problems, inhibition, working memory and cognitive flexibility*. The latter include empathic capacity, emotional regulation, theory of mind and decision-making capacity with an affective component, skills necessary to regulate our behavior with a purpose (Enseñat et al., 2015)

The development of the **prefrontal lobe begins in the prenatal period**, with subsequent metabolic and structural changes during childhood and adolescence but does not reach its evolutionary maturity until the thirties, when myelination is terminated.

There is an early maturation of attentional control and some working memory capacity, while other more complex skills such as planning and organization are acquired during adolescence and adulthood. Attentional control (selective attention, response inhibition, self-regulation, and self-supervision) is the first element of executive function to mature. Evidence regarding goal setting (planning, goal setting, and problem solving) during childhood age is scarce. By age 5, children can set goals and plans.

And finally, in relation to the ability to make decisions with an affective component, we know that children from 3 to 6 years old rely exclusively on immediate rewards. It is not until adolescence, when you begin to make decisions in an effective way.

This ability has been associated with late maturation of ventromedial and orbitofrontal prefrontal areas and appears to be independent of the improvement in inhibitory control and working memory that will occur at the same stage of development. (Anderson et al., 2008. Enseñat et al., 2015).

4. Brain plasticity in child brain development

The CNS has a remarkable ability to modify its function and to some extent, modify its anatomical structure in response to activity, environmental stimuli or damage that may suffer. Plasticity is a constant process, which can be observed in different areas: synaptic, structural and organization of neuronal maps. (Medina et al., 2004).

As a general rule, we can affirm that changes in behavior that are described (according to circumstances) such as learning, memory, habits, maturation, recovery, and others, are associated with corresponding changes in the nervous system.

The concept **of 'neural plasticity'** refers, under normal circumstances, to the ability of the nervous system to model its structure and function according to experience, which gives rise to learning processes.

And in circumstances of pathological loss, to its ability to try to update the potentialities of the individual genetic program through remodeling phenomena.

This brain property can be assessed on many levels, from observable changes in behavior, brain maps, synaptic organization, physiological organization, and molecular structure.

To understand processes such as memory and habits, it is necessary to understand the nature of brain plasticity. The genomic endowment allows, therefore, a margin of adaptability when handling information and also when attempting anatomofunctional compensations after suffering some pathogenic aggression. (Narbonne et al., 2012).

4.1. Types of brain plasticity

Learning and remembering new information is linked to some kind of change in the cells of the nervous system (neurons). These changes are considered to constitute the neurological record of learned information. As shown by Grenough and Black (1992) and Coll (2011)

It is possible to establish, summarizing three major types of plasticity: that of development, which induced by experience during life and finally, that induced by damage, loss of afferents or alterations in brain activity.

1.- Plasticity experience-expectant. (Expectant plasticity of experience)

This type of plasticity involves synaptic changes produced by aspects of the environment that are common to all members of the species and expected at certain times of development. (experiences).

As we have seen above, thereis initially an overproduction of synapses, followed later by neuronal loss (Coll, 2011).

This type of plasticity is limited to periods of maximum susceptibility during development to certain environmental variables **(critical or sensitive periods).** After this time window, the influence these experiences have on the brain and its connections will be much more limited. Therefore, the selection of the organization pattern of the SN will be permanently and sometimes irreversibly completed.

This mechanism allows genes to encode the nature of the connections to be established, already from the fetal period and later in the postnatal period, where it is “expected” that the child will experience basic episodes, common to the entire species, such as exposure to light and sound, to preserve the previously established nautical connections of the perceptual systems, of sight and hearing. (Siegel, 2016).

2.-Plasticity experience-dependent. (Experience-dependent plasticity).

The second type of plasticity reflects changes produced by information absorbed from the environment that may be unique to the particular individual, (vocabulary-specific learning) that are experiences throughout the life cycle.

This plasticity is not limited to fixed periods of time. **This type of plasticity is maximum during childhood and adolescence.** It is maintained throughout life, except for the presence of neurodegenerative diseases or neurodevelopmental disorders.

It is triggered by the detection of relevant relationships between relevant stimuli between stimuli (learning and memory) or alterations in the stimulating situation (injuries, loss of limbs). This type of plasticity exclusively activates the genetic machinery to create synapses, whose creation undoubtedly depends on that set of experiences that have previously triggered the creation of these synapses. This type of plasticity is temporary and subject to change depending on experience. (Siegel, 2016).

3. Plasticity independent experience:

It responds to changes in the number and/or function of synapses that occur as a result of the programmed expression of certain genes without external or experiential factors. This type allows an optimal adaptation of behavior to the changing environment. These experiences are an endorsement of techniques that are based on sensory stimulation and learning, although this effect (increased synapses in the cortices

involved in learning) is especially noticeable in the "sensitive" or critical periods of early development, although they are also demonstrated in the adult brain (Castaño, 2002).

At present both terms are still used, but sometimes "experience-dependent" is used exclusively to refer to both the plasticity of development and the plasticity present in the rest of life.

Summary

This chapter has addressed the main concepts of early neurodevelopment, both from the neuroanatomical point of view and from the functional point of view. The main neuroanatomical processes involved in the development, cognitive, motor, affective and functional of the child have been analyzed. As well as the phenomena of brain plasticity, involved in this neurodevelopment.

Glossary of terms

Apoptosis: consists of causing the programmed death of different cells. This process arises as a result of an adaptive development to achieve an efficient nervous system.

Cell migration: Mass movements or displacements of nerve cells, or precursor cells, in order to establish differentiated populations of nerve cells (layers of the cerebral cortex, subcortical nuclei) it seems that some supporting cells (glia) help guide this process of cell migration.

Differentiation: The process by which cells become more specialized. In the early stages of embryonic development, cells are similar to each other, but they specialize later and acquire specific characteristics as they are part of different structures of the nervous system.

Heterochrony: biological process that encompasses all those changes in the rhythm of ontogenetic processes that give rise to transformations in the shape and size of organisms.

Myelination: coating of axons with a myelin sheath in order to allow adequate transmission of nerve impulses.

Neurogenesis: or also called proliferation, a process that consists of the miotic division of stem cells in the neural tube to later produce neurons and glia.

Neurulation: Anembryonic mechanism in which the neural tube is formed.

Ontogeny: The study of the individual development of an organism.

Phylogeny: The historical and generic development of a species, i.e., how a species has changed over time

Synaptic pruning: A process of elimination of synaptic connections that the brain does not use during the developmental stage that takes place in two evolutionary moments; in childhood and adolescence.

Action potential: Oran electric discharge that travels along the cell membrane modifying its distribution of electric charge. Necessary to perform the electrical synapse and subsequent chemical synapse.

Synaptogenesis: The establishment of synaptic connections as neuronal tissue develops and axons and dendrites grow.

Synaptic reorganization: Loss of some synapses and the development of new ones in order to improve the efficiency of synaptic connections.

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Comprehension questions

Answer (true answer is in bold)

Question 1. With regard to brain maturation. This refers to:

a) **This brain maturation will occur at different rates in different brain regions.**
b) This maturation will occur in a continuous way and mainly in motor areas to later develop the sensory areas.
c) This maturation will take place in a continuous manner and at the same rate in different brain regions.
d) All are correct.

Question 2. The complexity of grammatical constructions will depend on:

a) **On the availability of lexical content and related to its capacity to increase vocabulary.**
b) On their ability to increase their vocabulary and not so much on the availability of lexical content.
c) This process is only observable once the child has reached the age of three years.
d) From the age of three onwards, children increase verbs, not words.

Question 3. Neurogenesis is:

a) Mass movement of nerve cells with the aim of establishing differentiated populations of nerve cells.
b) A process that involves the establishment of synaptic connections as neural tissue develops.
c) **A process involving the meiotic division of stem cells in the neural tube.**
d) Genetically programmed death of non-functional neural networks.

Question 4. With regard to cold executive functions, these are:

a) **Refer to the capacity for planning, organisation, goal setting, behavioural monitoring, problem solving, inhibition and working memory.**
b) They refer to empathic capacity, emotional regulation, theory of mind and decision-making ability.
c) They refer to areas found in the frontal lobe (orbitofrontal and ventromedial).
d) All are correct.

Question 5. The ventral pathway is responsible for:

a) **Shape processing**
b) Movement processing
c) Distance processing
d) Speed processing

Question 6. With respect to the expectant plasticity of experience:

a) Reflects changes produced by information absorbed from the environment.
b) **Involves synaptic changes produced by aspects of the environment, common to all members of** the species.
c) Reflects changes in the number and/or function of synapses that are the programmed expression of particular genes.
d) All are correct.

Question 7. The evolution of episodic memory, in its entirety, will depend on a brain network that includes at least a:

a) **The hippocampus and the prefrontal cortex.**
b) The medial temporal lobe
c) The parietal lobe
d) The prefrontal, parietal and occipital networks.

Question 8. With regard to working memory, this reaches its maximum capacity:

a) At the age of 11 years
b) Between the ages of 15 and 19
c) It reaches maximum levels in adulthood.
d) **All are correct**

Question 9. The development of the prefrontal lobe begins:

a) **Begins prenatally**
b) Begins in infancy and adolescence
c) Begins in early childhood
d) Begins throughout childhood and ends in adulthood.

Question 10. Regarding the programmed death of certain nerve cells:

a) They come programmed as a consequence of gene expression.
b) It is established in those neurons that have not been able to establish functional synapses.
c) Neurons die because they have not been nourished by neurotrophic factors.
d) **All are correct**

MODULE III.1 CHILDHOOD BRAIN DAMAGE

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I. INTRODUCTION

Childhood brain injury is a sudden injury to the brain that involves a change in neuronal activity that causes partial or generalized deficits with varying severity, altering the physical, cognitive, emotional and social dimensions, conditioning the psychosocial adjustment of the child and his family. It can be temporary or permanent. This chapter will address the different types of acquired brain damage and the repercussions arising from them.

II. OBJECTIVES

1. Addressing the concept of brain damage in children.
2. Know the most prevalent types of brain damage in children.
3. Know the most frequent neuropsychological alterations in brain damage, to assess the consequences of the injury in a developing brain.

III. SPECIFIC CONTENTS OF THE TOPIC

1. Childhood brain injury (CBI)

CBI causes a sudden injury to the brain that generates a change in neuronal activity altering the physical, metabolic and functional integrity of the NS cells that occurs after birth.

A greater number of school-age children survive severe brain injuries due to accidents and neurological diseases, but return to school (Table 1) with multiple cognitive, behavioral, communicative and physical sequelae that will have to be evaluated academically (Cámara-Barrio et al, 2020., Hayes et al, 2017).

Unlike the lesions produced in adults, in the child we find a developing brain, with a large number of functions still unacquired, which will lead to alterations much more diffuse and complex to specify.

As Carrillo et al (2015) point out in the balance of severity and prognosis of brain damage, they will counterbalance, among other things, brain plasticity at this stage of development, the location and extent of the lesion. In most cases, as the child advances in age and brain maturation, functions that were initially absent can be enabled and altered functions improved. But, on the other hand, difficulties may appear that did not appear at first. It will be then that it is possible to outline more accurately a general profile of functioning of the child who suffers brain damage.

Table 1. Main neuropsychological and psychosocial alterations in children suffering from ICD. Cámara Barrio et al, 2020.

	Most common alterations
Cognitive area	Alteration in processing speed Faster troubleshooting Alteration in memory (storage, retention and evocation of information) Short-term memory and new learning Language (its development does not keep up with the expected pace) Alterations in attention (concentration, sustained attention, selective)
Executive functions	Behavior planning and monitoring Difficulties in judgment and formation of concepts regarding what would correspond to their age and educational level
Emotion and behavior	Difficulty showing empathy or regret Low frustration tolerance with frequent mood swings
Social aspects	Loss of friendships Poor academic performance Poor performance in social skills Social isolation within the school environment

2. Early brain damage

There is a general consensus that injuries acquired during early stages were considered to have less serious and shorter consequences than if they occurred at later stages. (Junqué et al, 2009).

However, challenges in comprehensive intervention after acquired brain damage cause children to return to their new reality to face the future of completing child development with an injured brain.

Therefore, a proper understanding of the real problem of the child must take into account both the context of the brain injury and the moment of development in which it is. If we consider the context, it must include all the environmental variables that may affect your cognitive, emotional, functional and social functioning, as well as the time elapsed since the injury occurred and the specific treatments you have received.

If the moment of development of the child when suffering from ABI is assessed, it is considered that recovery will depend on the age at which the injury has occurred, highlighting three basic critical reference periods:

1. Before the first year of life.
2. Between the first and fifth year of life.
3. After five years.

If the ABI occurs in the previous months, before the first year of life and bilateral lesion appears in the cerebral cortex during the period of **neurogenesis** (*miotic division of stem cells in the neural tube that form neurons and glia*) that will be completed by the fourth or fifth month of embryonic development, recovery will be total, Due in part to the fact that the process of intact division of stem cells still continues, which would allow the brain to replace the cells damaged by the injury and redistribute the existing healthy ones, managing to continue performing this miotic division (Junqué et al, 2009).

Shortly after *neurogenesis* begins*, neuronal migration* begins, which will continue for several weeks afterwards then initiating *the differentiation process*, where cells become more specialized, becoming different types of neurons. This differentiation will end at birth, although neuronal maturation (growth of

dendrites, axons and synapse formation) will occur for years and in some regions (medulla oblongata and hippocampus) will continue until adult life.

If from the fourth month of life, when the massive displacements of neurons or precursor cells *(cell migration)* and differentiation for the basic formation of neuronal circuits completed *around the eighth month of birth occurs,* if neurons are altered or destroyed, the connectivity between different brain regions (cortical, corticosubcortical and subcortical) will be permanently affected, since at this stage, the brain is especially sensitive to injury (Junqué et al, 2009).

With respect to the lesions *that occur in the first year of life,* they produce greater functional alterations than those produced at later ages and will be related to lower intelligence quotients (IQ). In addition, those children who have suffered severe harm are at risk of suffering what Cámara Barrio et al (2020) call "cognitive stagnation" in phases after their recovery.

This has its importance in the learning processes because it will mean a stop or a slowdown in the stages of cognitive, social or motor development beyond this first year of life, despite the fact that there is a significant recovery of the premorbid level.

In turn, lesions that occur *around the first and fifth year* of postnatal life usually **have a certain degree of reorganization of brain function**. This reorganization is possible because dendrites and axons are still developing, having the ability to overcome the obstacles of the lesion achieving their synaptic objectives using other alternative routes. This adaptation mechanism allows to create functional connections when there is an alteration in its normal development.

Finally, injuries occurring *after the fifth year of life* usually have minimal or no functional recovery. If once the migration is established and the differentiation of the circuits has been carried out, they are damaged, the capacity to reorganize neural connectivity is already very limited.

As Junqué et al (2009) point out, it is very likely that some type of functional recovery will occur as a result of the reorganization of local circuits in the directly or indirectly affected areas.

3. Types of childhood brain damage

3.1. Head injury in the paediatric population

The causes of traumatic brain injury (hereinafter TBI) in childhood differ from adults and even within the same pediatric population, varying the causes significantly according to the age of the child suffering this type of injury (Enseñat et al, 2015). In the infant stage there is a greater risk of suffering TBI due to falls and abuses due to the greater activity of children and the absence of awareness of danger (Anderson et al, 1997). Older children and adolescents tend to be victims of sports accidents and accidents (Enseñat et al., 2010). The consequences of brain damage suffered at an early age have been considered different from adults both quantitatively and qualitatively.

The lesions produced by a TBI can affect various brain areas causing motor, sensory and neuropsychological alterations (Solís-Marcos et al, 2014). This type of injury is the leading cause of brain damage in children and young people. TBI will cause neuropathological changes as a consequence of primary damage and secondary damage. (Table 2).

TBI is defined as an injury to the brain caused by an external force, blow, or wound (open or closed wound) to the head that causes alteration or loss of consciousness. With respect to the open wound, it causes skull fracture and instead, in the closed wound, injuries occur by non-penetrating wound in which there is no skull fracture.

Be that as it may,the trauma will cause primary injuries, originated at the time of impact and secondary injuries that occur will go after a period of time as a result of complications (Enseñat et al., 2015).

With respect to primary damage, a consequence of the mechanical component of trauma (movements, product of brain acceleration and deceleration after impact) that results in stretching, twisting and

ruptures of axons and cerebral capillaries causing microhemorrhages. Primary lesion involves local lesion and diffuse lesion (Roig-Rovira et al, 2011)

The focal lesion within the primary lesion causes direct cortical contusions with a **more frequent location in the frontal and temporal lobes area.** Within this classification we also find injuries by blow/backlash mechanism.

Table 2. Neuropathological processes of traumatic injury Junqué, 2008

	Focal	**Diffuse**
Primary injury	Focal cortical contusion Deep cerebral hemorrhage Extracerebral hemorrhage	Diffuse axon injury Bleeding in white matter
Secundary injury	Delayed neuronal injury Microvascular injury Focal ischemic lesion-hypoxia Herniation Regional and diffuse hypometabolism	Delayed neuronal injury Microvascular injury Focal ischemic lesion-hypoxia Diffuse hypometabolism

On the other hand, diffuse lesions correspond to the mechanism of injury present in this type of trauma, being 40-50%. This term refers to the presence of multiple lesions located in specific regions, produced after long-term and high-speed brain decelerations. The most frequent locations are in parasagittal white matter, corpus callosum and the pontinomesencephalic junction adjacent to the superior cerebellar peduncles. (Roig-Rovira et al, 2011).

The secondary lesion causes cerebral edema, hematomas and ischemia (Junqué, 2008). It can increase brain damage established at the same time of injury.

Tertiary damage corresponds to deeper changes that generate modifications in neurotransmitters, ionic homeostasis and neuronal membrane.

With regard to the assessment of TBI severity, it is evaluated (initial *assessment at the initial moment of patient evaluation*) on the score obtained on the Glasgow Coma Scale (GCS) (Table 3) which classifies the severity according to three types of response; ocular response, motor response and verbal response.

The ocular response includes: 4. Spontaneous response, 3. Verbal order. 2. Pain. 1. No response. **The motor response**: 6. Obey verbal command. 5. Locate the pain. 4 Remove and bend. 3. Abnormal flexion. 2. Extension. 1. No response. **The verbal response**: 5. Oriented and preserved. 4. Disoriented and talking. 3. Inappropriate words. 2. Incomprehensible sounds. 1. No response. Maximum score: 15. Depending on the total response obtained by adding these three types of response, the TCE can be classified as mild, moderate and severe.

A mild TBI is one that has obtained a score between 13-15; a moderate TBI is between 9-12 points, and severe between 3-8 points. (Table 3)

Table 3. Severity of TBI taking into account the Glasgow Coma Scale. Excerpted from León Carrión and Domínguez-Morales, 2005.

GCS Score	**Severity**	**Neuropsychological deficit**	**Evolution**
15-13	Lightweight	Lightweight	Positive 1-6 months
12-9	Moderate	Moderate	Reserved 1-15 months
8-3	Grave	Grave	Months of rehabilitation

The loss of consciousness at the time of injury followed by time in a coma always occurs with diffuse lesions, due to rotational mechanisms that cause stretching and rupture of axons, subsequently producing neuronal death.

White matter lesions can interrupt the normal functioning of the frontal lobe ascending activator reticular system, leading to alterations of frontal-executive semiology**: attention and motivation.** In addition to attentional deficits, diffuse lesions are characterized by the presence of concentration difficulties, mnestic processes, slowing in the speed of information processing, fatigue, irritability and lack of initiative.

If we consider the neuropsychological alterations (Table 4) that appear as a consequence of TBI, we find **a cognitive profile** where alterations in processing speed predominate (white matter injury, corpus callosum), memory (hippocampus/prefrontal area), attention, executive alterations and alteration in the ability to acquire new learning. Process that causes a decrease in the ability to make new learning (anterograde amnesia, plus short-term memory dysfunction) vital for those children who are of school age (Cámara-Barrios, et al, 2020; Junqué, 2008).

The alteration of **frontal/executive** functions is a constant and is explained by the fact that these functions require the integrity of all circuits affected by LAD (Junqué, 2008). The cognitive, behavioral and emotional consequences of people who have suffered a mild TBI usually resolve before six months and even within the first month (León-Carrión and Domínguez, -Morales, 2005).

Table 4. Neuropsychological alterations in TBI. Based on Enseñat et al, 2015.

Neuropsychological process	Alteration	Injury
Attention	Attention deficit Selective, sustained attention (increase in number of omissions) Incomplete visual search, crawling	Prefrontal injury Diffuse axonal damage depending on the location of the lesion
Processing speed	Slowing (may interfere with other processes, attention, memory, language, visual-construction, motor and precision.	Diffuse axonal damage Focal basal ganglia lesions
Language	Aphasia, anomie, verbal fluency, pragmatics of language	Focal lesions or diffuse lesions
Memory	Alteration processes encoding and evocation of new information. Impact on learning ability	Loss of hippocampal volume Involvement of neuronal structures Frontal lobe damage
Executive functions	Lack of initiative, difficulty controlling impulses, disinhibition, inability to seek alternatives, inflexibility, poor planning skills and low tolerance for frustration	Prefrontal lesions
Emotion and behavior	Difficulty managing behavior, egocentrism, perseverance and impairment of social skills, emotional instability, aggressiveness	moderate, severe TBI

3.1.1. Neuroimaging of TBI

Neuroimaging techniques and lesional studies used to identify the neural basis and characterize the effects of TBI provide important structural and functional data. This allows to delimit the acute diagnosis and the long-term structural sequelae. (Junqué, 2009). Within neuroimaging techniques, structural magnetic resonance imaging and computed tomography (CT) are mainly used.

With magnetic resonance imaging, microhemorrhages can be visualized. It has a better resolution to detect areas of contusion or diffuse lesions of the white matter being this technique more accurate in the diagnosis during the acute phase.

However, CT has clear advantages in its use for several reasons:

1. With CT you can better visualize, bleeding in the acute phase.
2. Detects fractures, ventricular dilation and its correlation with the degree of cortical atrophy
3. It is relatively fast and has greater availability and facilitates rapid monitoring of the patient, especially in the acute phase.

In the acute phase, CT shows brain compression, reduction in ventricular size and tissue changes showing edema and presence of microhemorrhages.

This is important because it was traditionally believed that children recovered better from TBI. Children may even show better resolution of motor and sensory deficits. However, these differences are not met for cognitive functions and many studies have demonstrated the presence of long-term neuropsychological deficits after severe TBI in children (Enseñat et al, 2015).

Yuan et al, 2007, on a sample of children aged 6 to 9 years with TBI of at least one year of evolution, observed decreases in the size of the corpus callosum appreciating that the alterations of connectivity were not reversible.

This leads to the conclusion that pediatric TBI causes a reduction in size and microstructural changes in the posterior regions that indicate an interruption in neurodevelopment and altered myelination (Junqué, 2008). If magnetic resonance imaging is used, there are three parameters to classify the degree of diffuse axonal injury. (Table 5).

Table 5. Classification parameters of diffuse axonal injury Junqué, 2009.

DEGREE	DIFFUSE AXONAL INJURY
I	White matter and gray matter injury
II	Focal lesions in the corpus callosum
III	Additional brain damage to the brainstem

The most relevant quantitative measures in neuropsychology that reflect the impact of diffuse brain damage are the volume of the ventricular system, the surface of the corpus callosum, the volume of the hippocampus and that of the basal ganglia.

Both the volume of the ventricular system and the surface of the corpus callosum are an indirect measure of diffuse axonal damage. On the other hand, hippocampal and basal ganglia volume reflect diffuse neuronal loss of highly vulnerable brain structures. (Junqué, 2008).

The size of both surface and volume of these structures is related to the most frequent cognitive losses in TBI and that are the objective of intervention in neuropsychological rehabilitation, domains such as attention, learning capacity (vital for academic performance) and mental processing speed. The quantification of the atrophy of brain structures (loss of global brain volume) may have some interest to assess the impact of these sequelae on higher cognitive processes.

3.1.2. Educational needs of children who have undergone TBI

One of the most common problems that appear in children who have suffered a TBI (Table 4) is the slowdown in the **speed of information processing**, which implies that the student cannot continue learning at an adequate pace. You may need to present information more easily or you may also need more time to understand the information before responding (Carney et al, 2013)

Another aspect of vital importance is related to how the child with a TBI **assimilates the learning of school.** In general, the children did not forget what they had learned before suffering the trauma, and the pre-injury learning was relatively intact.

On the other hand, new difficulties will arise when new knowledge has to be stored, a mnesic process altered due to the ECT. We see that the child shows important limitations that affect their academic performance, so it will be necessary to take into account when considering the curricular adaptations that must be

taken into account, how is the student's ability to learn new skills and be able to overcome the respective academic years.

If we assess the alterations in **the mnestic processes** produced by the injury, we have a type of student with alterations in memory both in the coding phase and evocation of new information, which will have an impact on their learning capacity (Enseñat et al, 2015).

If we focus on **the attentional processes** altered after the injury, children who have suffered TBI are especially vulnerable to presenting attentional alterations, since these capacities are in continuous development during childhood. (Enseñat et al., 2015).

Attentional deficits are associated with frontal lobe lesions or diffuse axonal injury. The attentional manifestations will vary according to the type and location of brain damage. The most frequent attentional alterations are both in **sustained and selective attention,** showing a greater number of omissions (oversights) that increase over time. Attentional deficits of alternating type and divided attention are more evident in the later stages of development.

3.2. Childhood brain infections

Among the CNS infections that can occur in children, are those that are caused by viruses or bacteria, which invade the central nervous system (CNS) producing inflammation of the brain (encephalitis and meningitis). These CNS infections arise as a result of invasions by viruses and bacteria in the brain and spinal cord, through transmission via the nose, ears or mouth resulting in a wide number of neurological sequelae ranging from severe disability to complete recovery, through subtle alterations. (Enseñat el al 2005).

3.2.1. Viral encephalitis

Encephalitis is an inflammatory process of the brain of viral origin that produces a neurological dysfunction characterized by the presence of fever, headache and altered consciousness being infectious, autoimmune, etc. Others include acute cognitive dysfunction, behavioral changes, **focal neurological signs** and seizures. (Huanca et al, 2012),

Most cases of viral encephalitis are caused by Herpes simplex virus (HSV) types 1 and 2, varicella-zoster, Epstein Barr virus (EBV), measles, mumps and enterovirus. However, this will depend on the continent and environmental factors.

The herpes simplex virus mainly affects the brain parenchyma in the temporal lobes, and in some cases, frontal and parietal area. The mumps virus can cause acute viral encephalitis or postinfectious encephalitis.

The influenza virus causes diffuse cerebral edema as the main component in pathogenesis and for the varicella zoster virus the vasculitic process predominates.

The mechanism by which the virus crosses the blood-brain barrier explains the pathogenesis of any viral encephalitis. The usual neurotropic pathway consists of the penetration of the virus into the motor or sensory nerve terminals reaching the ganglion cells or motor neurons. HSV-1 encephalitis occurs during primary infection in younger children, however, in older children and adults, the most common mechanism is viral reactivation from the latent phase in which the viruses are located at the level of olfactory bulb and brainstem (pons and medulla oblongata). Huanca et al, 2012.

3.2.1.1. Symptoms of encephalitis

The symptoms are often similar to those of a flu-like picture (fever, headache, lack of energy), although in severe cases there are serious neurological disorders (altered speech and hearing, diplopia, hallucinations, changes in personality, loss of consciousness, loss of sensation in some parts of the body, muscle weakness, partial paralysis in the arms and legs, sudden severe dementia, impaired judgment, seizures, and memory loss).

In babies it is especially important to also pay attention to symptoms such as vomiting, body stiffness, tense or protruding fontanelle and /or constant crying and hypoactivity. Guaman, 2018.

3.2.1.2. Neuropsychological disorders caused by encephalitis

With regard to neuropsychological alterations, we find a cognitive profile where alterations are observed in memory processes (retrograde amnesia) and mainly alterations in executive functions (attention, planning, supervision of behavior). (Mogollón et al, 2010).

3.2.2. Meningitis

Meningitis involves inflammation of the meningeal membranes being this pathology relatively common in childhood. The most frequent symptoms are, **headache, fever, stiffness, vomiting, confusion and lethargy, and** may progress to a loss of consciousness with seizures unless treatment is instituted quickly. (Enseñat et al, 2015).

Meningitis can be caused by either a viral or bacterial infection, with viral infection being the most common, but it is the most difficult to diagnose. On the other hand, bacterial meningitis is easier to detect and already with the use of vaccination in children under five years of age the incidence of this disease has dropped considerably.

The treatment of bacterial meningitis requires the isolation and identification of the pathogen, as well as treatment with antibiotic therapy and in some cases, the use of anticonvulsant medication is necessary. In the acute phase of the disease there is an interruption in the dynamics of the cerebrospinal fluid (CSF) that causes a series of processes that increase intracranial pressure, causing hydrocephalus, cerebral edema and subdural effusions. (Enseñat et al, 2015).

All these events secondary to infection can negatively influence causing an increase in intracranial pressure (ICP) obstructing the flow of CSF in the ventricular system causing herniation (pressure that displaces structures) within the pons, medulla oblongata and cerebellum, affecting part of the cranial nerves that are located in these anatomical areas, *which is why vestibular alteration and hearing loss* are more frequent sequelae in children suffering from meningitis (Enseñat et al, 2015).

3.2.2.1. Neuropsychological alterations caused by meningitis

It is known that suffering from the disease before 12 months, is a risk factor for suffering neuropsychological and neurological sequelae, Although most of the problems associated with meningitis are resolved over time, there is a percentage of children to whom it does not happen, leaving them with permanent sequelae.

The sequelae caused by meningitis include a series of alterations in the main cognitive processes involved in memory, processing speed and alterations in language. It has been shown that children who have suffered bacterial meningitis obtain an IQ on average at a low or even below average, in more than one standard deviation (Enseñat et al, 2015).

3.3. Brain tumors

Brain tumors represent the most frequent type of solid tumor in pediatric age, being the second in general frequency after the group formed by leukemias and lymphomas. (López-Aguilar et al, 2011).

The signs and symptoms of neurological dysfunction in a child with a brain tumor vary and will depend on both the child's age and developmental level, as well as the location and origin of the tumor. The most prevalent brain tumors in childhood are **medulloblastomas and primitive cerebellar neuroectodermal tumor** , whose onset is located in the posterior fossa.

The usual age of diagnosis is between 3 and 9 years of age, being more common in boys than in girls. There are different treatment options, but the irreparable damage that radiotherapy can cause on the developing CNS of children is also recognized, which is why we try to delay its application whenever possible until 5 and even 8 years (Enseñat et al, 2015).

Neuroscientific research postulates that the neurotoxic effects of these treatments will lead to the presence of alterations in hippocampal neurogenesis (fundamental for mnestic processes), destruction of CNS neuron precursors (oligodendrocytes and alterations in white matter).

This can cause cognitive and behavioral alterations associated with chemotherapeutic and radiotherapeutic treatment. If we take into account specific cognitive skills, it is observed that, in these children, there is a decrease in general intellectual capacity, with lower scores on the manipulative quotient versus the verbal quotient. In addition, there are alterations in attentional processes (sustained attention), low speed in information processing, alterations in expressive and compressive language, abstract reasoning and the ability to store new information.

This has its relevance in terms of the academic assessment of children who return to classes, seeing that academic difficulties will appear in both reading and writing, as well as calculation, processes necessary for the acquisition of knowledge. (Enseñat et al, 2015).

Table 6. Main most common alterations in brain tumors (Grau Rubio and Cañete, 2002).

	Sensory	Motor	Cognitive	Emotional
Type of alteration	Uni- or bilateral perceptual deafness Total or partial blindness, temporary or homonymous hemianopsia, ocular motor impairment, nystagmus and mydriasis	Hemiplegia and hemiparesis, spasticity, ataxia, adiadochokinesia and paresthesia	Attentional disturbances, drowsiness, mental clumsiness (fog), mnestic difficulties and decrease in IQ scores Aphasia, dysarthria, akinetic mutism.	Mental fog, self-esteem issues and social skills

3.4. Neonatal ischemia-hypoxia

Perinatal asphyxia remains one of the major causes of neurological morbidity and mortality. **Hypoxic-ischemic neonatal encephalopathy** is a major cause of brain damage, affecting 1-3 in 1,000 newborns in a moderate-severe manner and posing a high risk of permanent neurological deficits. The only current therapeutic approach consists of moderate hypothermia, whose efficacy, although proven, does not always provide a total functional recovery (Moral et al, 2019).

Fetal asphyxia decreases cerebral and systemic blood flow with decreased oxygen and glucose supply, reversal of aerobic to anaerobic metabolism, decreased energy production, and apoptosis with or without permanent neuronal damage. Three forms of clinical presentation have been described. The mild form is characterized by total recovery in three days and without, or minimally, sequelae of neurodevelopment without body hypothermia. Moderate and severe forms lead to permanent neurological deficits and neurodevelopmental disturbances (48%) or death (27%) after treatment with body hypothermia (Papazian, 2018).

Perinatal hypoxic-ischemic encephalopathy (HIE) presents a set of clinical and neuropathological manifestations that occur in the NB after an episode of asphyxia, being necessary to clearly differentiate asphyxia from encephalopathy, since physiopathologically they are different, even if they are sequential events: asphyxia is cause, while encephalopathy is effect; however, asphyxia does not always produce HIE, nor is the choking factor found in all injuries. (Rizzo Ortega, 2017).

This syndrome of neurological dysfunction affects newborns older than 35 weeks, with an estimated incidence of 1-3/1000 live births. It is currently known that this pathology has a wide spectrum of symptoms characterized by the presence of motor alterations, movements, muscle tone, auditory dysfunctions with or without hearing loss, oculomotor alterations and tooth enamel dysplasia among others. Neonatal encephalopathy should not be seen as a causal risk factor for CP, but as a more reliable isolated prognostic factor in children born at term and near term. Perinatal asphyxia causing brain damage and subsequent sequelae is invariably caused by acute encephalopathy. (Barcia de la Cruz et al, 2021).

Summary

In this item III. 1 The concept of brain damage in children has been addressed and the different types of brain damage most prevalent in the child population have been reviewed. The neuropsychological function of the neuroanatomical and neurobiological structures involved, as well as their most frequent alterations in brain damage, has been reviewed to know the possible impact associated with the injury on a developing brain.

Glossary

Aconitic mutism: the estate in which a person is virtually unable to speak (mutism) or move (akinetic). Akinetic mutism often occurs due to damage to the lower frontal lobe of the brain.

Adiadochokinesia: The ability to perform rapid and repetitive opposite movements; this is the lack of coordination of body movements.

Anosognosia: neuropsychological disorder that generates in the patient an inability to have a state of full awareness about his disease or deficit, product of brain damage or a neurodegenerative process.

Apoptosis: programmed cell medicine.

Cell migration: the optimization of movements or massive displacements of nerve cells, or precursor cells, in order to establish differentiated populations of nerve cells (layers of the cerebral cortex, subcortical nuclei).

Cerebral parenchyma: brain mass consists mainly of neurons, glial cells and blood vessels, which together give a structure and intensity.

Differentiation: The process by which cells become more specialized. In the early stages of embryonic development, the cells are similar to each other, but they specialize later. Nerve cells acquire specific characteristics by being part of different structures of the nervous system.

Diffuse axonal injury (DAI): A form of traumatic brain injury. It occurs when the brain moves rapidly within the skull when an injury occurs. The long connecting fibers in the brain called axons are cut as the brain rapidly speeds up and decelerates within the hard bone of the skull.

Enamel dysplasia: Qualitative or quantitative structural disorders that occur during the period of amelogenesis (formation of tooth enamel). Dysplasias are included within the dentinal anomalies that imply that the teeth present an opalescent, bluish-gray opaque and amber appearance

Encephalopathy: malfunction of the brain. In current medical use, encephalopathy refers to a syndrome of brain dysfunction, which can be caused by multiple medical conditions.

Focal neurological signs: signs that appear by the presence of neurological disease and whose appearance, allows to locate the lesion in the cerebral area where the clinical findings are observed. In meningitis, Kernig's sign (resistance to passive extension of the knee) is observed

Myelination: Balancing axons with a myelin sheath in order to allow adequate transmission of nerve impulses.

Neurogenesis: also called proliferation, this being a process that consists of the miotic division of stem cells in the neural tube to later produce neurons and glia. It leads to the formation of brain regions at precise times. It begins with the caudal cortical regions to end with the most complex structures of the cerebral cortex.

Synaptogenesis: The establishment of synaptic connections as neuronal tissue develops and axons and dendrites grow.

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Resources

Web

Childhood brain damage: https://neurointegra.com/dano-cerebral-adquirido-infantil/

Spanish Federation of brain damage: https://fedace.org/

Active training in Early Care Pediatrics:
https://fapap.es/articulo/304/atencion-temprana-recursos-criterios-de-derivacion

Foundation to help newborns with neurological problems: https://www.neurologianeonatal.org/

Comprehension questions

Answer (true answer is in bold)

Question 1. Unlike injuries produced in adulthood, in the child we find

a) **Adeveloping brain, still with a large number of brain functions not yet acquired**
b) The same injury profile as if the injury occurred in an adulthood
c) Usually the lesions are solved almost in their entirety
d) The alterations that occur are simpler and less extensive than the lesions in the adult.

Question 2. If the brain injury occurs after the age of five, recovery will be:

a) The recovery will be total
b) The recovery will be total as long as the injury is bilateral during the neurogenesis process
c) Recovery will be partial
d) **They usually have minimal or no functional recovery**

Question 3. The main neuropsychological alterations found in childhood traumatic brain injury:

a) Alterations in gait, balance and the ability to learn new information
b) They do not usually have relevant neuropsychological alterations, except for a slowdown in the speed of information processing
c) **Expressive and comprehensive language, memory, attentional disturbances, lower processing speed, executive functions, emotional instability**
d) Loss of friendships, alterations in comprehension, poor performance in social skills.

Question 4. Attentional injuries are especially associated with injuries in:

a) **Frontal lobes and diffuse axonal injury**
b) Injuries to the hippocampus and cerebral ventricles
c) Basal ganglia lesions and generalized axonal damage
d) Lesions in the cerebellum and parietal lobe

Question 5. Encephalitis caused by the herpes simplex virus affects the lobes:

a) Occipital lobe and temporal lobe
b) **Cerebral parenchyma in the temporal lobes and in some cases frontal and parietal area**
c) Occipital lobe and ventricular system
d) Frontal lobe and occipital lobe

Question 6. Symptoms of encephalitis in infants are:

a) Similar to those of a flu-like picture, but without presenting the tense or protruding fontanel
b) Dizziness, dizziness, loss of balance
c) **Vomiting, body stiffness, tense or protruding fontanel with constant crying and hypoactivity**
d) Irritability and constant crying

Question 7. The main motor tracts most common in childhood brain tumors are:

a) Mental nebulosity and akinetic mutism
b) **Hemiplegia, hemiparesis, ataxia and paresthesia**
c) Apraxia, and left heminegligence
d) Hemiplegia, adiadochokinesia and dysarthria

Question 8. The most common causes of meningitis are:

a) **Viral or bacterial infections with viral infections being the most common**
b) Bacterial or viral infections, with bacterial being the most common
c) Viral, bacterial and fungal infections
d) Opportunistic infections due to an immature immune system

Question 9. Neonatal hypoxic-ischemic encephalopathy:

a) Asphyxia is the effect of encephalopathy
b) **Suffocation is the cause of encephalopathy**
c) Asphyxia always causes neurological deficits and alterations in neurodevelopment
d) Affects newborns younger than 35 weeks

Question 10. The usual age of diagnosis of childhood brain tumors is:

a) **Between 3 and 9 years old**
b) Between 3 and 6 years old
c) Between 3 and 5 years old
d) Between 3 and 4 years old

MODULE III.2 EPILEPSY

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I. INTRODUCTION

Epilepsy is one of the most common neurological disorders that occur during childhood. It can occur as a result of a wide range of CNS disorders such as brain infection, toxic, metabolic disorders, genetic malformations or acquired brain damage. It involves the presence of epileptic seizures (both focal and generalized).

Although most cases of epilepsy at school age are benign and have a good prognosis, the estimagtizante load that epilepsy usually has has a negative influence on the child, causing a negative social and psychological impact on their schooling process. In this chapter, the main epileptic syndromes will be reviewed, as well as the presence of certain syndromes in three age periods.

II. OBJECTIVES

- To Know the fundamental characteristics of childhood epilepsy.
- To Know the epileptic syndromes most frequent at this stage of development.

III. SPECIFIC CONTENTS OF THE TOPIC

1. Epilepsy and neonatal period (birth to 2 months)
2. Childhood-onset epilepsy (2 months to 12 months)
3. Childhood-onset epilepsy (from one to 12 years)

1. What is epilepsy?

Epilepsy is a neurological disorder of a chronic nature; whose clinical manifestation is **epileptic seizures.** According to the International League Against Epilepsy (ILAE), epilepsy is classified by differentiating epileptic seizures on the one hand and, on the other hand, categorizing the types of epilepsy and epileptic syndromes (ILAE, 2017).

Epilepsy can affect people of all ages, although there is a higher incidence (greater number of cases) between the first years of life and in old age. This disorder could be defined by the presence of at least **two epileptic seizures** not provoked (without stimulus that causes it) or reflex (induced by a stimulus: light, auditory, tactile, etc.) that occur separately on different days. (ILAE, 2014., Caraballo, 2019).

Epileptic seizures are the abnormal transient discharge of synchronous neurons in the cerebral cortex that produces a clear effect observable by the person experiencing it or by an observer (Fisher et al., 2017).

Epileptic seizures (Figure 1) are classif ied according to the **onset of the abnormal discharge** that gave rise to them, therefore, there are two types:

1. **Focal: epileptic** seizures that originate in a localized area of the cerebral cortex (known as the epileptic focus).
    a) They are seizures with motor, sensory, or psychomotor manifestations that depend on the location of this focus.

b) They do not initially produce loss of consciousness.

2. **Generalized:** They affect simultaneously and from the beginning the entire cerebral cortex.

a) They cause loss of consciousness since the beginning of the seizures.

b) The most common generalized seizures are tonic-clonic seizures.

Within generalized seizures, there are two types of crises that occur within childhood and adolescence. *In the grand mal crisis,* the child suddenly loses consciousness and may fall to the ground. This loss of consciousness is followed a few seconds later by the generalized contraction of all the muscles (tonic phase) that are followed by whole-body jerking (clonic phase). There is relaxation of sphincters and frequent biting of the tongue. The fall that causes the seizure can cause trauma or other injuries. After the seizure, the child falls asleep, disoriented, or drowsy. On the other hand, the *small mal type of seizures* is manifested by the presence of generalized seizures, although there are no seizures and there is a brief loss of consciousness (Caraballo, 2019).

Finally, ***epileptic syndromes*** refer to the association of a type or several types of seizures showing electroencephalographic (EEG) interictal (during the seizure) or ictal (the epileptic seizure itself) alterations that compromise the proper functioning of the central nervous system (CNS).

The most common forms of these syndromes are age-dependent or self-limiting, particularly in school-age children, which means that these epileptic seizures will remit or disappear definitively with brain maturation and that they also respond very well to treatment with antiepileptic drugs.

2. Classification of epilepsies and epileptic syndromes according to age

The classification proposed by the ILAE, (Figura 1) is created to respond to the categorization of **epilepsy** in a clinical context, being necessary for the diagnosis, the classification in three levels. Therefore, as we will see throughout this chapter, it is necessary to differentiate between the type of **epileptic seizure, the epileptic syndrome and the type of epilepsy** (ILAE, 2017).

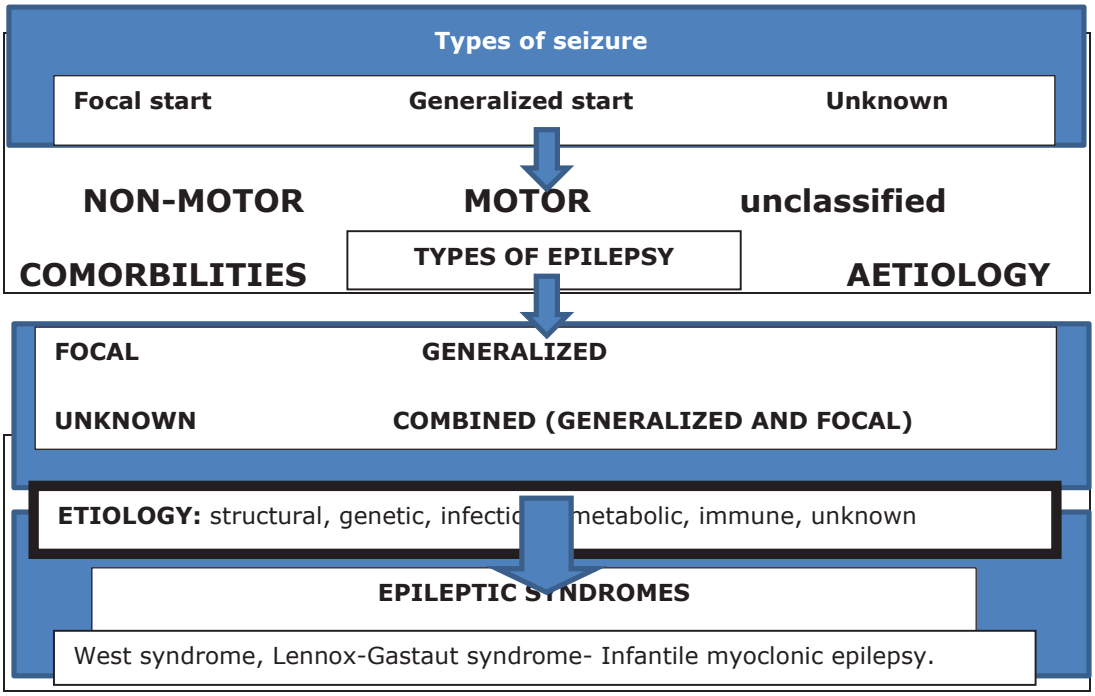

Figure 1. Classification of seizure types, based on ILAE, 2017.

The first diagnostic approach, once the seizure is identified (Figure 1) is to classify the type of epilepsy that will be part of an epileptic syndrome. Considering the classification made by the ILAE (2017) the epileptic syndrome (*set of symptoms and signs that define an epileptic disorder)* is classified into **four types of epilepsy** that are:

1. Focal epilepsy (motor onset the start of the engine).
2. Generalized epilepsy.
3. Focal or generalized epilepsy (combined).
4. Unknown, it is not known whether its origin is focal or generalized.
    a) Symptomatic or probably symptomatic.

With respect to *focal epilepsy,* (Figure 2) it is associated with abnormal neuronal discharge in a specific area of the brain and may include alterations in behavior, similar to the functions of the region where they originate. Focal seizures *can be with motor onset or with non-motor onset.* Symptoms with motor onset involve musculature, muscle contractions, automatisms, spasms, movements. In contrast, seizures *with non-motor onset* will involve the presence of behavioral, cognitive, emotional, sensory detection (Salinas et al, 2018).

With respect to *generalized seizures*, they result in loss of consciousness, but without more specific sensory or behavioral characteristics (Salinas et al, 2018).

Seizures of unknown cause are those seizures that cannot be classified due to lack of information or cannot fall into a certain diagnostic category. Also called symptomatic or probably symptomatic.

Type of epilepsy	Characteristics	Signs/symptoms
Focal motor epilepsy	Seizures that occur in a specific area of one of the two cerebral hemispheres.	It involves the musculature in some way, the event could be the increase or decrease in muscle contraction that generates the movement. No loss of consciousness
Focal epilepsy in the motor	Seizures that occur in a specific area of one of the two cerebral hemispheres.	Presence of behavioral detection, cognitive, emotional, sensory. No loss of consciousness
Generalized epilepsy	Seizures whose semiological features indicate that its onset compromises both cortical hemispheres.	Tonic-clonic seizures. Loss of consciousness
Focal or generalized epilepsy (combined)	Generalized seizures as focal	Both generalized and focal seizures.
Unknown epilepsy	Seizures that cannot be classified due to lack of information or do not fall into a certain diagnostic category.	The onset of seizures is unknown, and the person has an unknown type of epilepsy

Figure 2. Types of epilepsy. Based on Palacios et al, 2016; ILAE, 2019.

3. Evolutionary development of epilepsy

Brain maturation is a process that involves innumerable transformations, produced from conception, throughout gestation and later, until reaching maturity, reaching an adult brain. If the child's brain is expressed at each age in relation to the degree of maturation reached, with given patterns of behavior, before any functional or structural disorder that appears, his behavior will also be expressed differently (Etchepareborda, 1999).

Numerous studies show that the brain of the newborn has multiple fundamental differences in function, cellular composition and connectivity compared to the brain in childhood or in adulthood (Fons-Estupiña, 2018) Together with this, the presence of congenital brain abnormalities, inborn errors of metabolism and genetic disorders can determine the presence of recurrent seizures during the neonatal period (Caraballo, 2019).

Within the classification by age of epilepsy and following the classification of Browne (2009) in the neonate-infantile period, we highlight:

1. Epilepsy and neonatal period (birth to 2 months)
2. Childhood-onset epilepsies (2 months to 12 months)
3. Childhood-onset epilepsies (from one to 12 years)

3.1. Epilepsy and neonatal period

The neonatal period is especially vulnerable to seizure development because of the combination of specific factors in a developing CNS. Neonates have a highly excitable brain so the clinical expressiveness of a crisis in this age group is **focal type** by neuronal discharges of erratic origin in **one or another hemisphere**. (Etchepareborda, 1999., Browne et al, 2009., Fons-Estupiña, 2018).

The brain at this stage of neurodevelopment is manifested by presenting a bioelectrical continuity, interhemispheric synergy, wake-sleep differentiation, and reactivity to external stimuli in sleep.

The increased susceptibility of the newborn brain has the following characteristics:

1. **Anatomical maturity:** The presence of epileptic seizures is due to poor stratification of the cerebral cortex, poor development of dendrites, immaturity of the commissural pathways and cortico-subcortical pathways.
2. **Increased excitation:** Abundant glutaminergic synapses appear, with abundant receptors of the neurotransmitter glutamate in the hippocampus and with a certain proportion of receptors that we know are involved in the phenomena of brain plasticity.

Neonates often exhibit repetitive and stereotyped behaviors that may be mistaken for an epileptic seizure. These behaviors can range from repeated sucking or performing other orobucolingual movements, adopting abnormal postures, pedaling, or rowing movements with the arms, blinking, nystagmus or apnea. However, it is important to note that, if these behaviors are observed from a record of EEG activity, they are not generally associated with an activity that could indicate an epileptiform phenomenon (Browne, 2009).

The presence of **epileptic seizures** at this stage of neurodevelopment constitutes an alteration of neurological function that can *be motor, behavioral, autonomic (alteration of the autonomic nervous system) or a combination of the three (* Fons-Estupiña, 2018). Neonatal seizures are classified into *clonic, tonic, and myoclonic.*

Clone seizures consist of rhythmic jerks of muscle groups and may follow both a focal and multifocal pattern. In *multifocal clonal seizures*, movements may oscillate from one part of the body to the other. Although focal seizures associated with localized brain lesions can be seen (see neonatal strokes). Theycan also be seen in disorders that affect the brain diffusely, such as asphyxia, subarachnoid hemorrhage, hypoglycemia, and infections. (Brown, 2009).

On the other hand, ***tonic seizures*****,** the neonate adopts asymmetrical postures of the trunk or there is a deviation of the eyes to one side.

With regard to ***myoclonic seizures*****,** they are seizures very similar to those affecting older children and consist of rapid jerking of the muscles. These crises manifest themselves in the form of bilateral jerks, although occasionally a unilateral or focal myoclonus may appear.

The most frequent causes of neonatal seizures are *hypoxic-ischemic encephalopathy, ischemic and hemorrhagic strokes,* followed by *CNS infections congenital malformations of metabolism and epileptic syndromes of genetic origin*. During the first months and subsequent years of life, the infant is at high risk of seizures, due in part to the great cortical excitability and the poor maturation of inhibitory mechanisms. And because of birth, the infant is at risk from a series of aggressions, such as trauma, hypoxic-ischemic problems, intracranial hemorrhages and infections.

The presence of epileptic seizures mayindicate the existence of a CNS disorder and its recognition may be relevant for its subsequent approach. Seizures often remain a significant prognostic factor for an unfavorable neurological outcome.

Neonatal epileptic syndromes, as well as their electroclinical characteristics, are:

1. Benign neonatal seizures (fifth day seizures)
2. Benign neonatal epilepsy (ENBF)
3. Early childhood epileptic encephalopathy or Ohtahara syndrome.
4. Early myoclonic epileptic encephalopathy (PMS).

With respect to benign neonatal seizures, *also called fifth-day seizures*, unilateral, bilateral clonal movements of the limbs and face lasting minutes are observed, and apnea may appear. Seizures disappear spontaneously in most cases and the evolution is favorable. (Fons-Estupiña, 2018).

Familial benign neonatal epilepsy encompasses a group of benign epileptic syndromes that begin on the second or third day of life (in full-term newborns) that are defined by the presence of **tonic seizures** (*increase in muscle contraction for seconds or minutes)* with autonomic symptoms (symptoms, palpitations, etc.).

A family history of neonatal seizures may be found. Seizures begin with an initial tonic phase (symmetrical or asymmetrical) associated withapnea/cyanosis, followed by clonic movements, unilateral or bilateral, symmetrical, or not.

Semiology (study of symptoms) can also constitute a "*fixed gaze"* with arrest of the activity associated with autonomic or oculofacial phenomena. Seizures are brief and common (up to 30 episodes a day). Remission of seizures occurs around 4 to 6 months of age. Neurodevelopmentis usually normal and some of these children may have febrile or afebrile crises in childhood after a period without seizures (Fons-Estupiña, 2018).

Early childhood epileptic encephalopathy (Ohtahara syndrome) is a rare epileptic syndrome that has a poor prognosis. The onset of seizures may occur in the fetal period or after birth. The type of seizures, as in benign neonatal epilepsy, are tonic, symmetrical, or asymmetrical seizures, although focal motor seizures may also occur in approximately 30% of these infants.

Among the most frequent causes, cortical developmental malformations, genetic alterations related to channelopathies and synaptopathies stand out. Progression to infantile spasms or multifocal epilepsy is very common. (Fons-Estupiña, 2018).

With regard to *early myoclonic encephalopathy*, syndrome similar to Ohtahara, but differentiating the type of crises that are predominantly *myoclonus* The frequency of seizures can be variable but is usually continuous. The onset of crises is usually early, in the first hours or days of life and in some cases intrautero. Seizures are focal or subtle clones and may be followed by myoclonus. (Fons-Estupiña, 2018).

3.2. Epilepsy in infancy and early childhood (2 months to 12 months)

The groups of epileptic syndromes and the specific ones that begin between 2 to 12 months, are the *symptomatic and probably symptomatic focal epilepsies*, of which are the mesial, lateral, frontal, parietal, and occipital temporal epileptic syndromes). (Browne et al, 2009).

Regarding *generalized/symptomatic epilepsies*, highlight West *syndrome* and tonic seizures and atonic seizures.

With respect to *idiopathic and symptomatic generalized epilepsies*, there are three types of epilepsy: benign childhood epilepsy with centrotemporal tips, benign childhood epilepsy of early onset (with vegetative symptoms), and late-onset occipital epilepsy of childhood (with visual symptoms).

When we refer to symptomatic or probably symptomatic crises, these are related to the presence of structural injury.

And finally, with regard to seizures that do not necessarily carry a diagnosis of epilepsy, they are febrile seizures.

Within focal epilepsies and probably symptomatic, they can appear at any age. They produce three types of seizure.

1. Simple focal seizures
2. Complex focal seizures (psychomotor, temporal lobe)
3. Tonic-clonic seizures (grand mal)

Within this classification is organized into five syndromes where the semiology of the crisis will respond to the location of the epileptogenic zone (temporal, frontal, occipital, parietal lobe).

For example, if the epileptic focus is located in the temporal lobe, hallucinations of taste, vertigo, and auditory illusions, etc. may appear; in the occipital lobe, the symptoms are visual; in the frontal lobe, presence of stereotyped movements, complex automatisms, etc. On the other hand, if the location is parietal, the symptoms are burning in the contralateral hemibody, involuntary movements of the same in the form of flexion-extension.

A special mention within this category of focal epileptic syndromes in which is the *hemiconvulsion-hemiplegia, syndrome* that constitutes a rare form of epilepsy that occurs during the first two years of life. It consists of a sudden and prolonged unilateral clonic crisis followed by unilateral hemiparesis ((loss of sensation on the contralateral side of seizure onset) (Browne, 2009).

As for *generalized/symptomatic* epilepsies, there are four types of epilepsies (*West* syndrome, *tonic seizures, atonic seizures* and *Dravet syndrome)*

With respect to *West syndrome*, this type of epilepsy appears in children during the first year of life, with the peak age of onset between 4 and 6 months. Characterized by the presence of a triad of symptoms consisting of infantile spasms (IE), intellectual disability and a characteristic EEG called hypsarrhythmic.

These electroencephalographic alterations, characteristic of this syndrome causea stop of the neurological maturation process of the child at the beginning of the critical manifestations (during the crisis) and it is common to find its focal onset, age-dependent, being exceptional its aparición after the year of age.

As for the symptoms of this syndrome, highlight the presence of infantile spasms that are brief, bilateral, and symmetrical contractures of the muscles of the neck, trunk and extremidades and that in a sudden way determine the appearance of the spasm either in flexion, extension or mixed, being able to be of differentintensity (mild or massive).

On the other hand, *tonic seizures* consist of the sudden appearance of an increase in tone in the extensor muscles. The duration of seizures is longer than that of myoclonic seizures. On the other hand, in *atonic seizures* there is a sudden loss of muscle tone, involving the head, trunk, jaw or muscles of the extremities, which causes falls that cause trauma and injuries due to this type of crisis.

Another of the syndromes that appear at this stage of development is *Dravet Syndrome*. Se presents in the first year of life in a normal child with prolonged, febrile, and afebrile seizures, focal and generalized tonic-clonic. Seizures are usually untreatable, and from the second year of life, children show cognitive and behavioral impairments. (ILAE, 2017). A syndrome characterized by the onset of seizures typically around 6 months of age. Most babies have had an onset of seizures before 15 months of age; however, a small minority of cases begin in the second year of life.

The first seizure is associated with fever in about 60% of cases. Not all babies start with febrile seizures. The sensitivity of seizures to fever can persist throughout life. Head size and neurological examination are usually normal, but over time, ataxia and pyramidal signs may develop. (ILAE, 2017).

3.3. Childhood-onset epilepsies (from one year of age)

Among the epileptic syndromes that occur at this stage, we find *symptomatic and probably symptomatic* focal epilepsies, idiopathic *focal epilepsies, generalized idiopathic epilepsies, epileptic encephalopathies and those chrisis*that do not necessarily entail a diagnosis of epilepsy.

With respect to *symptomatic and probably symptomatic focal* epilepsies, there are the five mesial, lateral, frontal parietal and occipital temporal epileptic syndromes. These types of syndromes involve three types of seizures: simple focal seizures; Complex focal (psychomotor, temporal lobe) and tonic-clonic (grand mal). (ILAE, 2017., Browne, 2009).

On the other hand, *idiopathic focal epilepsies* may be the significant component of three important syndromes: benign *childhood epilepsy with centrotemporal spikes, benign occipital epilepsy of childhood, and Lennox-Gastau and Landau Kleffner epileptic encephalopathy*.

Benign partial epilepsy of *childhood with centrotemporal tips (rolandic) represents* a type of epilepsy that begins between 3 and 10 years in previously healthy children, characterized by the presence of focal sensory-motor seizures affecting the face, oropharynx, and upper limb (oro-facio-brachial clones, speech blockage and oral paresthesias). Seizures are infrequent and predominantly nocturnal. No treatment is recommended, except for frequent crises. The EEG shows a focus of tips in the center-temporal, uni or bilateral region. (Martínez et al, 2014).

Within *childhood epilepsy* with *occipital* paroxysms, also known as *Panayiotopoulos syndrome,* which appears in young children with a peak age of five years. The main symptoms are characterized by ictal vomiting, deviation of the eyes, and often with impaired consciousness. Seizures are rare and often solitary, but according to Browne (2009) about a third of children, episodes evolve into focal status epilepticus. The prognosis of this type of early onset is excellent and usually resolves within a few years of its onset.

As for *epilepsy with absence in childhood*, they can produce typical, myoclonic and tonic-clonic seizures of generalized onset. Childhood absence epilepsy is a genetic/idiopathic generalized epilepsy that should be considered in an otherwise normal child with multiple daily absence seizures associated with generalized peaks and waves of 2.5 to 3.5 Hz. Absence seizures are caused by hyperventilation. This syndrome is characterized by the appearance of frequent absence crises between 2 and 12 years (maximum 5-6 years). Development and cognition are typically normal. Attention deficit hyperactivity disorder and learning difficulty may occur. Seizures are usually self-limiting. (ILAE, 2017).

With regard to *Lennox-Gastaut syndrome,* severe form of epileptic encephalopathy that begins in childhood. Children with Lennox-Gastaut syndrome have frequent seizures of various types. Seizures usually begin between the ages of 2 and 6 and are usually accompanied by intellectual disability. Tonic seizures are a major component and exhibit a slow-wave tip EEG pattern. However, children with this syndrome usually present a mixture of different types of seizures, such as tonic-clonic, myoclonus, typical absences and head falling, which is a form of atonic, tonic, or myoclonic seizure. This syndrome is characterized by having very frequent seizures and it is common for atypical absence crises to go unnoticed by the parents and for the child (Browne, 2009).

And finally, *Landau-Kleffner syndrome* is defined by a subacute onset of acquired aphasia in a child with normal previous development and cognition. The syndrome begins between 2 and 8 years of age (maximum between 5 and 7 years), or rarely later. Seizures may not occur in all cases and, when present, are infrequent and self-limiting. However, there is a high risk of significant residual language impairment.

This syndrome is characterized by a subacute onset of progressive aphasia in a child with previous age-appropriate language development. The initial presentation may be with progressive aphasia (40%), seizures, or both. Children become progressively unable to understand the spoken word, stop understanding when spoken to them and respond verbally.

Psychiatric and cognitive disorders are commonly observed in addition to language impairment. Language impairment typically fluctuates. Seizures and EEG abnormalities resolve with age in most cases,

however, in most (>80%) residual language impairment is observed that can be severe (especially if onset is earlier). (ILAE, 2017).

Table 3. Main epilepsy and epileptic syndromes during childhood.

NEONATAL	
Severe epileptic syndromes	**Benign epileptic syndromes**
Ohtahara syndrome Myoclonic epileptic encephalopathy	Benign neonatal seizures Benign neonatal epilepsy
BREASTFEEDING/EARLY CHILDHOOD	
Severe epileptic syndromes	**Potentially benign epileptic syndromes**
West syndrome Lennox-Gastaut syndrome Dravet syndrome Landau-Kleffner syndrome	Benign epilepsy of childhood with centrotemporal tips. Benign epilepsy (vegetative symptoms). Benign occipital epilepsy of childhood. Symptomatic and probably symptomatic focal epilepsies (mesial, lateral, frontal, parietal, and occipital temporal epileptic syndromes).
CHILDHOOD (FROM THE FIRST YEAR ONWARDS)	
Epileptic syndromes of reserved prognosis	**Benign epileptic syndromes**
Symptomatic and probably symptomatic focal epilepsies Lennox-Gastau Landau-Kleffner syndrome	Benign partial epilepsy of childhood with centro-temporal tips (rolandic) Childhood epilepsy with occipital paroxysms (Panayiotopoulos syndrome) Epilepsy with absence in childhood

4. Neuropsychology of epilepsy

In general, epilepsy as such does not produce cognitive impairment, however, if it appears and is noticeable after the neuropsychological evaluation performed, this deterioration may be due to the presence of epileptic encephalopathy or an underlying brain injury (Ronconi, 2019).

Therefore, the process of describing the possible neuropsychological alterations found will have an added complexity that must be adapted to each child in particular. Another interesting issue is to assess that both behavioral and cognitive difficultiesmay be due to the impact of the underlying lesion or the epileptiform activity itself (electrical discharges) in neural networks in the process of maturation, which as we know, the child's brain is a developing brain.

The literature shows a decrease in the neuropsychological performance of the student with epilepsy in multiple domains, including general intelligence (Salinas et al, 2018).

1. *Cognitive functioning*: Although most children with epilepsy show normal intellectual functioning, significant variability is observed within groups , with a higher percentage in children outside the normative values when assessed with the general child population.
2. *Attentional functioning:* Certain antiepileptic drugs can cause lower attentional span concentration, and fatigue. It should also be noted that some epileptic syndromes have been associated with a specific alteration in attentional control, such as, for example, childhood absence epilepsy and, in addition, it is common to find comorbidity with ADHD (combined type). Importantly, studies show that attention problems can precede the onset of epilepsy, which has led to these two conditions being described as concurrent comorbidities (Salinas et al, 2018).

3. *Executive functions: Research on the effect of epilepsy* on the development of executive functions in children shows poorer executive performance in generalized epilepsy compared to, for example, focal onset epilepsy. The most frequent alterations found in these functions have more to do with working memory, processing speed and difficulty in solving problems. Thus, as these authors affirm, problems in executive functions have been shown to be a predictor of adaptability and quality of life in children with epilepsy as significant as the variables related to the disease and its severity. (Salinas et al, 2018).
4. *Memory:* It is observed that the type of epilepsy and its location (onset versus focal epilepsy) (hemispheric lateralization) affect mnestic performance (retrieval of previously stored information). Also, as a prognostic factor of this performance, assess that focal onset epilepsy originating in the frontal or temporal region may be a risk factor for observing low memory performances.
5. *Learning difficulties: There is* agreement in this regard when considering the presence of low academic performance both the level expected for their age and grade and an academic performance below what is expected at the cognitive level in the child with epilepsy. In terms of specific learning disorders, math problems are the most prevalent and verbal performance in both reading difficulty and the presence of poor performance on semantic memory tests.

Summary

This chapter has reviewed the main epileptic syndromes in the three stages of development with their most defining characteristics and showing the neuropsychological impact that these types of epilepsy could show.

Glossary

Asymmetric seizures: crises that cause a sustained muscle contraction consisting of the extension of one of the arms.

Channelopathies: These are disorders of muscle membrane excitability associated with mutations in calcium, sodium or potassium channels and acetylcholine receptors. This group of diseases has been called channelopathies.

EEG: Electroencephalogram.

Epilepsy: A CNS disease in which one or more seizures occur. The word comes from ancient Greek and means “sudden attack that overwhelms”.

Epileptic Syndrome: A disorder characterized by a set of signs and symptoms that usually occur together, including seizure type, etiology, anatomy, precipitating factors, age of onset, severity, chronicity, relationship to the circadian cycle, and sometimes prognosis.

FIS: Known as Flashing light stimulation, stimulation that occurs by n strobe that causes flashes of light, brief every 10-15 seconds. Especially useful for activating electroencephalographic recording and for the diagnosis of photosensitive epilepsies.

Hemiparesis: decreased motor force or partial paralysis affecting an arm and leg on the same side of the body. Consequence of the presence of hemiconvulsion-hemiplegia syndrome.

Hemiplegia: disorder of the body in which the counter-lateral half of the body is paralyzed. Consequence of the presence of hemiconvulsion-hemiplegia syndrome.

Hyperventilation: consists of inhaling and exhaling deeply for a few minutes. Very useful technique in the assessment of the crisis of childhood absence.

Hypsarrhythmia: slow activity characterized by slow waves of very high voltage, random, with peaks and focal sharp waves.

Hemorrhagic stroke: A stroke caused by the rupture of a blood vessel.

Idiopathic: No known cause or reason

Idiopathic Epilepsy: Epilepsy with seizures determined by alterations in genes, in which no alterations are found to justify seizures.

Ischemic stroke: A stroke caused by a lack of blood supply in a certain area of the CNS.

Paroxysmal activity: sudden increase in brain electrical activity, which may be normal or abnormal, depending on whether or not there are neurological symptoms.

Seizures: Transient occurrence of signs and symptoms arising from excessive or synchronous abnormal activity of neuronal activity. Phenomena that occur suddenly, transient, motor, sensory-motor, or psychic.

Stroke: Stroke.

Secondary or symptomatic epilepsy: Epilepsy that is due to a brain injury such as a tumor or scar on the brain or by some brain damage produced at birth.

Nystagmus: rapid and involuntary movements of the eyes that can be from one side to the other (horizontal nystagmus) up and down (vertical nystagmus) and rotational (rotational or torsional nystagmus).

Semiology: part of medicine that studies the symptoms of diseases.

Symptoms: indication or sign of a disease and serves to determine its nature. The symptoms of epilepsy are epileptic seizures, a seizure, loss of consciousness, absence, etc.

Sign: Something that is identified during a physical exam or lab test. For example, the sign of the four which is an asymmetrical tonic posture of the upper extremities at the beginning of the generalization phase in a secondarily generalized focal seizure.

Synaptopathies: Diseases of the brain related to malfunction of synaptic junctions.

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Resources

Web

International League against Epilepsy. https://www.ilae.org/translated-content/spanish

Terms about epilepsy. https://www.apiceepilepsia.org/glosario-terminos-la-epilepsia/

Comprehension questions

Answer (true answer is in bold)

Question 1. To consider epilepsy, according to the ILAE there must be at least:

a) **Two unprovoked or reflex epileptic seizures (induced by a stimulus: luminous, auditory, tactile) that happen separately on different days.**
b) Two epileptic seizures caused by an external or internal event (sleep deprivation, toxic consumption, metabolic disease) that happens several times on the same day.
c) Three unprovoked or reflex epileptic seizures (induced by a stimulus: luminous, auditory, tactile) that happen separately on different days.
d) Three epileptic seizures recorded by means of the electroencephalogram (EEG) with the characteristic graphoelements (wave-polypoint tip, theta activity)

Question 2. With regard to focal crises, these are characterized by:

a) **Epileptic seizures that originate in a localized area of the cerebral cortex**
b) They cause loss of consciousness since the beginning of the crisis
c) The most common crises are tonic-clonic seizures
d) They affect the entire cerebral cortex from the beginning

Question 3. Neonatal epiletic syndromes, as wellas their electroclinic characteristics, are:

a) Benign neonatal seizures, familial benign neonatal epilepsy, early childhood epiletic encephalopathy, and early myoclonic encephalopathy.
b) Benign neonatal seizures, familial benign neonatal epilepsy, Ohtahara syndrome and early myoclonic encephalopathy.
c) Benign neonatal seizures, familial benign neonatal epilepsy, early childhood epiletic encephalopathy, and Dravet syndrome.
d) **a and b are correct**

Question 4. With respect to Landau-Kleffner Syndrome:

a) Children who have this syndrome have frequent seizures of various types.
b) **It is defined as a subacute onset of acquired aphasia in a child with normal prior development and cognition.**
c) It is characterized by the symptomatic triad of infantile spasms, intellectual disability and a hypsarrhythmic EEG.
d) The child suffers frequent absence seizures and are caused by hyperventilation.

MODULES III.3 Y III.4 PREMATURITY AND MATURATIONAL DELAY

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I. INTRODUCTION

In the first years of life, specifically in the period 0-3 years of age, a series of developmental delays can be detected that may be due to a known vs. unknown aetiology. This chapter will specifically address two cases, prematurity and mild developmental delays. Both can lead to permanent developmental problems. Therefore, early detection and intervention are essential to prevent significant impairments in the future.

II. OBJECTIVES

1. To understand the most significant characteristics of prematurity in human babies.
2. To understand the most significant characteristics of mild developmental delays in ages 0-6 years.

III. SPECIFIC CONTENTS OF THE THEME

1. Prematurity

A term birth is defined as a birth at 40 weeks' gestation. Prematurity includes babies born at less than 37 weeks gestation, or with a birth weight of less than 2,500 grams. The causes of these circumstances are diverse and complex, and may be related to problems during gestation (socio-economic, multiple pregnancies, emotional and affective situations of the mother, hospitalisations or chronic illnesses of the mother, among others).

Low birth weight (LBW) has long been an important topic in neonatological and paediatric studies, as it is directly related to infant mortality and short- and long-term morbidity. However, the analysis of low birth weight has an associated prognostic scaling. Babies born weighing between 1,500-2,500 grams would be understood as low birth weight, those between 1,000 and 1,499 grams as very low birth weight, and those weighing less than 1,000 grams would fall into the category of extremely low birth weight. However, it is important to consider the causes of underweight, as the aetiology is related to the type of intervention and the prognosis.

Birth weight is determined by the growth of the foetus during gestation and the duration of gestation. LBW may be due to preterm birth but with normal growth up to the time of preterm delivery, or because the new-born is small for its gestational age, i.e. there has been an intrauterine growth restriction (IUGR). The aetiology will have differences for the development of the baby. For example, preterm birth leads to high mortality rates, as well as medical, neurocognitive and behavioural problems, and IUGR in its most severe form leads to metabolic disorders and, in less extreme cases, long-term growth deficits, learning disabilities and even chronic diseases in adulthood, such as hypertension, type 2 diabetes and coronary heart disease (Minded and Zelkowitz, 2020).

1.1. Babies with low birth weight due to premature birth

Children who are born prematurely and have a low birth weight have a higher probability of mortality, neurodevelopmental disabilities, behavioural problems and economic costs for the affected families.

Furthermore, the families of these children are often exposed to long periods of hospitalisation of their baby in the neonatal and/or paediatric intensive care unit (ICU). This situation can lead to stress and anxiety in parenting figures. However, advances in medicine combined with technological advances are now leading to a better prognosis for this type of condition. The common characteristics of low-birth-weight babies are:

1. Problems in psychomotor development.
2. Joint attention problems.
3. Problems in language development (morphosyntactic and semantic).
4. Problems in cognitive development.

However, the degree of impairment will depend on weight and other circumstances of embryonic development and/or birth. Early intervention is recommended to alleviate these difficulties. This intervention will focus on working with children and their families, guided by an interdisciplinary intervention delivered by multi-professional teams.

1.2. Very low birth weight babies due to premature birth

Babies with a very low birth weight are at a higher risk of suffering cognitive and behavioural problems. Early stimulation interventions have been developed in relation to sensory stimulation, medical follow-up, support to parenting figures and early schooling in a nursery school with specialised special needs education professionals. Premature babies move from the maternal environment to a Neonatal Intensive Care Unit (NICU) environment where there are strong stimuli such as bright lights, noises, etc., which are difficult for them to process.

1.3. Proposals for intervention in prematurity

There are now several options for early intervention in cases of prematurity. In addition to the absolutely essential medical follow-up for these babies, sensory stimulation programmes are being developed to enhance relationships between babies and parents in NICU settings. Particularly noteworthy are pre- and post-discharge parenting programmes based on the use of cognitive, motor and behavioural self-regulation, such as the " Infant Health and Development Program (IHDP)" (Ramey et al., 1992). The "Neonatal Behavioral Assessment Scale" (NBAS) (Aydlett, 2011; Barlow et al., 2018; Brazelton, 1973; Buckner, 1983) is also being used. This scale facilitates parental observation of the infant's sensory skills and responsiveness to self-regulatory processes. In addition, it offers an intervention proposal "Neonatal Induvidualized Developmental Care and Assessment Program" (NIDCAP), the application of this programme facilitates a decrease in the incidence of intra-ventricular haemorrhage, reduces days of mechanical ventilation, enables weight gain and decreases days of admission to the NICU (Als, 2009; Als and B McAnulty, 2011; McAnulty et al., 2010; Westrup, 2007).

Another intervention that is proving to be very effective is the application of the Kanguro method. This method was originally developed to care for premature newborns in unreliable incubator environments. This method can be applied by either the mother or the father and is considered to be effective in preventing hypothermia, improving sleep rhythm and quality, physiological stabilisation of behaviour and in the newborn's growth and neurodevelopment. It also improves parental stress and attachment between the baby and parenting figures, along with reducing hospitalisation and antibiotic use in low-birth-weight infants (Birhanu and Mathibe-Neke, 2022; Jamehdar, el al., 2022; Letzkus et al., 2022; Mehrpisheh et al., 2022; Pradhan et al., 2022; Kiputa et al., 2022; Taha and Wikkeling-Scott, 2022).

2. Maturational delay

Maturational delay is a delay without the detection of a specific etiology, whether physical, psychological or sensory. It presents as slower development according to the parameters in the developmental scales (paediatric, Brunet-Lézine, Battelle, etc.) and does not exceed one year of difference with respect to the age level of the subject being assessed, it also presents with a Global Development Quotient CDG of not less than 70, ranging between 70-99 out of 100. The delay may affect one, two, three or all areas of

development (motor, cognitive, language, social-emotional, and/or personal autonomy). We must start from the premise that development, especially in the 0-3 years stage, is global and interrelated, for example, fine or gross motor skills will condition cognitive development and this is directly related to the development of communication, language and socialisation. Likewise, psychomotor development will affect the development of personal autonomy.

Early detection is essential to implement stimulation programmes in the required areas of development and such detection is directly linked to a better prognosis.

2.1. Proposals for intervention in maturational delay

Module VIII will deal specifically with the creation of early stimulation programmes in the periods 0-3 and 3-6 years. However, we will then give an overview of possible instruments to be taken into account when creating intervention programmes. In the first place, the Portage Guide is a very useful instrument for creating programmes aimed at children with prematurity and those with a slight maturational delay.

The Portage Guide to Preschool Education (revised edition) is the result of a project, Project Portage, from the Cooperative Educational Service Agency 12 in Wisconsin (USA) (Bluma et al., 1978). The guide is available in both English and Spanish.

The Guide has a list of Objectives (behaviours) ordered by developmental age (from 0-1, 1-2, up to 5-6 years) that helps users to make an accurate observation of the child's development. Each objective has a number that corresponds to a card. It offers different activities or tasks that can help to implement the development of the specific behaviour specified in the objective. The Portage Guide covers the following areas of development: Stimulating the baby, Socialisation, Language, Self-help, Cognition and Motor Development. It also provides a series of guidelines for the design of the stimulation programme. In addition, it includes a section on reinforcement and work on the basic prerequisites for learning (attention, imitation and following instructions), which are fundamental elements for the proper development of early intervention programmes. It is worth highlighting the importance of the "How to stimulate the baby" area for intervention with premature babies or babies with developmental delay. This includes both objectives for observational behaviours in the 0-1 year stage as guides to intervention in this period. Similarly, the Portage Guide includes guidelines for intervention by early childhood professionals that describe the type of support that can be given (physical, through language, or both, including the behavioural techniques of modelling, shaping and social reinforcement). Table 1 shows the number of targets and guidance sheets per developmental area.

Table 1. Objectives and guidance sheets by area of development in the Portage Guide.

Development area	Objectives	Intervention sheets
How to stimulate the baby	45	45
Socialisation	83	83
Language	99	99
Self-help	105	105
Cognition	108	108
Motor Development	140	140
TOTAL	**580**	**580**

Another important tool for recording, developmental analysis and intervention is the eEarlyCare web application (Sáiz-Manzanares, Marticorena-Sánchez and Arnaiz-González, 2020a; 2022; Sáiz-Manzanares et al., 2020b). eEarlyCare includes a module for recording and analysing behavioural observation indicators and a module for therapeutic intervention, the "eEarlyCare intervention Program". A more detailed review of the tool is presented in Module VII. 3.

Summary

This topic,III.2, covered the definition of types of prematurity and the definition of mild developmental delay in children in the 0-6 years age range.

Glossary

CDG: Global Development Quotient.

IHDP: Infant Health and Development Program.

IUGR: Intrauterine growth restriction.

LBW: Low Birth Weight. Low birth weight.

NBAS: Neonatal Behavioral Assessment Scale.

NIDCAP: Neonatal Induvidualized Developmental Care and Assessment Program.

ICU: intensive care unit.

NICU: neonatal intensive care unit.

PICU: paediatric intensive care unit.

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Resources

Web

Brazelton Institute NBAS.
https://www.childrenshospital.org/research/centers/brazelton-institute-research/nbas

Mentoring Caregivers. Changing Hospitals. Improving the Futures for Newborns and Their Families.
https://nidcap.org/

NIDCAP Cincinnati. NIDCAP Training Center: A National Leader in Developmental Care.
https://www.cincinnatichildrens.org/service/n/nicu/hcp/nidcap

Comprehension questions

Answer (true answer is in bold)

Question 1. At what weeks is a full term birth?

a) At 39 weeks
b) **At 40 weeks**
c) At 38 weeks.
d) At 42 weeks.

Question 2. Neonates weighing less than 1000 grams are referred to as

a) Low birth weight neonates.
b) Very low birth weight neonates.
c) **Extremely low birth weight neonates.**
d) Neonates with intermediate weight.

Question 3. Prematurity may be due to

a) Intrauterine growth failure.
b) Premature birth.
c) **Both a and b.**
d) Neither a nor b.

Question 4. Premature babies can have problems

a) Joint attention.
b) Language development (morphosyntactic and semantic).
c) Problems in cognitive development.
d) **All of them.**

Question 5. The application of NIDCAP facilitates:

a) A decrease in intra-ventricular haemorrhage.
b) Days of mechanical ventilation.
c) Days of admission.
d) **All of the above.**

MODULE III.5 AUTISM SPECTRUM DISORDERS

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I. INTRODUCTION

Autism Spectrum Disorder (hereinafter ASD) is a neurodevelopmental disorder, which shows great heterogeneity and is difficult to identify since there are no observable biological markers. Early detection, based on the observation of certain risk indicators; the assessment of the child's development and behaviour, as basic diagnostic tools, and early intervention will be essential for people with ASD to receive, as soon as possible, support and specialised services that favour the development of personal competences and adequate coping strategies to face everyday life situations.

II. OBJECTIVES

1. To know what ASD is and its diversity.
2. Know and identify warning signs.
3. To learn about different tools and strategies for early detection, diagnosis and intervention.
4. Understand the importance of early action in the acquisition of skills to help minimise the impact of ASD.

III. CONTENT SPECIFIC TO THE THEME

1. Definition

The term Autism Spectrum Disorders (ASD) comprises a heterogeneous group of neurodevelopmental alterations of neurobiological origin and beginning in childhood that affect the configuration of the nervous system and brain functioning. They accompany the person throughout his/her life affecting fundamentally the development of communication and social interaction, and the flexibility of behaviour and thought (Confederación Autismo España, 2022). They present a chronic evolution, with different degrees of affectation, functional adaptation and personal development in the indicated areas according to the evolutionary moment (Hervás et al., 2017), the experiences and supports received (Rivière, 2001).

2. Approach to the concept of Autism Spectrum Disorders (ASD)

Although recent studies have confirmed that the first technical description of autism was made by the Ukrainian psychiatrist and researcher Grunya Efimovna Sukhareva in 1925 (Merino, 2016), Kanner (1943) (Austrian psychiatrist living in the USA) has been considered the first to describe this disorder in his article *Autistic Affective Contact Disorders* where he refers to a set of symptoms that characterised a population of 11 children, in such a precise way that his definition has endured for a long time.

The symptoms identifying the group of children described by Kanner were, according to Rivière (1991): Inability to establish relationships with people, extensive set of delays and disturbances in the acquisition and use of language; obsessive insistence on keeping the environment unchanged, accompanied by the tendency to repeat a limited range of ritualised activities and repetitive and stereotyped play sessions; occasional appearance of special skills, generally related to mechanical memory, and good cognitive potential, normal physical appearance and intelligent physiognomy and appearance of the first symptoms

very early (from birth). This last characteristic has generated great difficulties in diagnosis, it has now been shown that skills in certain areas can coexist with great deficiencies in others, and that from a special ability it cannot be inferred that there is a general level of intelligence.

In October 1943, shortly after the publication of Kanner's article, Hans Asperger, an Austrian neuropsychiatrist, published in German the article *"Die, Autistisehen Psychopathen im Kindesalter"* (Asperger, 1944) which did not become internationally known until 1981, when Lorna Wing published an English-language review of the Austrian doctor's work. In this work, Asperger describes four cases of people without intellectual disabilities, which he called "autistic psychopathy".

Following Martín Borreguero (2004), both Kanner and Asperger used the same term "autism" to refer to the primary and central deficit: the child's incapacity for social contact with other people. Both describe children with egocentric behaviour, a tendency towards social isolation and an apparent disregard for the emotions expressed by their reference figures. On the other hand, both doctors postulate the existence of an organic aetiology with unknown genetic involvement. In addition, they emphasise the existence of a profound deficit in the child's non-verbal communication skills, the presence of a restricted pattern of obsessive behaviours and interests, the absence of flexibility for symbolic play and a marked tendency to resist change (Murillo, 2013).

Despite these similarities, there are some differences between the two. Asperger considers "autistic psychopathy" to be a personality disorder whose initial symptoms do not manifest themselves until late in the child's childhood. Furthermore, according to this author, the child affected by this disorder showed adequate or advanced language development.

Wing (1981) has been the driving force behind the idea of a continuum, considering that the pathologies described by Kanner and Asperger were not different and independent categories, but that both were included within the broad spectrum or continuum of autistic disorders. This author replaces the original term "autistic psychopathy" with the term "Asperger's syndrome", establishes that the first symptoms begin to manifest themselves during the first year of the child's life, postulates that although language development is adequate, in some cases there may be an initial moderate delay and highlights the possibility that the child may show a degree of specific cognitive difficulties (repetitive and rigid reasoning strategies; difficulties in the effective application of their knowledge and cognitive strategies, with serious problems in solving practical questions, making basic decisions...; use of their memorising capacity with a high degree of difficulty, with a high degree of difficulty in the use of their cognitive skills, with a high degree of difficulty in the use of their cognitive skills...; use of their memorising capacity with a high degree of difficulty in the use of their cognitive skills...).; use of their memoristic capacity for the mere purpose of accumulating unlimited amounts of information about a particular topic of their interest).

This author differentiated four main dimensions of autism spectrum variation: 1. impairment in social recognition abilities, 2. in social communication abilities, and 3. in imagination and social understanding skills (these three dimensions define what is called "Wing's triad") to which is added, 4. repetitive patterns of activity. It also refers to other psychological functions such as language, response to sensory stimuli, motor coordination and cognitive abilities.

It is now widely accepted that the clinical presentation of autism is highly variable, which has led to the idea of heterogeneity being promoted, prompting a pluralistic and individualised view of "Autism" (Coleman and Gillberg, 2012; Waterhouse, 2013). Until specific biological markers are identified, ASD will continue to be defined by virtue of the behavioural symptoms it manifests. These symptoms are described in the international diagnostic and identification systems of the American Psychiatric Association and the World Health Organisation, DSM-5 and ICD-11 respectively.

3. Core characteristics of autism

Despite the existing diversity, people with ASD have specific characteristics, which can sometimes be associated with other conditions such as intellectual disabilities, language disorders or mental health problems.

3.1. Disturbances in communication and social interaction

Difficulties focus on the pragmatic and intersubjective aspects of communication and interaction, such as adjusting language, initiating an interaction, maintaining it, regulating paralinguistic aspects such as tone of voice, rhythm, prosody, silences, gestures, interpersonal spaces.

People with ASD have difficulties in joint attention; in communicative and social initiative; in the use of communication and pragmatic interaction, despite the appearance in many cases of a remarkable command of language; in the use and understanding of verb tenses that involve abstraction, tending to use imperative rather than declarative forms to a greater extent; in the development of creative language that they compensate for with reproductive and sometimes echolalic language (Merino, 2016). They show difficulties in showing adequate social and emotional reciprocity, so that, as they do not grasp social details, their social behaviour is often difficult to understand, generating great difficulties in making friends.

3.2. Restrictive patterns of interests and behaviour

The insistence on invariance, the difficulty to regulate sensitivity to certain stimuli and to react flexibly to them is affected, as well as imaginative activity, which influences their ability to understand the emotions and intentions of others. Many people with autism fail to develop normal pretend, fictional or fantasy play. Although in some cases imaginative activity may be present in the form of absorbing and evasive fantasies, in most cases it is ineffective, reproducing in some way scenes or visualisations that interfere with the person's appropriate participation in their contexts. Lacking the ability to imagine the thoughts of others, it is very difficult for them to anticipate what might happen and to cope with past events.

Behavioural patterns are often repetitive and ritualised. They may include attachment to strange and unusual objects. Repetitive and stereotyped movements and the use of verbal or behavioural rituals are common. They often show great resistance to change, manifesting significant behavioural alterations when their routines are varied or when their expectations are not met. Many people affected by autism develop specific interests or preoccupations with peculiar themes. Their thinking is also usually rigid and they only conceive of one way of understanding the world (Martos and Llorente, 2019).

In many cases they show unusual sensitivity (hypo- or hyper-sensitivity) to sensory stimuli - tactile, auditory, visual - which would imply either reduced reactivity to stimuli such as pressure, pain, heat, loud sounds or hypersensitivity, showing extreme reactions to light sounds, textures, touch, as well as a combined pattern in which some stimuli are barely perceived and others show hyper-reactivity.

3.3. Other associated characteristics (comorbidities)

Psychiatric conditions: anxiety disorders (generalised anxiety disorder, panic disorders, agoraphobia, specific phobias, social phobia, separation anxiety disorder); obsessive-compulsive disorder (OCD); depressive disorders, bipolar disorder, sleep disorders, behavioural problems...

Cognitive and learning dysfunctions: attention deficit hyperactivity disorder (ADHD); intellectual disability (associated in three out of four cases, so that the degree of intellectual disability covaries with the severity of the disorder). If we talk about learning difficulties, the percentage can be around 25%, problems in auditory and visuospatial processing and motor clumsiness.

Medical pathologies: Genetic syndromes (Fragile X syndrome or tuberous sclerosis), epilepsy, tic disorders...

4. Diagnostic criteria for ASD according to DSM-5 (APA, 2014)

A. Persistent impairments in social communication and social interaction in a variety of contexts, as manifested by the following, currently or by history:

1. Deficits in social-emotional reciprocity range, for example, from abnormal social approach and failure of normal two-way conversation through diminished shared interests, emotions or affections to failure to initiate or respond to social interactions.
2. Impairments in non-verbal communicative behaviours used in social interaction range, for example, from poorly integrated verbal and non-verbal communication through abnormalities of eye contact and body language or deficiencies in understanding and use of gestures, to a complete lack of facial expression and non-verbal communication.
3. Impairments in the development, maintenance and understanding of relationships range, for example, from difficulties in adjusting behaviour in various social contexts through difficulties in sharing imaginative play or making friends, to lack of interest in other people.

B. Restrictive and repetitive patterns of behaviour, interests or activities, which are manifested in two or more of the following, currently or by history:

1. Stereotyped or repetitive movements, use of objects or speech (e.g. simple motor stereotypies, alignment of toys or repositioning of objects, echolalia, idiosyncratic phrases).
2. Insistence on monotony, excessive inflexibility of routines or ritualised patterns of verbal or non-verbal behaviour (e.g. great distress at small changes, difficulties with transitions, rigid thought patterns, greeting rituals, need to take the same route or eat the same food every day).
3. Very restricted and fixed interests that are abnormal in intensity or focus of interest (e.g., strong attachment to or preoccupation with unusual objects, excessively circumscribed or perseverative interests).
4. Hyper- or hyporeactivity to sensory stimuli or unusual interest in sensory aspects of the environment (e.g., apparent indifference to pain/temperature, adverse response to specific sounds or textures, excessive sniffing or touching of objects, visual fascination with lights or movement).

C. Symptoms must be present early in the developmental period (but may not be fully manifested until social demands exceed limited capacities, or may be masked by strategies learned later in life).

D. Symptoms cause clinically significant impairment in social, occupational or other important areas of usual functioning.

E. These disturbances are not best explained by intellectual disability (intellectual developmental disorder) or global developmental delay. Intellectual disability and autism spectrum disorder often overlap; to make **comorbid** diagnoses of autism spectrum disorder and intellectual disability, social communication must be below that expected for the general developmental level.

Note: Patients with a well-established DSM-IV diagnosis of autistic disorder, Asperger's disease or pervasive developmental disorder not otherwise specified shall be given a diagnosis of autism spectrum disorder. Patients with marked impairments in social communication, but whose symptoms do not meet criteria for autism spectrum disorder, should be evaluated for a diagnosis of social communication disorder (pragmatics).

According to DSM-5, the diagnosis of ASD includes several conditions that used to be diagnosed separately: autistic disorder, pervasive developmental disorder not otherwise specified (PDD-NOS), and

Asperger's disorder. Instead it proposes three levels of severity of ASD, depending on the need for supports required.

	Social communication	***Restricted and repetitive behaviours***
Level 3 **"Needs very noticeable help**	Severe impairments in verbal and non-verbal social communication skills cause severe impairments in functioning, very limited initiation of social interactions and minimal response to social overtures from others. For example, a person with few intelligible words rarely initiates interaction and, when he/she does, engages in unusual strategies only to meet needs and only responds to very direct social approaches.	Behavioural inflexibility, extreme difficulty coping with change or other restrictive/repetitive behaviours interfere markedly with functioning in all domains. Intense anxiety/difficulty in shifting focus of action.
Level 2 **"Needs remarkable help"**	Notable deficits in verbal and non-verbal social communication skills; apparent social problems even with on-site assistance; limited initiation of social interactions; and reduced or non-normal responses to the social openness of others. For example, a person who utters simple sentences, whose interaction is limited to very specific special interests and who has very eccentric non-verbal communication.	Behavioural inflexibility, difficulty coping with change or other restricted/repetitive behaviours often appear clearly to the casual observer and interfere with functioning in a variety of contexts. Anxiety and/or difficulty in shifting the focus of action.
Level 1 **"He needs help"**	Without help in situ, deficiencies in social communication cause significant problems. Difficulty in initiating social interactions and clear examples of atypical or unsatisfactory responses to other people's social openness. May appear to have little interest in social interactions. For example, a person who is able to speak in full sentences and establishes communication, but whose extensive conversation with others fails and whose attempts to make friends are eccentric and usually unsuccessful.	Behavioural inflexibility causes significant interference with functioning in one or more contexts. Difficulty in alternating activities. Organisational and planning problems hinder autonomy.

Regarding the core characteristics of ASD, the ICD-11 (WHO, 2022), also includes the same two categories as the DSM-5 (difficulties in social interaction and communication, on the one hand, and restricted interests and repetitive behaviours, on the other), eliminating a third one that appeared in the previous ver-

sion, related to language problems. Both classifications also point out the importance of examining unusual sensory sensitivities, something common among people with autism.

However, there are also some differences between ICD-11 and DSM-5. For example, the WHO classification provides detailed guidelines to distinguish between autism with and without intellectual disability, but the DSM-5 only states that autism and intellectual disability can occur simultaneously. ICD-11 also includes the loss of previously acquired skills as a feature to be taken into account when making a diagnosis.

As far as the infant stage is concerned, ICD-11 puts less emphasis on the type of play children engage in (as it may vary according to country or culture) and focuses more on whether children follow or impose strict rules when playing, a behaviour that can be perceived in any culture and that may be a sign of inflexibility in thinking, a common feature among people with autism.

5. Aetiology

Since 1943, when the symptomatology of autism was identified until nowadays, there have been multiple causes that have been pointed out as responsible for the disability generated by autism. In the first years, the mother-child relationship was pointed out as the main factor. Its defender was Leo Kanner himself, who affirmed that the origin of the autistic disorder was in not having established an appropriate affective relationship with the child in the first childhood. This is the so-called "refrigerator mother" theory (cold, incapable of showing affection). This explanation constitutes one of the myths of autism and nowadays it has been completely discarded. It has been demonstrated that there is no causal relationship between the attitudes and actions of fathers and mothers and the development of autism (Murillo, 2013).

It is now known that ASD is a genetic condition, although so far no single gene directly linked to autism has been discovered, but rather it is the result of multiple mutations in interaction with the environment. Scientific studies lead to consider that more than one hundred possible different genes and environmental factors (such as certain characteristics of parents or perinatal events) may be involved in ASD and contribute to the development and evolution of this condition (Confederación Autismo España, 2022).

6. Explanatory theories

In the study of autism, three epochs can be differentiated. The first one (from 1943 to 1963) considered autism as an "emotional disorder" produced by inadequate affective factors in the relationship of the child with the foster figures, and in order to help the child with autism, the dynamic therapy was used with the aim of re-establishing the emotional bonds. In the second period (from 1963 to 1983), the first indicators appear that allow associating autism with neurobiological disorders; in this period, the efficacy of behavioural techniques for the treatment of autism is demonstrated. From the 80's onwards, specific programmes are created, education is recognised as the best treatment for autism, and autism is considered from an evolutionary perspective as a "developmental disorder" (Rivière, 2000; Alcantud and Dolz, 2003). Finally, research has been focussing on finding a cause that explains the wide set of anomalies and developmental lags observed in people with autism. In this way, theories have been generated that try to explain the reason of these disorders. Some of these theories are commented below.

Several attempts have been made to explain the cognitive processes underlying autistic disorder. The theory of *mind deficit theory*, one of the best known, shows the existence of a deficit in the ability to attribute mental states, thoughts, beliefs, intentions and emotions in others, i.e. the difficulty in inferring or making representations about the minds of others (Baron-Cohen et al., 1985). These authors propose that people with ASD lack this ability to think about thoughts and therefore have problems in certain (but not all) communication, social and imaginative skills.

The presence of mentalistic evidence and the analysis of social behaviours, moral judgements and the development of social motivation dependent on this explanatory theory, has boosted the development of works of intervention and behavioural explanation of autism that have notably improved the understanding of the cognitive mechanisms that differentiate people with ASD. Nevertheless, this theory presents limitations in the explanation of aspects such as the insistence on invariance. Later studies have shown the

capacity of learning and solving first and second order mentalistic skills, as well as the generalisation of these competences in their life, existing skills such as deception or insight (Fombonne et al., 1994).

Another of the explanatory theories of autism is the theory of ***executive function*** *deficit* proposed by Ozonoff et al. The difficulties in organisation, time comprehension, goal orientation linked to autonomy and social behaviour of people with ASD suggest the presence of an executive dysfunction, i.e. difficulties in establishing self-instructions and internal regulation systems linked to the achievement of goals, flexibility and adaptation to change, decision making, problem solving and control of actions and impulses, through processes of monitoring and inhibition of responses.

A third theory is that put forward by Frith and Happé (1994) which states that autism is characterised by *weak* ***central coherence*** or detail-focused processing. This theory suggests that in autism this aspect of information processing is impaired, and that people with ASD show part-centred processing, in which details are captured and retained at the expense of global configuration and contextualised meaning, i.e. they fail to extract gist or to take context into account.

Happé and Frith (2006), reconsidered the original suggestion of a basic deficit in central processing and questioned it in three ways, firstly, posing it as an ability for local information processing, secondly, contemplating that this is not a cognitive deficit but a partial processing mode and thirdly, proposing the need to revise this theory as explanatory in itself of the cognitive deficits linked to autism. This theory proposed that difficulties in integrating information from the context explained social difficulties; nowadays, the authors add to the importance of studying each autism in a more particular way and admit that the deficit in central coherence does not explain, nor is it the origin, of the social deficits of ASD (Merino, 2016).

Other theories are those of the *deficit in* ***intersubjectivity*** (Hobson, 1993), which posits a deficit in the processing of emotions and their regulatory function in interaction. Or *deficits in* ***joint attention***, deficits in sharing, and in showing and representing emotional states and affect (Mundy et al., 1992). Or deficits in the functioning of mirror neurons (Rizzolatti et al., 1999; Rizzolatti and Fabbri-Destro, 2010).

These theories, although necessary, since they allow explaining certain aspects of ASD, are still insufficient if they are considered in an isolated way. People with autism present alterations in areas that affect the whole development, so it is not possible to talk about a unique cause. It is fundamental the approach and knowledge, along the whole life cycle, considering other important variables such as gender, the presence of diagnostic comorbidities and the socio-cultural and family environment. The underlying deficits in autism should help to focus interventions by addressing not only the core symptoms, but also the way in which the daily life and functioning of the person are affected by these deficits. That is to say, intervention should also be directed towards the environment that represents society at large (Merino, 2016).

7. Prevalence

The increase in the prevalence of autism in the last years has meant a change in the image of people with ASD, as well as in the way of approaching intervention. The reference of studies carried out in different European countries allows us to say that ASD is present in 1 out of every 100 births (1%) (Zeidan et al., 2022). Data provided by the Atlanta Center for Disease Control based on an analysis of 2016 data (Maenner et al., 2020) indicated that ASD affects 1 in 34 boys and 1 in 144 girls.

In Spain, although there is no prevalence study with the necessary reliability and validity to provide us with realistic data on the incidence of these disorders, we could point to data on the prevalence of ASD in the province of Guipúzcoa, through a project[1] which has collected prevalence data from 14 European Union countries. This study was carried out with a general population and in the educational environment. The prevalence figure obtained was 0.6%, i.e. 1 in 160 (which corresponds to data from other international organisations such as the WHO). In addition, within the study a sensitivity analysis was performed to estimate potential new cases of ASD globally, leading to a final figure of 87 cases of ASD in this age group at the date of the study (2020) (Fuentes et al. , 2021), which would provide a population prevalence of 0.59%, lower than those reported by some other studies.

[1] Autism Spectrum Disorder in Europe of the European Union, ASDEU (https://asdeu.eu)

Starting from the estimation made on the basis of provisional data of the census (31/01/2021), as the exact number of people with ASD living in Spain is unknown, it can be stated that in Spain there are more than 450.000 people with autism; more than 4.500 babies with ASD are born every year and more than 1.500.000 people are linked to ASD, taking into account their relatives (Confederación Autismo España, 2022).

8. Early detection and diagnosis

Early detection constitutes a fundamental aspect in the approach to autism, since the beginning of an early intervention is intimately linked to its prognosis and, therefore, to the quality of life of the people who present it. According to Hernández et al. (2005) and Hervás et al. (2017) when we talk about ASD detection, different levels can be established: first, developmental surveillance; second, specific ASD detection, and third, specific diagnostic assessment by a specialised service.

The aim of screening is to improve the processes involved in detection in order to anticipate the moment when the first warning signs can be observed in order to achieve the highest quality care that will result in a reduction of diagnostic delay, the achievement of a diagnosis that meets internationally validated parameters and coordination with resources that guarantee specific ongoing intervention in the immediate environment of the person with ASD (Arnaiz & Zamora, 2013). Detection, diagnostic assessment and specific intervention in people with ASD constitute an inseparable triad that requires the coordination and training of specialists in the field of health, social services and the educational environment, as well as the development of specific intervention programmes.

Currently, there are no conclusive biological traits or markers to make a diagnosis of ASD, so behavioural indicators remain fundamental in the detection and clinical diagnosis. Research continues on the neurobiological, genetic and metabolic patterns of people with ASD with the aim of understanding the aetiology of this disorder and trying to determine early neurobiological markers that help to accelerate and facilitate the detection and diagnostic assessment processes (Arnaiz and Zamora, 2013; Hervás et al., 2017).

In recent years, progress has been made in the early diagnosis of ASD due to greater knowledge of early symptoms, improved detection and diagnostic tools (Busquets et al., 2018) and dissemination and information campaigns; greater specific and specialised training of professionals; access to detection and diagnostic tools; modification of diagnostic criteria through the DSM-5; better knowledge of protocols in detection and diagnosis. However, the inherent difficulties in the detection of these disorders still require professionals with good specialised training; stable coordination protocols and a high degree of ethical responsibility in understanding the impact that a diagnosis of ASD has on the person and their environment (Arnaiz & Zamora, 2013).

8.1. Early warning indicators and early detection tools

Throughout early childhood development, as babies mature and interact with their environment, they acquire a series of developmental milestones. When any of these milestones do not appear or appear atypically or very late, it is important to be alert to possible signs of ASD. These signs, in an isolated way, do not imply that a child has autism, but they do make advisable to start a surveillance system and to carry out a specialised assessment to confirm or rule out the diagnosis. However, it should not be forgotten that not all signs occur simultaneously in all children (Diez-Cuervo et al., 2005; Jimenez, 2013).

Developmental monitoring involves the systematic use of assessment scales. According to the Confederación Autismo España (2022) we could talk about the following warning signs that can be detected through the monitoring of the child's development (Centre for Disease Control and Prevention[2]):

Before 12 months:

- Little eye contact.
- Does not show anticipation when to be held.

[2] https://www.cdc.gov/ncbddd/spanish/autism/screening.html

- Irritability or emotional lability.
- Lack of interest in simple interactive games (such as tickling, peek-a-boo).

At 12 months:

- Absence of babbling, sounds or simple words.
- Little use of communicative gestures (such as pointing or waving goodbye).

Between 12 and 18 months:

- Absence of or limited response to own name.
- Do not look where others point.
- Do not point to ask for something; do not show objects.
- Unusual response of rejection to certain auditory stimuli.

Between 18 and 24 months:

- Delayed or precocious language development.
- Do not imitate gestures or actions.
- Repetitive and non-symbolic forms of play (e.g. lining up objects or repeatedly opening and closing doors).
- Lack of interest in interacting with other children.

The most successful studies in identifying early indicators of ASD have been prospective studies of siblings of children with ASD, based on evidence that siblings have an increased risk (5-10% higher than in the normal population) of developing an ASD (Zwiangenbaum et al., 2009). According to these authors, behaviours that may raise suspicion of ASD and/or initiate a surveillance system could be grouped into the following areas:

Language

- Delayed onset of first words and phrases.
- Altered response to naming.
- Delay in the use of communicative signs. s
- Reduced babbling.

Visual attention

- Fixation on certain objects.
- Reduced visual attention flexibility.
- Reduced social orientation (low motivation towards social interests) and increased orientation towards non-social stimuli.
- Prolonged exploration of play materials and difficulty in changing games.

Social communication

- Atypical gaze (eye tracking studies).
- Different visual orientation (1st year).
- Altered, less intense and less frequent expression: social smile, social interest, anticipatory response, joint attention behaviours, expression of positive affect).

Game

- Imitations of scarce actions.
- Interest in reduced social play.
- Repetitive game actions.
- Prolonged visual examination of toys (observed, manipulated, but not played with).

Motor development

- Delayed fine and gross motor skills.
- Atypical and repetitive motor behaviours and postures (in 5-month-old infants).

Temperament

- Abnormal behavioural reactivity.
- Atypical sensory reactivity.
- Irritability, difficult to console.
- Passivity, non-reaction to any social stimulus.
- Regulation of atypical care.

The identification and recording of early symptoms or warning signs is done by means of detection tools. Among the many existing ones, the following are highlighted:

- M-CHAT, M-CHAT-R/F (*Modified Checklist for Autism in Toddlers*) (Robins et al., 2009). It is a screening tool that parents respond to in order to assess the risk of autism spectrum disorder. It is the most widely used screening test internationally and has been adapted and validated for the Spanish population of 16-30 months of development (Hernández et al., 2005; Canal et al., 2011).
- 25 typical indicators of autism at the 18/24 months stage (Rivière, 2000).
- *Pervasive Developmental Disorder Screening Test-II* (PDDSTII) (Siegel, 2004). It comprises questions about the child's development in the first 48 months of life. It is based on information from parents and has 3 versions for 3 different stages of consultation.
- ESAT *(Early screening for autistic traits questionnaire)* (Dietz et al., 2006). It is a 14-item questionnaire designed to identify children at risk for ASD at 14-15 months in combination with specific developmental monitoring.
- CSBS DP (Wetherby and Prizant Social and Symbolic Behaviour Scale, 2002). It is not specific for the detection of ASD, but it is used to monitor social and communicative development between 6 and 24 months. It allows to establish alterations in the areas of language (vocalisations, words...), social (emotions, eye contact, gestures...) and symbolic (understanding and use of objects). It consists of 24 questions to be answered by the child's parents or carers.
- For older ages, the Social Communication Questionnaire (SCQ) can be used (Rutter et al., 2003). It is a questionnaire answered by parents and caregivers to assess possible ASD. It is composed of 40 items that add up to a total score and three possible additional scores (social interaction problems, communication difficulties and restricted, repetitive and stereotyped behaviour). It is indicated from the age of 4 years. It is divided into two parts: A (lifelong) and B (current). The cut-off point is 15.
- The Haizea-Llevant Scale, (Fernández Matamoros, 1991) validated in Spain, allows to check children's maturation between birth and 5 years of age, to alert about the possible presence of ASD and other disabilities in childhood (Hernández et al., 2005).

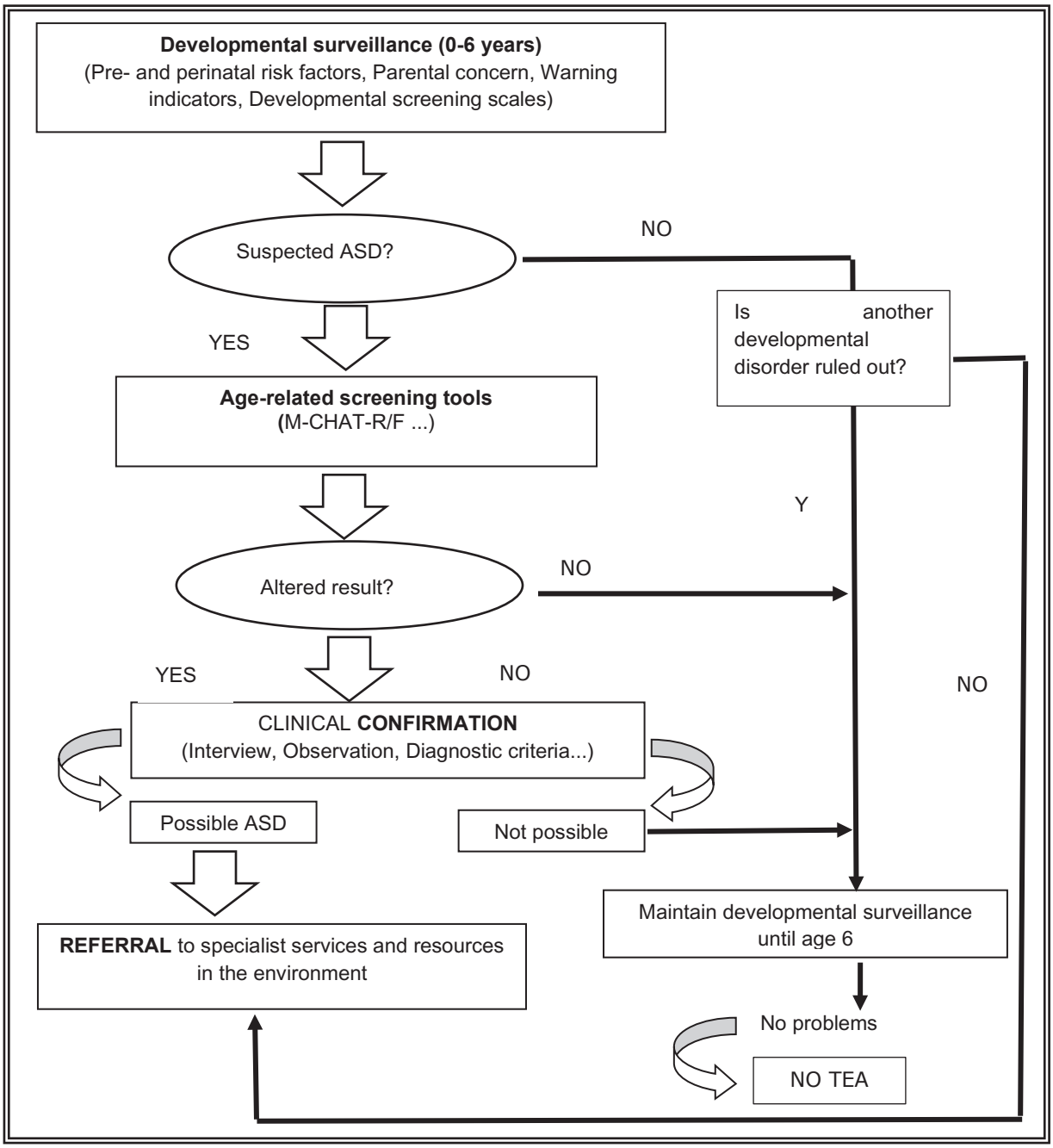

Figure 1. Decision algorithm for the detection of autism spectrum disorders. Adapted from Arnaiz, and Zamora (2013).

The figure above shows an example of the screening and referral process to be carried out by health, education and social services.

Alonso-Esteban et al. (2020) in their study on the quality of available ASD screening instruments concluded that more coordinated and joint research efforts are needed to improve our understanding of ASD and to increase and improve early detection tools in the Spanish-speaking population.

In the field of early detection of ASD it is important to note that research studies using eye-tracking[3] as a biomarker, which aim to find risk indicators in infants, are currently of particular note.

[3] The BB Miradas programme for the early detection of autism https://www.autismoburgos.es/programa-bbmiradas/ has collected millions of data from 276 babies aged 4 to 36 months in Burgos, of which 60 have been diagnosed early, "which greatly improves their quality of life and that of their families". https://www.diariodeburgos.es/noticia/zc2e8f416-d479-6f9c-0c3efed265b2a0cf/202209/fundacion-miradas-autismo-y-la-ubu-refuerzan-su-colaboracion; http://bbmiradas.fundacionmiradas.org/

8.2. Early diagnostic assessment

Once signs of ASD have been detected, the child should be referred to specialists for a comprehensive assessment. The diagnosis is made based on observation of their behaviour, knowledge of their developmental history and the application of medical and psychological tests to detect the presence of the signs and symptoms of autism. That is to say, the diagnostic assessment must include: an exhaustive medical and neurological assessment, complete family history, physical and neurological examination (head circumference, general examination -including mental state in all aspects associated to autism-, motor examination, audiometry) and laboratory tests (metabolic and genetic studies, electrophysiological tests, neuroimaging tests...) (Hervás et al., 2017).

It must be carried out quickly and effectively, avoiding any delay in diagnosis and therapeutic intervention, by a multidisciplinary team of professionals specialised in ASD, with the collaboration of other professionals who are in contact with the affected person (teachers, professionals from early intervention teams, etc.) and, of course, the family.

The current international criteria used (DSM-5 and ICD 11) have sufficient reliability to ensure the validity of the diagnosis. The assessment should include information from parents, observation of the child, interaction with the child and clinical judgement. For this purpose, there are structured systems to obtain information, such as the ADIR interview and structured observation systems such as the ADOS, which confer a higher reliability to the diagnostic classification (Autismo Burgos, 2005). The ADI-R (autism *diagnostic interview-revised)* and the ADOS2 (*autism diagnostic observational schedule)* are considered key instruments in the clinical and research assessment of ASD. The ADI-R is an interview with parents or caregivers of children, adolescents and adults with ASD. The ADOS2 (updated version of the ADOS) is a semi-structured interview for children, adolescents and adults with ASD. These tools should be used by professionals trained in their use.

As established in the guidelines for good practice in assessment and diagnosis (Díez Cuervo et al., 2005), it is necessary to use standardised tests and examinations, validated and adapted to the Spanish population, for the assessment of cognitive and language areas that can establish criteria for making decisions on the development of the person in these areas.

8.3. Difficulties in the diagnostic process

When making the diagnosis, especially at early ages, it can be difficult to establish the limits with respect to other developmental disorders that show some behavioural overlap (specific language disorders, intellectual disability, comorbid psychological disorders...). To overcome these difficulties, it is necessary to effectively and thoroughly assess the behaviours and competences indicated in the diagnostic criteria, mainly the socio-communicative area and the repertoire of interests, activities and repetitive behaviours (Arnaiz and Zamora, 2013).

Another important challenge relates to improving the diagnosis of girls with ASD. The presentation of symptoms may be different from that of boys, and this means that in some cases their difficulties may go unnoticed. Merino (2018) points out some of these divergences. Girls may not show: repetitive or stereotyped behaviours, or clearly show unusual interest, symptoms that are expected and observable in many children with ASD, but just because they are not observed in girls does not mean that they are not present; repetitive and stereotyped behaviours that are as marked or frequent as in boys (Merino, 2022). In addition, they may present special interests similar to their typically developing girl peers with the same themes, and often less quirky or peculiar than those more commonly reported in their male peers on the autism spectrum, etc. (Martos and Llorente, 2019).

Detection and diagnosis is particularly difficult when we encounter individuals with ASD in what the DSM-5 calls grade 1 (previously called Asperger syndrome). These cases are diagnosed, on average, at the primary school stage. This does not imply that before this age their main characteristics had not manifested (parents usually report their first suspicions at around 22 months of age) but that, in many cases, they have not been correctly diagnosed and may be referred to erroneous diagnoses such as communication disorders, ADHD, schizoid personality disorder (Arnaiz et al., 2007). A proper diagnosis benefits the family and pro-

fessionals in different areas, but above all the person with ASD, as it has a direct impact on the planning of educational resources and medical and social support which, together with society's increasing awareness of ASD, can offer the person the ideal context for their personal and social development.

To finish the section of diagnostic assessment, to point out the importance of families in this process. They present a multiple and diverse role: they constitute the most exhaustive source of information on the development of the child, providing key data in the issuing of the diagnosis; they request and receive the diagnosis; they unconditionally support the family member with autism in all the stages of his/her life, they look for and plan supports and resources; and they bear for life the effects and impact of this disorder on the persons and the family functioning (Arnáiz and Zamora, 2013). To these roles, we must add their responsibility as creators and managers of resources, as they are an active part of Associations that run specific services for ASD.

9. Early intervention and care

Nowadays, there is no specific medical treatment to modify the nuclear characteristics of autism. Early detection and the consequent implementation of an early intervention programme is still the main option, as it is related to a better clinical evolution of the child.

The main approach to ASD is of a psychoeducational nature, through interventions that are used alone or in combination with pharmacological treatments, which do not explicitly address the main symptoms of autism. These constitute support measures for behavioural management and reduction of associated clinical symptomatology, such as uncontrolled behaviours, insomnia, self-harm, etc. (Saldaña and Moreno, 2013).

According to Rivière (2001), intervention priorities depend on the developmental stage and characteristics of each child. Taking into account that a child with ASD does not necessarily learn at a slower pace than others, but has a learning style that is divergent from others, the degree of evolution will vary according to his intelligence and the severity of his symptoms, as well as his possibilities of symbolic and linguistic development, the degree of family assimilation, the quality of educational and therapeutic services.

The implementation of intensive and comprehensive early interventions specifically designed for children with ASD indicates very satisfactory results. These interventions have certain common aspects: persisting in a naturalistic approach, empowering parents and significant others, and being designed taking into account both the theories of interpersonal development and the implementation of behaviour modification techniques and strategies aimed at managing behavioural problems of infants with ASD (Hervás et al., 2017).

Early intervention needs to include goals based on the expected developmental milestones of a "typical" child. It should revolve around social routines, taking into account the child's motivation and interests, in order to stimulate and work on the most impaired areas of neurodevelopment (imitation, communication and language, social initiation and motivation, development of motor and cognitive skills such as play, and, at the centre of all intervention, interaction with an adult). Priority should be given to developing the capacity to generate opportunities for social interaction in which the child with signs of ASD is the natural initiator of the interaction. Therefore, the person providing the intervention needs to be sensitive, skilled and creative and therefore motivating. Through imitation and initiation of actions, movements and activities in interaction with another person, the aim is to stimulate brain structures related to gaze following, joint attention, facial perception, emotion recognition and imitation, among others.

According to Hervás et al. (2017) any type of intervention must meet the following requirements:

- Start as early as possible.
- Shared and coordinated between the parents, the educational centre and the therapist responsible for the child, throughout the different stages of development.
- Individualised, applying strategies adapted to the needs and characteristics of each child.
- In the child's natural environment, whenever possible,
- Intensive, including the hours the child is in school and the hours spent with his or her family.
- As in the diagnosis, count on a multidisciplinary team and the collaboration of other professionals, if deemed appropriate.

9.1. Early intervention programmes

9.1.1. Communication programmes

Alternative or augmentative communication systems aimed at people with ASD who have little verbal communication capacity, either because they have not developed language, or if they have language, it is scarce and they need visual support as a complement to their verbal language.

One of these programmes is the *Picture Exchange Communication System* (PECS) created by Bondy, and Lori Frost in 1985 and whose main objective is to teach functional communication. Through pictures, images or pictograms the person with ASD can make requests for things they want or can make comments or longer sentences and through a "sentence strip" answer questions. It presents different levels of complexity, from teaching the child to deliver the image of an object to the receiver (request) to expressing wishes, feelings, emotions... The progress in the levels is determined by the age and characteristics of the people to whom it is applied.

9.1.2. Programmes on social interaction and promotion of social competences

As we have already mentioned, people with ASD have difficulties in theory of mind, i.e. in attributing mental states to others, giving them their own thoughts and feelings, different from those of oneself; and in executive functions, i.e. in attending to the signs of the environment and the people with whom they interact, planning actions, solving possible problems and being flexible to seek more than one solution, evaluating the consequences of each one. Therefore, in order to develop competences in the social area, it is first necessary to work on metalistic capacity (Rivière, 1991), through mentalistic stimulation programmes (Saiz Manzanares and Román Sánchez, 2010, 2011) and executive functions.

There are different types of interventions to teach social skills (understanding social situations, responding to others' social initiatives, initiating social behaviours directed at both adults and peers, decreasing stereotyped behaviours and using a varied repertoire of flexible responses, thus developing self-regulatory behaviour). Social stories, social scripts, etc. are some of the strategies to be used to improve these kinds of competences.

9.1.3. TEACCH Programme

The TEACCH programme, Treatment *and Education of Autistic and Related Communications Handicapped Children (*Schopler 1988, in Mesibov and Howley, 2021), is based on the knowledge of the abilities of the person with ASD, in understanding autism. Its main objective is to offer security and to generate autonomy in people with ASD. It starts from the general philosophical principle of the need for an adjustment between the person and his/her environment, through the improvement of the person's abilities by means of education and the introduction of changes in the environment to respond to his/her difficulties (Saldaña and Moreno, 2013).

It is the educational intervention methodology that best understands people with ASD and is primarily based on structured teaching, which, according to Mesibov and Howley (2021), evolved in order to make educational actions responsive to the different ways of understanding, thinking and learning of people with ASD.

Structured teaching is based on the evidence and observation that people with ASD share a neurological pattern of strengths and weaknesses called Autism Culture (Mesibov and Shea, 2010). It is designed to address the main neurological differences that occur in autism (Mesibov and Howley, 2021).

According to these authors, the main elements of structured teaching, which should be present, as far as possible, at home and in the pre-school, are:

- Physical structuring and spatial organisation: This refers to the way furniture, materials and the general environment are placed in order to add meaning and content to the environment. It allows to organise and clarify the purpose of the space, as well as to reduce distractions ...

- Timetables and agendas: They provide cues that tell children with ASD what activities will take place over a period of time and in what order; they organise and communicate sequences of events in a way that is understandable to the person.
- Work system and task organisation: It provides a systematic way of approaching the work to be done in order to get the tasks done. It serves as a complement to the timetable that outlines the sequence of activities a person has to follow during the day, the work system tells the person what activity to do and how to do it. It is a type of support that helps people with ASD to develop organisational skills.
- Visual information: Includes everything that is used to organise, clarify and differentiate tasks and activities. They are visual aids to guide the person with ASD, providing information on how to complete tasks and how to use the necessary materials. Each task should be visually organised and structured to minimise anxiety. Therefore, three components must be taken into account: visual clarity, visual organisation and visual instructions.

9.1.4. Positive Behavioural Support

Educational intervention strategy, based on the principles of behaviour modification, with scientific support and experience, in terms of its high efficacy in people with ASD.

According to this approach, a behavioural problem is due to confusion, a lack of communication skills... in other words, it is a reaction to a situation that the person with ASD does not understand or for which he/she does not have communication or coping tools. Therefore, in order to cope with behavioural problems, environmental conditions and/or skill deficits must be corrected (Carr et al., 1996). It therefore places emphasis on the context, modifying it, and on the person's skills, helping to empower the person by acquiring communication, social and coping skills.

The principles of Positive Behavioural Support are:

1. Behaviour has a function for the person.
2. Behaviour is related to context.
3. Effective understanding must be based on an understanding of the person, their social context and the function of the behaviour.
4. Intervention should focus on the values of the individual, respect for his or her dignity, preferences and aspirations.

9.1.5. Sensory Stimulation and Integration

As has also been discussed throughout this module, hyper- and hyposensitivities are a characteristic of ASD, consisting of either an increased (hyper) or decreased (hypo) capacity for sensory perception and integration (commonly auditory and nociceptive or physical pain perception). This different form of sensory processing is often the cause of problems in learning, behaviour and motor coordination, and may affect global development (social, cognitive, care and personal autonomy skills and communication).

Sensory stimulation and integration facilitate the ability to organise oneself in the world around us. However, taking into account the diversity of response to stimuli that people with ASD may present, when intervening it is important to know the individual characteristics and to make a specific sensory profile in order to maximise the intervention and facilitate the assimilation and understanding of information.

In terms of intervention, modifications can be made to the environment, such as reducing clutter, minimising noise and other distractions... Space dividers can be helpful in reducing alertness by removing stimuli. For example, it can be useful to divide the space into a work area, a movement area and a quiet zone.

According to Miñano (2019), sensory integration could be a useful tool for improving adaptive skills in children with ASD, improving their sensory experiences and their occupational performance in their daily lives, although he refers to the need for more rigorous studies. Abelenda et al. (2020) conclude their study by stating that the use of sensory integration with people with ASD is currently an evidence-based intervention.

10. Characteristics of Early Intervention Programmes

In conclusion, we present the main aspects that, according to AETAPI (2012) (see Márquez, 2013), need to be taken into account in order to achieve quality programmes.

1. To offer *advice and coordination to families* in their daily problems and in everything related to the regulatory framework and resources available in the environment.

2. To start from *psychoeducational approaches* as these are the ones that provide the best evolution for people with ASD. They include psychological and educational services focused on assessment and intervention in socio-emotional, communicative, play and behavioural aspects, without neglecting aspects related to personal self-regulation, autonomy, family relationships, academic skills, leisure and community life.

3. Using *specific programmes and techniques* that facilitate the understanding of the physical and social environment around the child and thus increase the child's possibilities to communicate and relate. Use of visual systems to support communication and/or understanding of the environment, the strategy of minimising or reducing or adapting language to children's needs and abilities, the strategies of the natural model or pragmatic model for language stimulation, or the strategies of the motivational model and structured work environments.

4. Include the family. The *participation of the family* is relevant within the early intervention programme, and for this reason, it is very important to count on the full inclusion of the family as members of the team and to offer training for this task.

5. Individualisation of intervention. After a detailed assessment, a *global or comprehensive* intervention plan should be drawn up, agreed upon by all the adults in the different settings, which responds to individual needs and characteristics, which promotes the best possible development and which is focused on everyday life, on the promotion of legitimate personal and family well-being.

6. Intervene *intensively* and *extensively*. Provide an intervention that is feasible to develop at all times, in a generalised manner and by the people who make up the child's social and educational environment.

7. The intervention programme should focus on developing *meaningful* and motivating *learning*, taking into account personal interests, age and different environments.

8. The areas of *communication skills, social development and play,* those most in need of support, should be a priority target for intervention, as overall development can be advanced as a result of intervention that focuses on these areas as opposed to the sometimes excessive weighting on cognitive, oral, motor, academic skills or general stimulation programmes. During the first years of life, learning is basically *incidental*. Learning takes place through play and experimentation with the environment and in relation to others, accompanying these interactions with the appropriate strategy at any given moment. Children with ASD also learn through interaction with their environment, as long as intentional incidental learning is promoted.

9. The early use of *augmentative and/or alternative communication systems* is very useful for the improvement of communication and oral language in people with ASD, so it is necessary to ensure that communication will be favoured from the earliest ages using these systems from practical experience and flexibility. It is essential that communication aids are used by all the people in the child's environment and it is also necessary to have an individualised intervention, focused on the interests of the child and his/her family.

10. The principles of *positive behavioural support* recognise that the best way to manage problem behaviours is to know in advance the function of the behaviour for the person engaging in the behaviour and that the intervention respects the legitimate aspirations and desires of the family and, therefore, of the child. Once the reason for the inappropriate behaviour is known, preventive and/or educational strategies are proposed, in addition to promoting appropriate skills and behaviours that fulfil the same function as the inappropriate behaviour.

Summary

Throughout this module III. 5 we have been getting into the reality of the Autism Spectrum Disorders (ASD). The definition, history, core characteristics, aetiology, explanatory theories and prevalence have been approached. It has been highlighted that early detection and attention constitute a primordial need to improve the quality of life of people who, in their condition of ASD, present a different cognitive style, a different learning rhythm, given that their brain processes information in a different way. Tools (assessment tests, intervention programmes) aimed at achieving this goal have been demonstrated.

Glossary

Joint attention: Interactions in which attention is paid to the same thing as the interlocutor's attention and are mediated by gestures such as **eye tracking** or non-verbal body and facial language.

Central/global coherence: Tendency to process the information we receive, within a context in which the essentials are captured - piecing information together to make more sense - often at the expense of memory for details.

Comorbidity: Presence of one or more disorders in addition to the primary disorder.

Eye-tracking: A technological tool that aims to extract information from the user by analysing their eye movements. Its artificial intelligence-based software algorithms capture eye movements and translate them into precise actions on a screen to provide information on children's eye movements when exposed to a stimulus. This technology can be used to look for the connection between gaze and deficits associated with ASD and for the assessment of emotional recognition and the degree of communicative development of a person with autism.

Executive function: Set of skills involved in maintaining an appropriate framework for problem solving (planning, working memory, inhibition of inappropriate responses, monitoring one's own task...).

Intersubjectivity: Primary psychological mechanism that makes it possible to innately pay attention to human characteristics and to perceive the underlying emotions and attitudes in interaction and in the act of another human sharing attention and transcribing an emotion towards an object. It is the basis for the knowledge of others as persons with thoughts, emotions and states.

Biological marker: Any characteristic that can be objectively measured and evaluated as an indicator of a state of health or disease because it is characteristic and specific to a particular situation. Such as, genetic markers.

Developmental monitoring: The active and ongoing process of observing a child's growth and encouraging conversations between parents and/or caregivers and professionals about the child's skills and abilities. It involves observing how the child is growing and whether the child is reaching the typical developmental milestones, or skills that most children reach by a certain age, in playing, learning, talking, behaving and moving.

Mirror neurons: Motor cells found in the premotor cortex and inferior parietal lobe of our brain. They allow us to understand the feelings of others and make connections between other people. When one person observes another person acting, thinking or feeling, small "electrical triggers" are produced in the brain that activate the received signal. They play an important role in imitation, learning and empathy.

Prevalence: Proportion of individuals in a population suffering from a disorder at a given time or time period.

Theory of mind: Ability to attribute independent mental states to oneself and others in order to explain and predict behaviour, enabling the representation of mental states.

Neurodevelopmental disorders: Group of disorders that originate in the development period. They often manifest themselves at an early age, before beginning primary school and are characterized by a development deficit that results in limitations in personal, social, academic and occupational functioning.

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Resources

Web

AETAPI. Association of Autism Professionals https://aetapi.org/

https://aetapi.org/informe-evidencia/ (document in English)

ARASAAC. Aragonese Centre for Augmentative and Alternative Communication, https://arasaac.org/

Application Follow the development, https://www.cdc.gov/ncbddd/spanish/actearly/spanish-milestones-app.html

The birthday party. Video about the signs of autism in children .

https://autismwales.org/en/community-services/i-work-with-children-in-health-social-care/the-birthday-party/

Testing and diagnosis of autistic spectrum disorders, https://www.cdc.gov/ncbddd/autism/screening.html

Tools for monitoring development indicators, https://www.cdc.gov/ncbddd/actearly/freematerials.html

Early Signs of Autism Spectrum Disorders Tutorial I Kennedy Krieger Institute, https://www.youtube.com/watch?v=Jkiz0pYqJ4k

https://firstwordsproject.com

https://pecs-spain.com/el-sistema-de-comunicacion-por-el-intercambio-de-imagenes-pecs/

https://teacch.com/

Comprehension questions

Answer (true answer is in bold)

Question 1.- Regarding the treatment of ASD:

a) there is only one universal method of optimal treatment.
b) **the teaching of socio-communicative skills, and the support in the natural environment in which the person develops are important intervention tools.**
c) specific medications are available.
d) options b and c are true.

Question 2.- People with autism in early ages, usually:

a) point to objects so that other people look at them and enjoy them together.
b) play at pretending to feed a doll.
c) **do not respond to their name in the frequency, form and intensity expected in a child.**
d) spontaneously perform a varied repertoire of communicative gestures.

Question 3.- In general, people with ASD:

a) may present obsessive or restrictive interests.
b) have no difficulty in adapting to different contexts.
c) are characterised by an absence or alteration in emotional reciprocity.
d) **options a and c are true.**

Question 4.- In relation to explanatory theories:

a) central coherence theory refers to the ability to extract aggregate information from details.
b) executive function is related to working memory, inhibition, planning,...
c) theory of mind is closely related to the attribution of mental states.
d) **all options are correct.**

Question 5.- In relation to the Autism Spectrum Disorders:

a) **nowadays, several aspects of Kenner's definition are still considered as necessary features for the identification of this disorder.**
b) The age of onset is an important diagnostic criterion and it is placed after the age of three.
c) The cognitive processes of people with the disorder are assumed to be similar to those of people with intellectual disabilities.
d) the symptomatology manifests itself in a stable way over time.

Question 6.- With regard to the maladaptive behaviours that some people with ASD may present at certain times in their lives, it is thought that:

a) **they should be understood, most of the time, as strategies or communicative tools of the person.**
b) professional intervention should be mainly aimed at eliminating these behaviours.
c) it is important to replace them with socio-communicative skills that have the same manifestation or form.
d) positively affect their opportunities for participation in the community.

Question 7.- Regarding interventions:

a) types of treatment should be based solely on scientific evidence.

b) **alternative and augmentative communication systems encourage the emergence and development of verbal language.**
c) the use of alternative communication systems and the TEACCH system are not recommended.
d) comorbid disorders should not be treated.

Question 8.- As a facilitator of support for people with ASD:

a) you would encourage them not to recognise or set limits on their behaviours.
b) **structure space and time.**
c) encourage them to remain inactive if they are willing to do so.
d) promote trial and error learning.

Question 9.- The Autism Spectrum Disorders:

a) are a type of psychosis like schizophrenia.
b) **are included in the so-called "neurodevelopmental disorders".**
c) in children are defined as a developmental delay.
d) their cause is to be found in relationship and bonding conflicts between mother-child.

Question 10.- We can affirm that:

a) ASD constitutes a syndrome originated by a clearly determined biological process.
b) there are evident physical and biological markers.
c) **ASD is a clinical condition characterised by difficulties in the capacity for social interaction and communication, as well as in the capacity to imagine.**
d) in people with ASD, comprehension problems only affect verbal communication.

Question 11.- The structured teaching of the TEACCH system:

a) aims for people to learn in an automatic and mechanical way, taking into account that people with ASD tend to be routine.
b) has a set of standard teaching materials that work for all individuals.
c) **builds on the strengths and abilities of individuals.**
d) encourages the use of timetables so that people with ASD become increasingly dependent on the clock.

Question 12.- Regarding the early detection of ASD:

a) **there are warning signs that can be assessed before the age of 18 months.**
b) the absence of pointing and other socio-communicative gestures at 6 months is considered a warning sign.
c) babbling is considered a warning sign.
d) the absence of spontaneous 5-word sentences at 12 months is considered a warning sign.

Question 13.- With regard to the learning profile of people with ASD, the following are considered a warning sign:

a) the skills they learn in one context they do not forget and are able to replicate the same skill in different contexts.
b) they learn better what they hear than what they see.
c) they respond perfectly well to learning programmes designed for people with intellectual disabilities.
d) **all options are false.**

Question 14.- People with ASD:

a) have difficulty integrating new information.
b) they tend to focus their attention on irrelevant aspects.
c) they tend to fail to generalise.
d) **all options are true.**

Question 15.- The creation of a pleasant and understandable environment:

a) will impair the motivation of the person with autism as well as their abilities to explore and learn.
b) **favour independence and autonomy.**
c) encourage the person with autism not to be able to adapt to new situations and contexts.
d) will encourage the increase of their obsessions and routines.

MODULE III.6 SENSORY IMPAIRMENTS

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I. INTRODUCTION

Sensory systems enable people to interact with the environment. This topic develops the seven sensory systems involved in the exchange of information between people and the environment: touch, hearing, taste, smell, sight, proprioception and vestibular. It also deals with the most common sensory impairments: visual impairment, hearing impairment and sensory integration disorders. The typology and cause of these disorders and the consequences they have on child development are detailed.

II. OBJECTIVES

The objectives of this thematic unit are:

- To know the seven sensory systems.
- Recognise sensory impairments.
- To observe the characteristics of sensory disturbances and their impact on child development.

III. CONTENT SPECIFIC TO THE THEME

1. Sensory systems

Sensory systems allow the interaction of the individual with the outside world, this interaction defines the person, as it influences how he/she performs activities, how he/she interacts with other individuals, and his/her state of alertness-wakefulness. Dr. Ayres in 1972, proposed that sensory information reaching the central nervous system (CNS) is processed and analysed to provide an adapted response to both the physical and social environment; to carry out this process the nervous system must coordinate a response according to the environment and previous learning.

The link of the CNS with the outside and inside occurs thanks to specialised neural structures called sensory receptors. Sensory stimuli produce in the receptors an excitation of afferent sensory fibres, which is integrated in the central sensory areas through the combination of the various synaptic circuits, which in general, this information is confronted with lived and learned experiences generating in the individual a perception of the sensory stimulus, therefore there are different levels of organisation that interact in the sensory physiology (objective and subjective) as shown in figure 1, the sensory stimulus goes through a series of objective and subjective stages until it generates a perception.

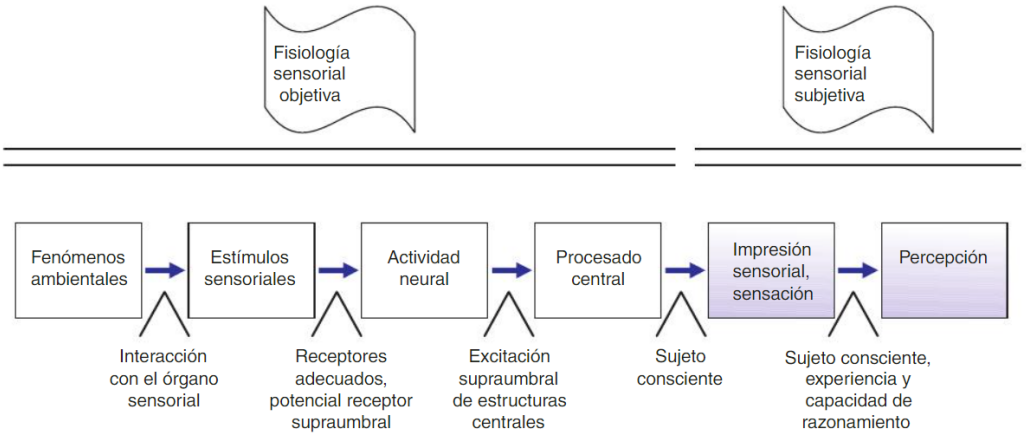

Figure 1. Levels of objective and subjective physiological organisation of sensory stimuli. Source: Cardinali, 2007.

Each stimulus has four basic dimensions (Cardinali, 2007):

- Spatiality and temporality describe the stimulus in time and space, e.g. when something touches the skin it can be located on an area of the body (spatiality) and the beginning and end of the stimulus is identified (temporality).
- Modality defines the type of sensation: visual, auditory, tactile, gustatory, olfactory, proprioceptive or vestibular. The environment is experienced through isolated elements produced by interaction with appropriate stimuli with their receptors (visual, tactile...). Within each modality in general, different qualities are distinguished, for example, the qualities of taste are bitter, salty, sweet, and sour.
- Intensity is the quantitative expression of a sensation, it is related to the stimulation of the receptor by the sensory stimulus.

2. Main sensory systems

There are five exteroceptive senses (vision, hearing, touch, smell and taste) that enable people to participate appropriately in their environment and two interoceptive senses (proprioceptive and vestibular). The importance of the senses is seen, for example, in a child's orientation in a static and dynamic environment, the CNS must construct and continuously update an accurate representation of our world, achieved by integrating signals from the different senses (Arshad et al., 2019).

2.1. Touch system.

The tactile system allows us to appreciate the external sensations of cold, heat, pressure, texture, vibration, tingling, as well as the weight we are holding, the force our muscles exert, etc. Touch is extremely important for every human being, it allows us to enjoy a caress, the warm rays of the sun, the cool wind, and an endless number of pleasant sensations; it also protects us against sensations that can cause us harm or pain.

The skin, the largest organ, is prepared to discriminate the size, shape and texture of objects (Abraira, Ginty, 2013). The skin is innervated by a large number of sensory neurons: nociceptors, which perceive painful stimuli; pluriceptors, which transmit itching; thermoreceptors, which register temperature information; and low-threshold mechanoreceptors, which perceive non-painful mechanical stimuli or touch (Abraira, Ginty, 2013; Zimmerman et al., 2014).

The person has different types of skin that have a differentiated role. Thus, the hairy skin is associated with affective touch, which evokes an emotional response, while the grafted skin found on the hands and

feet is specialised in discriminatory touch, determining texture and recognising objects, providing the CNS with control of grasping, reaching and proper locomotion (Zimmerman et al., 2014).

Touch has two main functions: protection against harmful stimuli, which is why this system is closely related to people's state of alertness to protect themselves, and discrimination of tactile stimuli, which allows us to recognise the objects with which we interact.

2.2. Auditory system.

The auditory system is the set of anatomical structures that enable the sensory perception of sounds. Auditory information reaches the CNS in the form of sound, which is the result of variations in air pressure produced by vibrations of its molecules that are transmitted in the form of waves. The human ear can pick up sounds whose frequency ranges from 20 Hz (bass) to 15,000 Hz (treble) (García-Porrero, Hurlé, 2014).

The ear (or peripheral auditory system) begins at the pinna and extends to the cochlea. Its mission is to convert mechanical vibrations into nerve impulses for processing in the brain. For its study, it is divided into three parts: the outer ear, the middle ear and the inner ear. The pinna captures the sound waves, sending them through the external auditory canal to the tympanic membrane (external ear); this membrane comes into contact with the vibration of the air molecules, which transmits the vibration to the hammer, anvil and stirrup (middle ear); the activation of the stirrup produces a liquid wave that generates an activation of the cochlea (inner ear) that converts the acoustic signals into electrical impulses capable of being interpreted by the CNS (Villamizar 2018).

2.3. Visual system.

The visual system is the most important of the human sensory systems. It allows us to acquire a large amount of information from the outside world. That is why a large part of the cerebral cortex is involved in the analysis of visual information, it can be said that the human brain is fundamentally optical (García-Porrero, Hurlé, J, 2014).

Visual information arrives via the radiation emitted by objects, luminous radiation of varying frequency and intensity that penetrates the interior of the eyeball through the pupil. The pupil dilates or contracts depending on the light conditions through the action of the iris. The light signal then passes through the cornea, the lens and the aqueous inner chamber to reach the retina, the photosensitive part of the eye, where the ganglion, bipolar and photoreceptor cells are located. The retina is a photoreceptor tissue that covers most of the inner surface of the eye and forms the plane onto which images are projected in an inverted form. In the retina, photoreceptors (cones and rods) convert light into electrochemical energy that is transmitted to the brain via the optic nerve.

The nerve bundles from each eye meet at the optic chiasm, where part of them cross over to the opposite cerebral hemisphere. Fibres coming from the left side of both retinas (and corresponding to the right side of the visual field) project to the left hemisphere, and those coming from the right side of both retinas (and corresponding to the left side of the visual field) project to the right hemisphere (Torrades, Pérez-Sust, 2008).

2.4. Olfactory and gustatory.

The senses of smell and taste are similar in their ability to detect chemical signals in air or saliva. These signals are transmitted to the CNS as nerve activity, where they are interpreted as smell or taste. The sensation of smell is extremely diverse, as it can distinguish thousands of different chemical compounds. Taste, however, is more limited and can distinguish about five different modalities (Champney, 2017).

The sense of taste is very important in food; certain tastes are perceived as pleasant and play a hedonic role; others, such as bitter tastes, are perceived as unpleasant and are associated with toxic substances. Strictly speaking, taste is the set of sensations that originate in the taste receptors; however, the perception of flavours is also influenced by olfactory sensations and proprioceptive sensations originated in the mouth

by the texture of food (García-Porrero, Hurlé, 2014). Taste receptors respond to a wide variety of molecular food components that give rise to five modalities: sweet, salty, bitter and umami.

The organ of taste is made up of taste buds, which are distributed throughout the lingual papillae, the mucosa of the palate and pharynx. Each taste bud contains different cells that are sensitive to the five taste modalities, at the base of the bud is linked to the afferent nerve branch that transmits the nerve impulse to the CNS.

Olfaction in humans is less important than for some animals, which have reproductive, social interaction and safety functions. Nevertheless, the olfactory system has the capacity to recognise more than 10,000 odours, and very low concentrations. Odours evoke our memories and influence mood and pleasure in eating. The olfactory system is stimulated by airborne substances called odour molecules, which are volatile substances. These substances enter the nose with the inspired air and can dissolve in the nasal mucus to reach the receptor. Most odours are a mixture of several odours that make up an odorous object which is perceived by the CNS. Thus, the CNS picks up odorous objects such as the smell of orange, chocolate, cheese...

The olfactory system is made up of the olfactory sensory organ, which is the olfactory epithelium of the nasal mucosa, the olfactory pathway and the olfactory centres. This system has three peculiarities (Champney, 2017, García-Porrero, Hurlé, 2014):

- The receptor cell is also the first neuron of the olfactory pathway.
- The information reaches the cerebral cortex directly through other structures.
- It is a system with a very low threshold of stimulation, but with a great capacity for adaptation, so that the perception of the odour stimulus lasts for a very limited time.

The olfactory system begins in the upper portion of the nasal cavity with specialised olfactory neurons within the mucosal epithelium. The dendrites of these neurons, which have specialised receptors for distinguishing different compounds, carry the nerve impulse to the olfactory bulbs on the lower surface of the frontal cortex. Neurons in the olfactory bulb project the information to the primary olfactory cortex, which has connections to the limbic system, the thalamus and the frontal cortex (Champney, 2017).

2.5. Proprioceptive system.

The term proprioception is defined as the subconscious and conscious awareness of the spatial and mechanical state of the body, which includes joint position, total or body part position in space, movement and force exerted on objects (Ager et al., 2017).

The main receptor of proprioception is the muscle spindle which specialises in detecting changes in muscle length and speed of contraction, this structure is able to anticipate changes because it can quickly detect changes in both the speed and length of muscles (Proske, 2005). In the joints there are free nerve endings in the different joint structures that report mechanical changes of the joint structures or severe inflammatory changes of the joints (Chu, 2017). Receptors of the Golgi tendon organ are found in the ligaments and menisci, they report joint boundaries (Hillier et al., 2015). In addition to all these receptors, there are skin receptors that contribute information about joint position and movement, e.g. skin tension in the fingers, elbow and knee informs the central nervous system about their position (Ager et al., 2017).

Proprioception plays a very important role in motor planning, coordination and adaptation to make rapid changes during task execution (feedback) (Hillier et al., 2015). In addition, proprioception plays an important role in motor learning of new learning, when a child first learns a new motor skill it requires all available information (visual, proprioceptive and tactile), as the skill improves, the movements are refined and the process becomes more subconscious, at this point, proprioceptive information is used as a feedback signal to confirm correct execution of the task (Chu, 2017).

2.6. Vestibular system.

The vestibular system encodes self-motion information by detecting head movements in space. In turn, it provides subjective information on movement, orientation and plays an important role in gaze stability, balance control and posture (Cullen, 2012).

The sensory organs of the vestibular system comprise two types of sensors: the semicircular canals, which detect angular acceleration in all three dimensions, and the two otolithic organs (saccule and utricle), which sense linear acceleration, i.e. gravity and translational movements (Cullen, 2012). The receptors of this system are activated when the cilia are flexed by the movement of endolymphatic fluid through the semicircular canals.

The most important functions of the vestibular system are balance, righting reactions, eye control, bilateral hemibody coordination and alertness control (Shayman et al., 2018).

3. Sensory disturbances

Within the range of sensory disorders there are a large number of dysfunctions that are linked to sensoriality, but which are very diverse and varied. Some of the common ones are detailed below.

3.1. Hearing impairment

According to the World Health Organisation (WHO), by 2021 more than 5% of the world's population will suffer from disabling hearing loss. Disabling hearing loss refers to a loss of more than 35 decibels (dB) in the better-hearing ear. Nearly 80% of people with this condition live in low- and middle-income countries. By 2050, nearly 2.5 billion people are expected to have some degree of hearing loss and at least 700 million will require rehabilitation.

A person with hearing impairment is someone who has an alteration in the auditory pathway, in the organ of hearing or in the brain, which will produce a loss in the quantity and quality of information from the environment via hearing that prevents them from being autonomous in daily life (Cañizares. 2015). Hearing is the main channel through which language and speech develop, so any alteration at a very early age affects linguistic and communicative development (FIAPAS, 2010).

3.1.1. Ranking

There are two types of hearing impairment: a) hypoacusis, people with hearing impairment who are able to acquire spoken language through hearing and use it functionally, although in most cases they use a hearing aid. B) deafness, profound hearing loss that prevents the acquisition of spoken language through hearing (Aguilar et al. 2008). Hearing loss can be classified based on different criteria (Cañizares. 2015., Aguilar, et al. 2008): place where the lesion occurs, degree of hearing loss or age of onset.

The site of injury:

- Conduction or transmission hearing loss: lesion produced by an alteration in the outer or middle ear, whereby the mechanical part of the ear is affected, preventing sound from adequately stimulating the cells of the organ of Corti. They correspond to pathologies of the outer and middle ear. The most frequent are serous otitis, perforation, sclerotic eardrum, otosclerosis, cholesteotoma.
- Sensorineural or perceptual deafness: damage to the cochlea (organ of Corti). Its most frequent causes can be classified according to the time of presentation as prenatal (genetic or acquired), perinatal (problems at birth) and postnatal (meningitis, otitis media, etc.).
- Mixed deafness: the pathology is both in the sound conduction pathway and in the perception pathway.
- Central deafness: loss of auditory stimulus recognition due to damage to the central auditory pathways. Some authors call it auditory agnosia.

Degree of hearing loss:

- Normal hearing: Hearing threshold (0-20 dB). The subject has no difficulties in speech perception.
- Mild or slight hearing loss (20-40 dB): the weak or distant voice is not perceived. In general, the child is considered inattentive, and its detection is very important before and during school age.
- Medium or moderate hearing loss (40-70dB): the hearing threshold is at the medium conversational level. Language delay and articulatory disturbances are very frequent.
- Severe hearing loss (70-90 dB): it is necessary to raise the intensity of the voice so that it can be perceived. The child will have very poor speech or no speech at all.
- Profound hearing loss or deafness (more than 90 dB): without appropriate rehabilitation, these children will not speak, they will only perceive very loud noises and it will almost always be more through vibrotactile than auditory hearing.
- Cophosis or anacusis. Total loss of hearing. These can be said to be exceptional losses.

Age of emergence:

- Prelocution hearing loss: the hearing loss is present at birth or appears before language acquisition (2-3 years of life) and therefore the child is unable to learn to speak in the case of severe or profound deafness.
- Post-linguistic hearing loss: hearing loss appears after the acquisition of language, progressively producing phonetic and prosodic alterations, as well as voice alterations.

3.1.2. Causes of hearing loss and deafness

According to the WHO, people can be exposed to the factors that cause hearing impairment during certain critical periods.

Prenatal period

- Genetic factors: including those that cause hereditary and non-hereditary hearing loss.
- Intrauterine infections: such as rubella and cytomegalovirus infection

Perinatal period

- Perinatal asphyxia (lack of oxygen at birth)
- Hyperbilirubinaemia (severe jaundice in the neonatal period)
- Low birth weight
- Other perinatal morbidities and their management

Childhood and adolescence

- Chronic otitis (chronic suppurative otitis media)
- Presence of fluid in the ear (chronic non-suppurative otitis media)
- Meningitis and other infections

Lifelong factors

- Cerumen impaction (earwax plug)
- Ear or head trauma
- Loud noise/sound
- Ototoxic medicines
- Ototoxic chemicals in the workplace
- Nutritional deficiency
- Viral infections and other ear conditions
- Delayed onset of hearing or progressive hearing loss due to genetic causes

3.1.3. Implications for child development

Babies and children need to be able to hear when others speak in order to develop the ability to listen and speak. When a baby is born with hearing impairment and does not receive appropriate interventions, he or she does not develop speech and language and falls behind other children with good hearing. The most important impairments are listed below (Cañizares, 2015, Aguilar et al., 2008, WHO, 2020).

Consequences for cognitive development:

- Their cognitive development is impaired due to an information deficit and a lack of use of their experiences, resulting in a lack of motivation for learning. The scarce information they receive, sometimes incomplete and even erroneous, makes it difficult for them to understand and accept rules.
- They have difficulties in planning their actions and reflecting, acting impulsively and immediately, often without calculating the consequences of their actions.
- They have great difficulty in performing tasks of abstraction or reasoning, as well as in formulating hypotheses or proposing various alternatives.
- The poverty or absence of an inner language greatly hinders the development and structuring of thought and language.

Development of sensory functions:

- Hearing loss means that a fundamental sense is missing, so vision takes on a central role.
- There is an imbalance in his spatial-temporal structuring, as his lack of hearing does not allow him to develop his orientation in space adequately.
- The loss of the sense of hearing makes it difficult to structure time and appreciate rhythm.
- Lesions of the inner ear sometimes lead to alterations of the vestibular apparatus, causing balance problems in some people with deafness.

Socio-affective development:

- The communicative processes of interaction between adult and child are poorer and their content is substantially reduced, mainly due to the lack of mastery of a common communication code for both. This implies an insufficient explanation of the facts, the reasons for things, the consequences of their actions, in short, a lack of information about the functioning and the rules that govern our society and the values on which it is based.
- The characteristics of tone, intensity and rhythm of language allow us to distinguish communicative situations of affection, tenderness, anger, etc. These emotions are difficult for the deaf person to perceive, given that their auditory channel is severely impaired, limiting their understanding of these situations to visual perceptions, which sometimes lead to errors.
- The lack of information and the lack of mastery of the immediate environment result in deaf pupils being distrustful, self-centred, touchy and sometimes impulsive.
- Deaf pupils often have difficulty in accepting frustration.

3.2. Visual impairment

Visual impairment is the total or partial impairment of sight. It is measured by various parameters, such as near and distance reading ability, visual field or acuity. Visual impairment or blindness is characterised by a total limitation or severe impairment of visual function. This severe loss of function affects people's autonomy, e.g. in moving around, activities of daily living, or access to information. On the other hand, it restricts the person's access to and participation in his or her different living environments: education, work and leisure.

According to the WHO there are 45 million blind people in 2020, of which 1.4 million are blind children. The prevalence of childhood blindness is higher in developing countries due to (Gilbert, Awan, 2003):

- There is an increased prevalence of conditions that cause blindness, e.g. vitamin A deficiency, harmful traditional ophthalmic treatments.
- Inadequate preventive measures for pathologies affecting vision such as measles, congenital rubella or ophthalmia neonatorum.
- There is a lack of facilities and qualified staff to handle conditions requiring surgery.

In middle-income countries, the pattern of causes is mixed, with ROP emerging as an important cause in Latin America and some Eastern European countries. Currently unavoidable causes (developed countries) include hereditary retinal dystrophies, central nervous system disorders and congenital anomalies.

There are different degrees of vision in visually impaired people, marked by optical pathologies and other possible sight problems derived from other anomalies, such as cerebral or muscular. There are two types of blindness:

- Total blindness: Blind or partially sighted people are those who see nothing at all or have only a slight perception of light (they may be able to distinguish between light and dark, but not the shape of objects).
- Partial blindness: people with visual impairment who, with the best possible correction, could see, or distinguish, some objects at very close range. Under the best conditions, some of them can read print at large size and clarity, but usually more slowly, with considerable effort and with the use of special aids.

3.2.1. Causes of visual impairment

According to WHO (2000) of the 1.4 million blind children in the world, it is estimated that 25% are blind due to retinal diseases, 20% due to corneal pathology, 13% due to cataracts, 6% due to glaucoma and 17% due to abnormalities affecting the whole globe. The following classification emphasises the most important causes of visual impairment (Gilbert, C., Foster, A. 2001):

- Corneal disorders: responsible for less than 2% of blindness in children, caused by vitamin A deficiency often precipitated by measles or gastroenteritis in children aged 6 months to 4 years.
- Cataracts and glaucoma: congenitally acquired rubella is a potential cause of childhood cataracts. The increase in this pathology is due to inadequate treatment of adult rubella together with an ineffective childhood immunisation strategy leading to an increase in congenital rubella, which can lead to cataracts.
- Successful treatment of cataracts and glaucoma requires a series of actions such as: training of health personnel caring for newborns; mechanisms to ensure that children with cataracts and glaucoma are seen by specialists; training of ophthalmologists in the assessment, surgery and long-term treatment of these children.
- Retinopathy of prematurity: it is vitally important that infant screening, detection and treatment programmes are established in all units for premature infants weighing less than 1,500g.

3.2.2. Implications for child development

There is a wide variety of limitations that can be generated by visual impairment, according to Pérez (2015) the most important of which are:

- Visual difficulties reduce the globalising aspect of vision. Perception of objects occurs in an analytical way, resulting in a slower pace of learning.
- There are difficulties in imitating behaviours, gestures and games observed visually, so he will always need personalised attention to help him understand what is going on around him, so that he is able to assimilate and reproduce it.
- His self-image may be altered as a result of the frustrations he receives when he realises that he does not react like others.

- Greater fatigue when carrying out their activities due to the greater effort they have to make when faced with any visual task.
- Exaggerated hyperactivity, if the child has not been taught, from an early age, to fix and maintain his or her attention on games and toys in his or her usual environment or on the activities we carry out with him or her.

3.3. Sensory integration disorders

Each child has some sensory peculiarities, these peculiarities are not of great importance, as adequate sensory processing is generated, the problem lies when the child manifests a problem in their occupation (activities of daily living, school and leisure) caused by inadequate sensory processing.

Dr Ayres proposed patterns of sensory integration dysfunction based on the results of the assessment of children with learning difficulties, and these findings were corroborated by a large number of subsequent studies (Lane et al., 2019; Mailloux et al., 2011). These patterns include:

- Sensory reactivity difficulty: adequate sensory reactivity is related to proper attention, alertness and emotion regulation (Lane et al., 2019). Sensory reactivity difficulty comprises inappropriate responses, either hyper-reactive or hypo-reactive, to everyday sensory stimulation to which most people readily adapt. It is a problem that occurs in approximately 5% of the normotypical population and in 40-80% of children with developmental disabilities. This disorder interferes with participation in daily activities such as eating, showering, toileting and socialising. There are different types of sensory reactivity difficulties: hyper-reactivity (or sensory avoidance) is characterised by an exaggerated or negative response to typical sensory experiences in everyday life; hypo-reactivity (or under-registration) is a delayed or decreased response to everyday sensory events; and sensory craving (or sensory seeking) is an insatiable drive for sensory experiences.
- Sensory discrimination: Sensory discrimination is the processing of information from one or more sensory channels that enables an individual to know body position, relative distance from other people, details and items on the body, and features of the environment quickly and accurately (Lane et al., 2016). Impaired sensory discrimination is the result of: slow and inaccurate processing of one or more types of sensory information; insufficient response to sensations; inadequate formation of perceptions; and impaired sensory associations (Lane et al., 2016). Difficulties have been reported in different sensory systems: 1) At the tactile level, there are difficulties in differentiating dangerous stimuli, identifying objects, recognising drawings on the skin, identifying where they have been touched (all these processes without vision); in addition, an excessive dependence on vision is observed when performing fine motor tasks. 2) At the proprioceptive level, there are difficulties in graduating pressure when grasping objects, difficulty in maintaining an appropriate posture and imitating it, lack of fluidity in movements, individuals tire easily when performing movements. 3) At the vestibular level, difficulty in maintaining balance, poor head-eye and eye-hand coordination, confusion between right and left and individuals fall easily.
- Dyspraxia: Praxia is the ability to conceptualise, plan and execute competent or specialised tasks (Lane et al., 2016). Dyspraxia is the sensory processing disorder for programming actions, in environments with a diversity of possibilities (Mailloux et al., 2011); one or more components of praxis may be impaired. Individuals with dyspraxia are observed to have: poor motor skills, slowness in the execution of movements, difficulty in playing (they do not seem to know what to do, they always do the same thing), alterations at the emotional level and in participation.

Summary

The sensory systems allow the interaction of the individual with the outside world, thanks to the five exteroceptive senses (vision, hearing, touch, smell and taste) that allow people to participate appropriately

in their environment and two interoceptive senses (proprioceptive and vestibular). The main sensory impairments are hearing impairment, visual impairment and sensory integration impairment.

A hearing-impaired person is a person who has an impairment in the auditory pathway, in the organ of hearing or in the brain, which will lead to a loss in the quantity and quality of information from the environment via the auditory pathway. The causes of hearing impairment can occur throughout life. Visual impairment consists of a total or partial loss of sight. It can be due to causes such as: corneal disorders, cataracts and glaucoma and retinopathy of prematurity. Sensory impairment occurs when a child manifests a problem in their occupation (activities of daily living, school and leisure) caused by inadequate sensory processing; there are three types of impairment: impaired sensory reactivity, dyspraxia and impaired discrimination.

Glossary

Sensory systems: allow the interaction of the individual with the outside world.

Touch: allows us to appreciate the external sensations of cold, heat, pressure, texture, vibration, tingling, as well as the weight we are holding, the force our muscles exert, etc.

Hearing: set of anatomical structures that enable the sensory perception of sounds.

Vision: perception of physical realities through sight.

Taste: set of sensations originating in the taste receptors.

Smell: bodily sense that allows us to perceive and distinguish odours.

Proprioception: subconscious and conscious awareness of the spatial and mechanical state of the body.

Vestibular: reports one's own movement by detecting head movements in space.

Hearing loss: people with hearing impairment who are able to acquire spoken language through hearing and use it in a functional way.

Deafness: profound hearing loss that prevents the acquisition of spoken language through hearing.

Total blindness: people who see nothing at all or have only a slight perception of light.

Partial blindness: people who, with the best possible correction, could see, or distinguish, some objects at a very short distance.

Sensory integration impairment: a child manifests a problem in his or her occupation (activities of daily living, school and leisure) caused by inadequate sensory processing.

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Resources

Web

http://www.fiapas.es/

https://www.who.int/es/news-room/fact-sheets/detail/deafness-and-hearing-loss

https://www.once.es/

https://research.aota.org/ajot

Comprehension questions

Answer (true answer is in bold)

Question 1. What are the basic dimensions of stimuli:

a) Spatiality
b) Modality
c) Temporality
d) **All answers are correct**

Question 2. How many senses does an individual have?

a) Vision, hearing, touch, smell and taste.
b) proprioceptive and vestibular
c) **Vision, hearing, touch, smell and taste, proprioceptive and vestibular**
d) None of the answers is correct

Question 3.

a) Outer ear impairment
b) middle ear impairment
c) inner ear impairment
d) **Outer or middle ear impairment**

Question 4. In total blindness

a) those who see nothing at all
b) Those who have slight perception of light
c) **A and b are correct**
d) Neither answer is correct

Question 5. Cause of visual disturbances:

a) Corneal disorders.
b) Cataracts and glaucoma:
c) Retinopathy of prematurity
d) **All the answers are correct**

MODULE III.7 SPINA BIFID AND SPINAL CORD INJURY IN CHILDREN

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I. INTRODUCTION

This topic deals with the definition, classification and aetiology of Spina Bifida (SB), as well as its treatment and functional consequences. It also defines and briefly explains some pathologies associated with SB such as **Hydrocephalus** and Arnold Chiari malformation. Finally, the bases of a multidisciplinary intervention program in early stimulation for children with BS or infantile spinal cord injury are proposed.

II. OBJECTIVES

The objectives of this unit are:

- To understand what is Spina Bifida and its main functional consequences.
- To approach the keys of a multidisciplinary program of early stimulation for children from 0-6 years old.

III. SPECIFIC CONTENTS OF THE THEME

1. Definition and classification of Spina Bifida

During embryonic development, the vertebrae close at the back, thus protecting the contents of the **neural canal** (**meninges** and spinal cord), however, in cases of Spina Bifida (SB), this does not occur and the contents are exposed. Babies are born with a cyst on the back (Figure 1) that must be surgically operated within the first hours/days of birth.

Figure 1. baby with SB, before the operation.

Therefore, SB could be defined as a congenital malformation characterized by the lack of fusion of one or more vertebral arches, with or without protrusion of the **meninges** or spinal cord, and whereby the contents of the **neural canal** are exposed to the outside (Gallar Pérez-Albaladejo, M.,2016).

1.1. Classification of Spina Bifida

Depending on whether or not the contents of the medullary canal come out, the SB is classified as follows (Gallar Pérez-Albaladejo, M.,2016):

1. **Spina bifida occulta.** Some of the vertebral arches have not fused, and the lesion is covered by skin along its entire length. It may go unnoticed throughout life, or it may be detected accidentally in a spinal X-ray. No symptoms are associated with it, except that sometimes a little hair or a patch of skin may appear in that area (Figure 2).
2. **Open spina bifida.** In these cases, the lesion is covered by membranes in the form of a cyst. If this cyst contains only the **meninges**, it is called a **meningocele**, but if, in addition to the **meninges**, it also contains part of the spinal cord, it is called a **myelomeningocele** (Figure 2). This second case is the most serious of all and has numerous consequences**.**

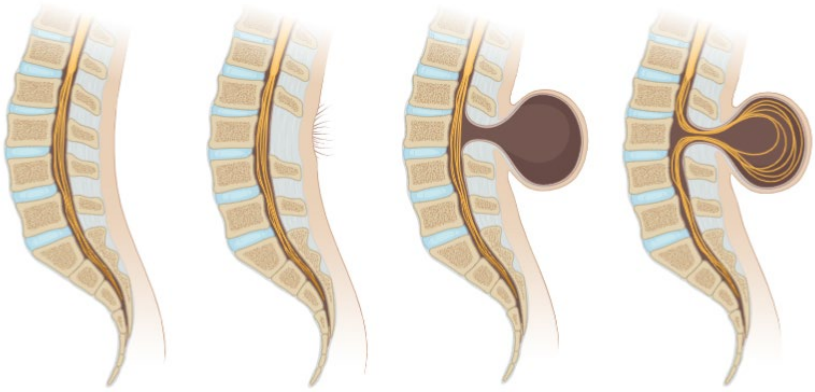

Figure 2. Spina Bifida classification: normal, occult, **meningocele**, **meningocele**, **myelomeningocele**.

The severity of **meningocele** or **myelomeningocele** depends on several factors (Gallar Pérez-Albaladejo, M.,2016):

- Location: the higher up (cervical area), the greater the sequelae, due to it affects more nerve roots.
- Extension: the greater the extension, the greater the sequelae. It depends on the number of nerve roots in the cyst.
- Presence or not of other associated malformations, such as **hydrocephalus** or Arnold Chiari malformation. The presence of these is associated with greater functional consequences. In addition to these two malformations that sometimes appear associated, there are also other complications such as tethered medulla that also cause greater functional complications.

2. Causes and prevention factors of Spina Bifida

The prevalence of neural tube malformations in Spain is estimated to be between 8 and 10 out of every 10,000 live new-borns, of which more than half of them are affected by BS (according to the Spanish Collaborative Study of Congenital Malformations) (AMEB, 2022). Other neural tube defects, such as **Anencephaly** or **Encephalocele**, are considered low prevalence diseases, and their sequelae are much more severe than those of BS.

2.1. Aetiology and prevention factors

The cause of SB is unknown, although its appearance has been related to different factors such as folic acid deficiency in the mother, the intake of valproic acid (antiepileptic) or etetrinate (psoriasis or acne drug) during pregnancy.

Prevention would therefore involve taking folic acid if pregnancy is being considered (it should be taken for at least one year prior to pregnancy) and the specialists should evaluate other alternative medication.

On the other hand, early diagnosis of SB during pregnancy is made through biochemical methods by determining the amount of alpha-fetoprotein in the mother. Ultrasound scans can also detect it, but it is difficult to see in the first weeks of pregnancy.

3. Spina Bifida Treatment

In the case of open lesions, as already mentioned, the baby must undergo surgery as soon as he/she is born, to close the cyst. This is a complex operation and the functional prognosis of the child will also depend on its outcome.

Since the consequences of SB are multiple and very complex, the treatment must be approached by a multi-professional team:

- Medical treatment: numerous specialists are involved in the SB process from birth, such as the neurosurgeon, in the first instance, but later and due to the manifestations of SB, other areas such as the urologist, traumatologist, rehabilitation physician and paediatrician, among others, will also intervene.
- Rehabilitative treatment: children with BS will have to receive rehabilitative treatment throughout early childhood, and possibly also later on, which should include the areas of physiotherapy, occupational therapy, orthopaedics and psychology.

In terms of rehabilitation, it is important to start an early care program as soon as possible in order to enhance their abilities and promote their development in all areas.

4. Consequences and functional implications

SB is considered a polydeforming disease, which has multiple organ involvement as a consequence of the neurological involvement resulting from the fact that the **meninges** and nerve roots have been exposed. In general, the consequences that usually occur are as follows (Gallar Pérez-Albaladejo, M., 2016):

- Muscle weakness or even complete muscle paralysis below the injury. The higher the injury is located, the more difficulties they will have, so that if the injury is high, they will not be able to walk and may even have problems with arm weakness. On many occasions they will have to use mobility aids, whether crutches, walkers or wheelchairs. Also, as a result of this muscle weakness or paralysis, children with SB may have a variety of orthopaedic deformities such as **scoliosis**, varus or equinus feet.
- Loss of sensation below the lesion. May carry risks of skin lesions and burns among others.
- Weakness of the muscles of the bladder and intestinal tract. May present urinary and faecal incontinence, which implies an important series of care in this regard, and may require, in addition to wearing diapers, having to be catheterized periodically (once or twice a day). Among the problems of the intestinal tract, they may suffer constipation that may even lead to **rectal prolapse**.
- **Hydrocephalus**. This complication appears in 70% of children with SB (explained below).
- Other sequelae: **precocious puberty**, tendency to obesity, Arnold Chiari malformation, among others.

5. Hydrocephalus

It is one of the most frequent complications of SB, but it can also appear not associated with SB as a primary pathology, also causing disability by itself.

It is an accumulation of cerebrospinal fluid (CSF) in the brain, due to poor circulation or its non-reabsorption.

This increase in CSF implies an increase of the cerebral ventricles (where this fluid is produced) and this in turn leads to an increase in pressure in the brain, deforming the skull. It is urgent to resolve this situation in order to avoid brain lesions. To do this, a valve must be placed in the cerebral ventricles, which evacuates the excess CSF into the peritoneal cavity (abdomen) or into the vena cava, which is done by a new operation from the neurosurgery department.

Occasionally, **hydrocephalus** is also associated with delays in motor and cognitive development, which, if it is associated with BS, it would add this type of consequences (see Figure 3).

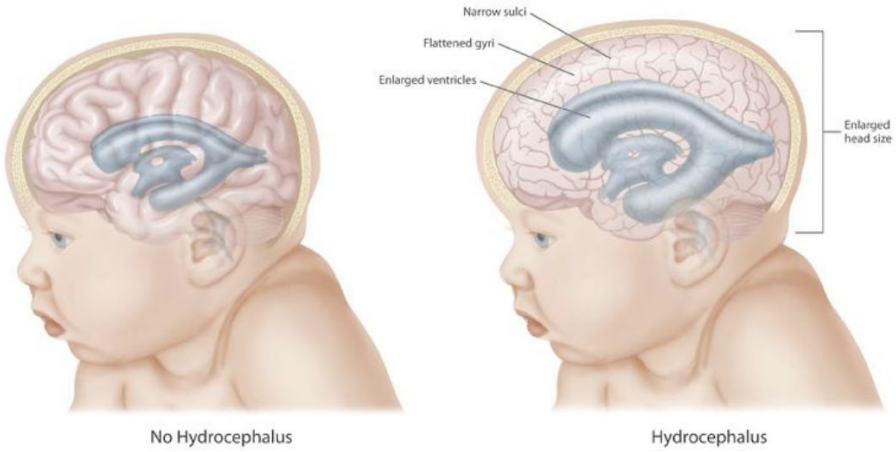

Figure 3. Brain ventricles imaging: without **hydrocephalus** with **hydrocephalus**.

6. Arnold Chiari malformation

Arnold Chiari malformation is a rare disease, which can also be found in isolation or linked to the presence of SB. When linked to SB, it is type 2, and consists of a descent of the cerebellum and the lower part of the IV cerebral ventricle into the **spinal canal**, also leading to elongation of the brainstem.

It is not necessarily associated with any other symptomatology, but sometimes there are difficulties in swallowing or breathing and weakness in the arms (see Figure 4).

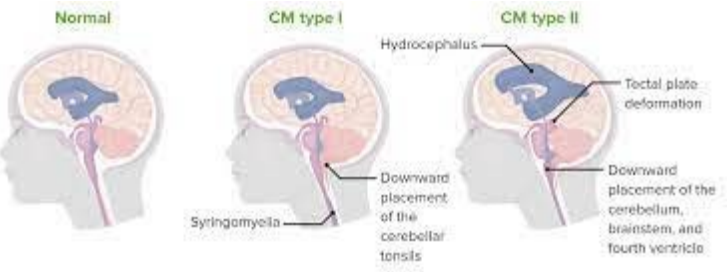

Figure 4. Image of Arnold Chiari malformation: normal, type I and type II.

7. Spinal Cord Injury in children

Spinal cord injury is a term that refers to the presence of damage to the spinal cord as a consequence of any traumatic or non-traumatic process. Therefore, SB could be included among spinal cord injuries of non-traumatic origin. However, injuries of traumatic origin (car accident, falls, etc.) are the most frequent in young adults, and although they represent a low percentage in early childhood, it is important to know that there are also children with spinal cord injuries of traumatic origin.

The consequences of these traumatic spinal cord injuries are very similar to those of SB, except that they do not involve, for example, the risk of **hydrocephalus** or other malformations. They share muscle

weakness or paralysis below the lesion, loss of sensation, and weakness of the muscles of the bladder and intestinal tract.

Like SB, it will also require a multi-professional approach to provide the child with intervention programs to facilitate his/her development and acquisition of independence.

8. Intervention proposal for Spina Bifida and spinal cord injury in children

The approach to both SB and spinal cord injury should be, as already mentioned, a multidisciplinary one. In the case of SB, the first year of the child's life, and in the case of spinal cord injury, the first year after the lesion appears, will be mainly marked by medical intervention and stabilization of the lesion (closure of the cyst, treatment of **hydrocephalus** if it appears, etc).

Once the injury is medically stabilized, it is advisable for the child to start the stimulation program as soon as possible in order to favour the development of his/her full potential.

8.1. Objectives of the physiotherapy intervention program

From the physiotherapy point of view, the objectives of the program should focus mainly on:

- Enhancing all preserved musculature, starting with trunk control to promote sitting and continuing with the lower extremities and upper extremities if affected.
- Achieving independent mobility, with or without orthopaedic aids. These orthopaedic aids can be, for example, foot splints, hip-knee-ankle-foot orthosis (see Figure 5), crutches, walkers or wheelchairs, among others.

Figure 5. hip-knee-ankle-foot orthosis.

- To prevent orthopaedic deformities. Ideally, this can be done from birth, even when the child remains in the hospital. From the incubator, appropriate postures of the lower limbs can be encouraged to avoid the appearance of the dreaded deformities. Some of these deformities that may appear are:
  - Trunk deformities: **scoliosis**, lumbar hyper lordosis, dorsal kyphosis.
  - More frequent deformities in the lower extremities: hip flexion, hip dislocations, knee varus/valgus, equinus/varus/valgus foot, among others.

8.2. Objectives of the occupational therapy intervention program

From occupational therapy point of view, an intervention program should include at least the following objectives:

- To achieve independence in Activities of Daily Living (ADLs), always respecting the pace of development (see module 6).

- To advise and train the use of support products that may be necessary to achieve this independence. In addition to mobility products (walkers, crutches, wheelchairs), children with SB and spinal cord injury may need other products to help them in their daily life, such as adaptations of cutlery or school utensils and materials.
- To adapt the environment and its materials to facilitate this independence.
- It is also important that the multidisciplinary program includes the family, also as part of the intervention.

8.3. eEarlyCare application web

The eEarlyCare web application (Saiz-Manzanares, Marticorena-Sánchez, & Árnaiz-González, 2020;2022; Saiz-Manzanares et al., 2020), offers one of the modules on transfers that can be applied in children with BS and spinal cord injury. A more detailed study of the tool is presented in Module VII.3.

8.4. Others

The presence of a child with a disability generates a multitude of feelings, which are sometimes difficult to manage and must be addressed.

Also, especially in cases of acquired spinal cord injury, the children themselves need, even at such early ages, psychological help to cope with the changes brought about by their situation.

The intervention of more professionals may be necessary, depending on the extent of the injury and the presence of other complications:

- In case it is detected cognitive delay, the program should also include this part.
- The nursing staff should also take care of the lesions that may appear on the skin, for example the presence of pressure ulcers.
- The dietician also can work as part of the team to avoid the tendency of children with SB to become obese.

Summary

The chapter defined SB and shown its classification, as well as its main functional consequences, briefly describing **hydrocephalus** and Arnold Chiari malformation, commonly associated with SB. It also established the most important objectives of an early stimulation program dedicated to children with SB or infantile spinal cord injury.

Glossary

Anencefalia: Malformación del tubo neural, que implica la no formación de partes del encéfalo (ya sean pAnencephaly: Malformation of the neural tube, which implies the non-formation of parts of the brain (either parts of the brain, brain stem or cerebellum) during embryonic development. It is a very serious malformation.

Spinal canal or neural canal: central hollow part of the spinal column in which the spinal cord is located.

Encephalocele: cyst-shaped protrusion in the skull, through which the **meninges** and part of the brain protrude. It occurs during embryonic development, and is a very serious malformation.

Scoliosis: Deformity of the spine, which implies a curvature of the spine in the anterior-posterior plane in the shape of a “C” or even in the shape of an “S”. It also includes a rotation of one or more vertebrae.

Sphincter: Muscle that controls the emptying of the bladder or bowel, depending on whether it is the urinary or anal **sphincter**.

Hydrocephalus: accumulation of cerebrospinal fluid in the brain.

Tethered spinal cord: A neurological condition in which the spinal cord is attached (tethered) to the surrounding tissues of the spine. This prevents the spinal cord from being able to move and grow as the child grows.

Meninge: The membrane that surrounds the spinal cord.

Meningocele: A type of open spina bifida.

Myelodysplasia: Synonym for Spina Bifida.

Myelomeningocele: type of open spina bifida.

Varus foot: deformity of the foot that adopts a "C" position, with the front part of the foot turned inward.

Equinus Foot: Deformity of the foot, where the foot appears stretched with the tip of the foot downward (as if on tiptoe).

Rectal prolapse: When passing stool, part of the rectum comes out. It usually occurs in infants and when they control constipation, it disappears.

Precocious puberty: Consists in the advancement of puberty, it occurs in girls with Spina Bifida, with the consequent advancement of menstruation at 8 or 9 years of age.

Raquisisis: Synonym of Spina Bifida.

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Saiz-Manzanares, M.C., Marticorena, R., & Arnaiz, Á. (2020). Evaluation of Functional Abilities. in 0–6 Year Olds: An Analysis with the eEarlyCare Computer Application. (2020). Int. J. Environ. Res. Public Health, 17(9), 3315, 1-17 https://doi.org/10.3390/ijerph17093315

Saiz-Manzanares, M.C., Marticorena, R., Arnaiz, Á., Diez-Pastor, J.F., y García-Osorio, C.I. (2020). Measuring the functional abilities of children aged 3-6 years old with observational methods and computer tools. Journal of Visualized Experiments, e60247, 1-17. https://doi.org/10.3791/60247

Resources

Images

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Image 3: CDC, Public domain, via Wikimedia Commons

Image 4: https://www.lecturio.com/es/concepts/malformaciones-de-chiari/

Image 5: https://www.ortopediamostkoff.com.mx/producto/ortesis-miembros-inferiores/pierna/afo-por-sus-siglas-en-ingles-ankle-foot-orthosis-ortesis-de-tobillo-pie/

Web

Living with Spina Bifida: Data that Make a Difference: https://www.cdc.gov/ncbddd/spinabifida/documents/cdcsworklivingwithspinabifida.pdf

Free resources about SB, available in English and Spanish: https://www.cdc.gov/ncbddd/spinabifida/index.html

Comprehension questions

Answer (true answer is in bold)

Question 1. Spina bifida is:

a) A bone disease.
b) **A congenital malformation affecting the closure of the vertebral arches.**
c) A disease of the muscular system.
d) None of the above.

Question 2. Meningocele is:

a) It is a type of open spina bifida, whose cyst contains only cerebrospinal fluid.
b) It is a type of open spina bifida, whose cyst contains meninges and nerve roots (part of the spinal cord).
c) It is a type of closed spina bifida.
d) **It is a type of open spina bifida, whose cyst contains only the meninges.**

Question 3. Myelomeningocele:

a) It is the mildest lesion within the types of spina bifida.
b) It is the most severe lesion within the types of spina bifida.
c) Its severity depends on its location and extension.
d) **b and c are true**

Question 4. Some of the functional consequences of spina bifida include:

a) **Muscle weakness or even paralysis below the lesion.**
b) Hearing loss.
c) Vision problems.
d) Behavioural disturbances.

Question 5. Intervention in children with spina bifida:

a) Requires a multidisciplinary approach.
b) The stimulation programme is started as soon as the child is born.
c) The stimulation programme is initiated once the lesion is medically stabilised.
d) **a and c are true.**

MODULE III.8 CEREBRAL PALSY

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I. INTRODUCTION

PCI encompasses a heterogeneous group of syndromes that show persistent motor dysfunction affecting muscle tone, movement, and posture, due to injury to a developing brain. Although by definition it is a non-progressive disorder, its clinical expression varies with the age of the child and the appearance of various comorbidities that can condition their quality of life even more than neurological disorders (Bax et al, 2003).

PCI is attributed to disorders that occurred in the developing brain and whose diagnosis is established during the first 4-5 years of life. Therefore, it is the result of a brain alteration whose origin is multifactorial (Peláez-Cantero et al, 2021). **PCI can occur both in the prenatal, perinatal and postnatal stages** , highlighting the presence of hypoxic-ischemic lesions, intraventricular and periventricular hemorrhage, early defects in neuronal migration, cerebrovascular malformations and infections of the central nervous system. (Carrillo et al, 2018).

The presence of any of these alterations causes a disorder in tone and muscle coordination, generating an alteration of movement that can also affect speech. PCI is a heterogeneous picture, whose severity can vary widely, conditioning different clinical manifestations.

According to the predominant motor disorder, these are clinically classified into spastic, *dyskinetic and*, ataxic, PCI The most frequent cerebral palsy is the spastic hemiplegic form. PCI is not only characterized by the presence of motor alterations, it can also be accompanied by perceptual, cognitive, communication and behavioral disorders. Likewise, epilepsy and secondary musculoskeletal problems are common, encompassing all these disorders within the current definition of PCI (Guiu Antem et al, 2017., Pascual, 2011).

PCI is usually associated with periventricular **leukomalacia with intraventricular or periventricular** hemorrhage, and in fewer cases with **micropolygyria and porencephaly (**Carrillo de Albornoz et al, 2018).

II. OBJECTIVES

Know the main causes of cerebral palsy. Clinical and topographic classification based on brain damage.

Know the main disorders related to cerebral palsy, as well as their main characteristics.

III. SPECIFIC CONTENTS OF THE TOPIC

1. Cerebral palsy (PCI)

Cerebral palsy is a clinical picture whose diagnosis requires the presence of **alterations in the development of posture, movement, and muscle tone**. The clinical picture is characterized by a disorder of movement and posture that causes an alteration in the child's ability to make voluntary use of his muscles.

Cerebral palsy is caused by an abnormality or disruption in brain development. The problem in brain development could arise at different times of development such as:

First trimester of gestation: Malformations, proliferation, cell migration, synaptic organization.

Second and third trimester of gestation: Brain injury. Prematurity

Brain injury of the newborn: injury of the premature child, white matter lesion (leukomalacia) Intraventricular hemorrhage, hemorrhagic infarction, cerebellar lesion. hypoxic-ischemic encephalopathy, metabolic disease.

Postnatal period: Trauma, infections.

With respect to the typology of PCI, the most frequent are *spastic PCI* where the lesion occurs in the **motor cortex or pyramidal bundle.** Increased muscle tone of greater or lesser intensity is observed, with decreased voluntary movement.

There is a predominance of flexor or extensor muscle groups that lead to shortening and deformities. (Carrillo de Albornoz et al, 2018). This type of paralysis can occur unilateral or bilateral, where muscle tone in both upper and lower limbs are increased.

On the other hand, *dyskinetic or dystonic PCI* arises as a consequence of injury to the basal ganglia or extrapyramidal bundle. Involuntary movements and sudden changes in tone appear. Download the presence hypokinesia and hypertonia being the type of dystonic paralysis and where hyperkinesia and hypotonia predominate is considered choreo-atheotosisal or dyskinetic paralysis.

With respect to *ataxic PCI,* it is caused by the lesion of the cerebellum. Characterized by the presence of hypotonia, incoordination and impaired balance.

If we consider the anatomical distribution of the motor disorder, CP is classified into diplegia (alteration of the movement of the four limbs, but with greater involvement of the lower limbs), *hemiplegia* (involvement of the upper and lower limbs of the same side) and *quadriplegia* (involvement of the four limbs).

Table 1. Classification of cerebral palsy. (Based on Carrillo et al, 2018).

Causes during pregnancy:
Prenatal: disorders of cortical development, intrauterine infections, toxic.
Perinatal: hypoxia, prematurity, jaundice.
Postnatal: infections, poisoning, accidents.
Compromised brain structure
Pyramidal pathway: spastic cerebral palsy.
Extrapyramidal pathway: pdyskinetic cerebral palsy.
Cerebellum: ataxic cerebral palsy.
The extent of affectation (topographic classification) Unilateral/Bilateral
Monoplegia (involvement of only one limb).
Hemiplegia: The effect of the upper and lower extremity of a hemibody.
Diplegia: greater involvement of the lower extremities than the upper extremities.
Tetraparesis: involvement of all four limbs.
Tryparesia: involvement of the lower extremities and a single upper limb.
According to the severity of the affectation

Functional classification (motor, manual, language, and functionality level)
Grade 0: normal.
Grade 1: slight anomalies with the possibility of voluntary correction.
Grade II: obvious abnormalities that do not impede function.
Grade III: limited function (slowness, tiredness and need for support).
Grade IV: impossible function (no gear, no manual function or language)
Gross motor function classification system (GMFCS)
Level I: unrestricted march
Level II: unaided walking, but with spatial constraints
Level III: gait with support or orthosis
Level IV: fairly limited independent skills.
Level V: tally dependent for displacement.

2. Associated problems in cerebral palsy

Children with cerebral palsy, as indicated by authors such as Peláez-Cantero et al, 2021, require in most cases a multidisciplinary approach to treat the problems associated with this motor pathology, so it is common to find associated problems described below.

***Neurological problems*:** Epilepsy is present more frequently in those children who show pathological findings in neuroimaging tests and present greater motor alteration. Performing an EEG can be useful to establish neurophysiological parameters compatible with the presence of seizures of epileptic origin. (Peláez-Cantero et al, 2021).

***Intellectual disability**:* Between 40-70% of children with spastic and quadriplegic paralysis have intellectual disability and to a lesser extent with dyskinetic and hemiplegic paralysis. It is also associated with the presence of epilepsy and pathological neuroimaging study.

Language disorders: The language disorders most present in PCI are dysarthria (40%) followed by 25% showing absence of verbal language. They may also present difficulties in other areas of communication, such as the development of gestures and facial expression, acquisition of comprehensive and expressive language and the production of voice.

***Hearing problems**:* In children with CP, neonatal screening should consist of otoemissions and auditory evoked potentials, warning signs can range from poor response to auditory stimuli, abnormal behavioral responses, and impaired language development.

Sialorrhea: It is found in 10% and 58% of children with PCI so it is important to quantify frequency, severity, and impact on the quality of life of children and their caregivers.

***Neuropsychiatric problems**:* Present in more than 50% of children with CP, being the most frequent, emotional disorders, behavioral problems and social interaction, presence of hyperactivity and attention deficit, which added to all the problems present aggravated the school and adaptive problems of these children.

Spasticity: Appears in 85% of children with CP and causes functional problems in ADLs (gait, feeding, clothing and hygiene). This alteration usually causes muscle pain, spasms, and dystonic postures.

Orthopedic problems: Caused largely by spasticity, which causes fixed muscle contractures that cause osteoarticular deformities (thumb included, wrist and elbow flexo, scoliosis, hip displacement / dislocation, clubfoot, which worsen the clinical situation of the child needing in certain cases, a surgical approach.

Digestive problems: Present in 80-90% of cases related to nutrition and growth and the presence of dysphagia, gastrointestinal reflux, and constipation.

Bone health problems: These children are at risk for low bone density and osteoporosis. Pathological fractures may be present in up to 20% of children with CP and most often affect the distal femur. Their recognition is important since in most cases they occur asymptomatically (80% of vertebral fractures).

Oral health problems: Children with CP more often have cavities, malocclusions, and periodontal disease (90%)

Respiratory problems: *One of* the main causes of morbidity and mortality in children affected with CP. Respiratory symptoms vary with the age of the child, with infants with feeding difficulties, aspiration or apparent life-threatening episode, persistent cough, noisy breathing and repeated respiratory infections being more frequent. There is also a risk of sleep apnea-hypopnea syndrome.

Visual problems: Between 40-75% of children have some type of visual disability, nystagmus, absence of reflex visual response, endless eye movements and lack of attention and visual curiosity may also appear.

Urological problems: 60% of these children have voiding dysfunction, enuresis, voiding urgency, incontinence, or neurogenic bladder. The warning signs are continuous drip incontinence, need for abdominal pressure for the onset of urination or weak voiding stream or polydipsia.

Sleep problems: The presence of sleep disorders is present in 25% of children with CP. The main sleep disorders in these children are difficulty initiating and maintaining nighttime sleep, difficult morning awakening, nightmares, and sleep anxiety.

Pain: Frequent symptom in PCI, the most frequent mechanisms that generate pain include both nocioceptive pain: somatic (spasticity, hip subluxation, fracture, etc.) and visceral (constipation, GER, gastric ulcer) neuropathic pain, and pain secondary to treatments: physiotherapy, infiltration of botulinum toxin.

3. Assessment of the functional ability of the child with cerebral palsy

Given all the alterations, it is clear that cerebral palsy is not just a motor disorder, but the sum of many alterations presents to a greater or lesser extent. To assess the functional capacity and degree of dependence of the child with CP, there are currently five scales that evaluate, motor aspects, manual function, communicative, feeding, and visual aspects.

With respect to the GMFCS (*Gross motor function Classification System*) it is the most widely used system currently to classify motor gravity. It establishes five levels of severity and allows to assess the natural history of PCI, which is different in the different levels of involvement and also to assess the usefulness of treatments (Palisano et al, 1997) (Table 1)

Regarding the *assessment of manual function,* evaluated by the Manual Skill Classification System (MACS) describes how children with cerebral palsy (CP) use their hands to manipulate objects in daily activities. This system describes five levels. The levels are based on the child's ability to self-initiate the ability to manipulate objects and his need for assistance or adaptation to perform manual activities in daily life. (Eliasson et al, 2006).

The classification proposed by the CFCS is to *assess the child's performance in daily communication.* This classification focuses on levels of activity and participation, as described in the World Health Organization (WHO) International Classification of Functioning Disability and Health (ICF). It establishes five levels of communicative effectiveness. CFCS is analogous to and complementary to the Gross Motor Function Classification System (GMFCS-ER), the Manual Skill Classification System (MACS), and the Eating and Drinking Ability Classification System (EDACS).

With respect *to the* Eating and Drinking Ability Classification System. (EDACS) (Sellers et al, 2013). It aims to classify and describe the ways in which people with CP eat and drink. It proposes five levels of

skills that evaluate the functional activities of eating, such as sucking, biting, chewing, as well as the adaptation of food consistencies, feeding pathway and level of independence.

The difference between the levels is established based on safety and efficiency at the time of eating. Safety is understood as the risk of choking and bronchoaspiration that is associated with eating and drinking. While efficiency refers to the time and effort required to feed. It also presents a decision algorithm as a graphic tool to determine the level at which the child with cerebral palsy is.

And, finally, the classification system of visual functions (VFCS) (Baranello et al, 2020) that allows to classify in five levels the visual abilities of these children and how these capacities are used by these children in daily life.

4. Multidisciplinary approach in the treatment of cerebral palsy

As seen throughout this chapter, children with CP present a state of fragility where there are periods of symptomatic stability, the disease itself makes these children more likely to present episodes of decompensation due to intercurrent processes that can worsen their baseline situation. Therefore, at certain times and throughout their development, the child with CP will require a multidisciplinary treatment that helps them recover their previous baseline situation and contribute to improving their quality of life and in which, in addition to the professionals, the family and the environment of the child with cerebral palsy must be included. (Peláez-Cantero et al, 2021).

Summary

Cerebral palsy (CPI) is one of the most common major disabilities in child development. It causes significant physical disability in childhood. The clinical manifestations of this disease will depend on the extent and location of the brain injury, as well as the ability of the brain to adapt to it. PCI is classified according to the clinical manifestations of the motor disorder, the brain structures involved, the period in which the injuries occur, and the severity of the type of PCI.

The approach of these children often requires attention by a multidisciplinary team since these children have complex medical care needs.

Glossary

Athetosis: Lesions originating in the extrapyramidal system manifested in slow, involuntary, uncontrolled, and objectless movements.

Ballism: Involuntary, very abrupt, and wide movements that occur while the person is conscious and are caused by an injury to the subthalamic nucleus of the brain or its connections.

Korea: Involuntary movements of the limbs, trunk, neck, or face. They are fast, abrupt, arrhythmic movements that pass from one body region to another irregularly.

Clonus: involuntary, rhythmic contractions that occur in a muscle group when a sudden and passive extension of the tendons is performed in a sustained manner.

Dystonia: A movement disorder that causes involuntary contractions of the muscles. These contractions result in twisting and repetitive motions. Sometimes they are painful. Dystonia can affect only one muscle, one muscle group, or all muscles.

Spasticity: Increased muscle tone in lower limbs that affects mobility and causes serious complications: pain, joint limitation, contractures, and pressure ulcers, which lead to a significant impairment of the individual's functionality and quality of life.

Pyramidal bundle: set of nerve fibers that allow the transfer of orders from the brain to the nerve cells contained in the spinal cord

Ventricular leukomalacia: Damage or softening of the white matter that transmits information between nerve cells and the spinal cord, as well as from one part of the brain to another. Damage that is located around or near the ventricles that contain CSF.

Micropolygyria: Decrease in the size of cerebral grooves and convolutions with an increase in their number.

Porencephaly: A congenital neural tube closure defect extending from the surface of the cerebral hemisphere to the underlying ventricle, including uni- or bilateral cystic cavities resulting from vascular lesions. related to intrauterine vascular accidents (trauma), neonatal hypoxia, and hypertensive disease of pregnancy.

Sialorrhea: oral disorder characterized by excessive accumulation of saliva. This abundant segregation generates an involuntary loss of saliva, causing difficulty in controlling oral secretions.

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Sellers D, Mandy A, Pennington L, Hankins M and Morris C (2013). Development and reliability of a system to classify eating and drinking ability of people with cerebral palsy. *Developmental Medicine and Child Neurology.* https://onlinelibrary.wiley.com/doi/10.1111/dmcn.12352

Resources

Web

Spanish Confederation of Federations and Associations of Care for People with Cerebral Palsy and Related (ASPACE Confederation) http://www.aspace.org/

Eating and Drinking Ability Classification System. (EDACS) (https://www.sussexcommunity.nhs.uk).

NIPACE Foundation for children with cerebral palsy. https://www.fundacionnipace.org/

Gross motor function classification System: https://www.abclawcenters.com/practice-areas/cerebral-palsy/gross-motor-function-classification-system-gmfcs-for-cerebral-palsy/

Comprehension questions

Answer (true answer is in bold)

Question 1. Spastic cerebral palsy has as its main characteristic:

a) Arises as a result of injury to the basal ganglia or extrapyramidal beam
b) It appears as a result of the cerebellum lesion.
c) Characterized by the presence of hypotonia, incoordination and impaired balance.
d) **The lesion occurs in the cerebral cortex or pyramidal bundle.**

Question 2. According to the degree of severity of cerebral palsy. Grade II involves:

a) **Obvious anomalies that do not impede function**
b) Slight anomalies with the possibility of voluntary correction
c) Limited function (slowness, tiredness and need for help)
d) Preserved function, slight alterations that slightly impede function

Question 3. The diagnosis of cerebral palsy is established.

a) Between the first 2 and 3 years of age
b) Between the first 3 and 4 years of age
c) **Between 4 and 5 years of age**
d) All are incorrect

Question 4. With regard to pain in infantile paralysis should:

a) To the presence of hip subluxation, fracture
b) Due to visceral pain (constipation, gastric ulcer
c) Pain secondary to treatments (physiotherapy, toxin infiltration)
d) **All are correct**

MODULE IV.1 OBSERVATION AND EVALUATION TECHNIQUES FROM INTELLIGENT RESOURCES: INTRODUCTION TO DATA MINING

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I. INTRODUCTION

We live in the information and communication society, the technology we use in the twenty-first century is associated with the collection and storage of large amounts of data. **Data Mining** (**DM**) allows you to find information contained in the data that is not always apparent, since, given the gigantic volume of existing data, much of that volume will never be analysed.

II. OBJECTIVES

1. Know key concepts related to **Data Mining**
2. Know and apply simple **Data Mining** techniques in the field of early care.

III. TOPIC-SPECIFIC CONTENTS

1. Data Mining

Data Mining is the process of searching and analyzing large databases to find useful information that is useful for decision making.

There are numerous **DM** techniques that employ mathematical analysis to deduce the patterns and trends that exist in the data. Typically, these patterns cannot be detected by traditional data exploration because the relationships are too complex or because the volume of data to be analyzed is too large.

Currently in the field of **Data Mining** it is continuously used for the analysis of large amounts of data in various fields of knowledge such as education, economics, business, the environment.

1.1. Basic concepts in Data Mining

Before knowing the process that is carried out and the types of algorithms that are used in the **DM** it is important to clarify some basic concepts that appear frequently in the bibliography associated with **Data Mining**.

Data set

It is a large collection of data usually organized into rows and columns containing variables and attributes. Each of these values is known by the data name. The dataset can also consist of a collection of documents or files.

Classes or tags

In the field of **Data Mining**, a class is the discrete attribute whose value you want to predict based on the values of other attributes. It is also known as a label.

Instance

An instance is each of the data that is available for analysis. Each instance, in turn, is composed of features that describe it. For example, in a spreadsheet, the instances would be the rows and the features the information stored in the columns.

Algorithm

In computer science, an algorithm is a set of defined, ordered, and bounded instructions to solve a problem, perform a calculation or develop a task. In other words, it is a step-by-step procedure to get a result.

1.2. Process of Application of Data Mining Techniques

The process consists of four main phases listed below:

1. **Problem definition**: this is the first phase in which a specific problem is translated into a **data mining** problem in which the objectives of the analysis and research questions are raised.
2. **Data preparation and collection**: It is the most extensive phase of the process since data quality is one of the most important challenges in **data mining**. Raw data must be identified, cleaned, and stored in a preset format.
3. **Modeling and evaluation**: in this step, different data modeling techniques (algorithms) are selected and applied and then the optimal parameters and values of these techniques are established.
4. **Deployment**: this is the last phase in which the results of **data mining** are organized and presented using graphs and reports.

See Figure 1.

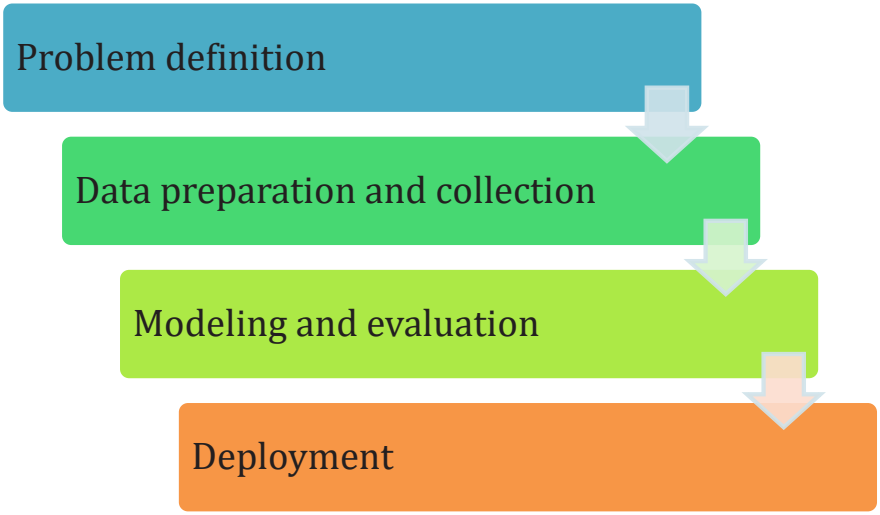

Figure 1. Process of application of **data mining** techniques. Source: Own elaboration

It is important to note that every **data mining** process is an iterative process, which means that the process does not stop when a particular solution is deployed. It may be just a new entry for another **data mining** process (Rodríguez-Arribas, 2021). That is, on many occasions the application of **DM** techniques requires several iterations and the use of different algorithms to be able to extract the final results of the research we are doing.

2. Types of Learning in Data Mining

There are numerous classifications of the algorithms used in the world of **Data Mining**, but it is essential to understand that there are two basic approaches: supervised learning and unsupervised learning.

The main difference is that in supervised learning there is a class that is used to obtain a function that allows you to associate new data with the corresponding class. However, in unsupervised learning there is no class, in this case algorithms try to discover hidden patterns in the data without human intervention in the form of tags associated with the data. (Chapelle, Schölkopf y Zien, 2006).

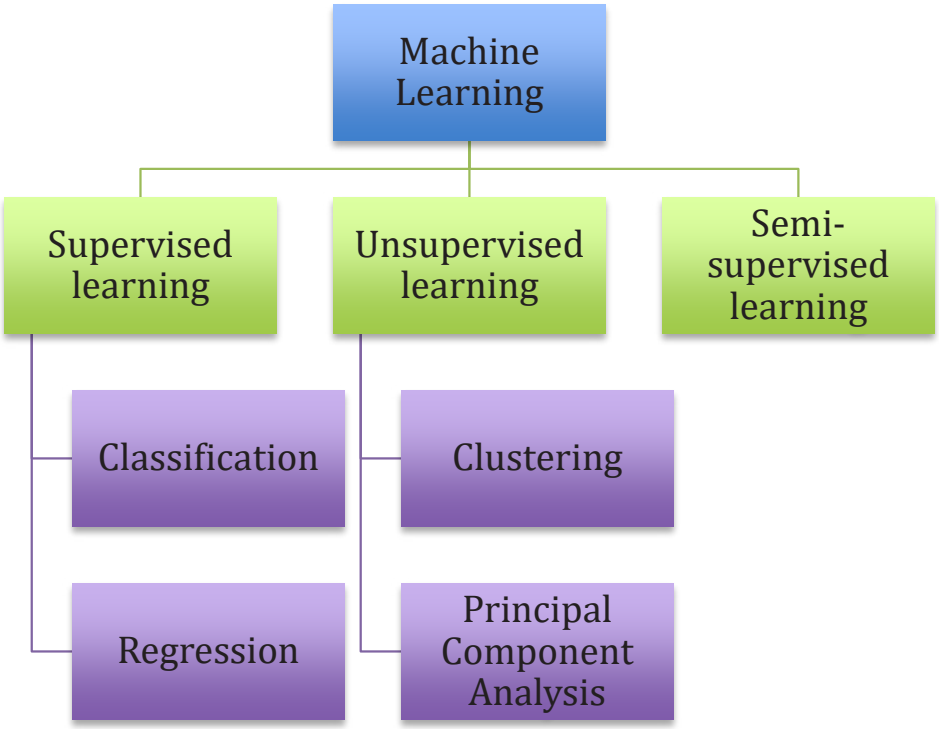

Figure 2. Data Mining Methods. Source: own elaboration.

When we must decide which algorithm will be used to perform data analysis, it is important to take into account what type of learning is being used, that is, if we are talking about supervised or unsupervised learning (García, Luengo and Herrera, 2015). According to the type of learning used, different techniques and algorithms will be used as can be seen in the previous image.

2.1. Supervised Learning

One of the learning modalities of **Machine Learning**, as mentioned above, is supervised learning.

The fundamental objective of supervised learning is the creation of a model that is able to predict values corresponding to input objects after having become familiar with a series of examples, training data.

This technique consists of two fundamental steps:

1. A training phase where a set of labeled data is used, which contain the input data and the desired results for that training data with an algorithm that allows to deduce a function from the data that we are providing to the algorithm
2. The test phase, where the function obtained in the previous step is used to generate new predictions with new data sets.

See Figure 3.

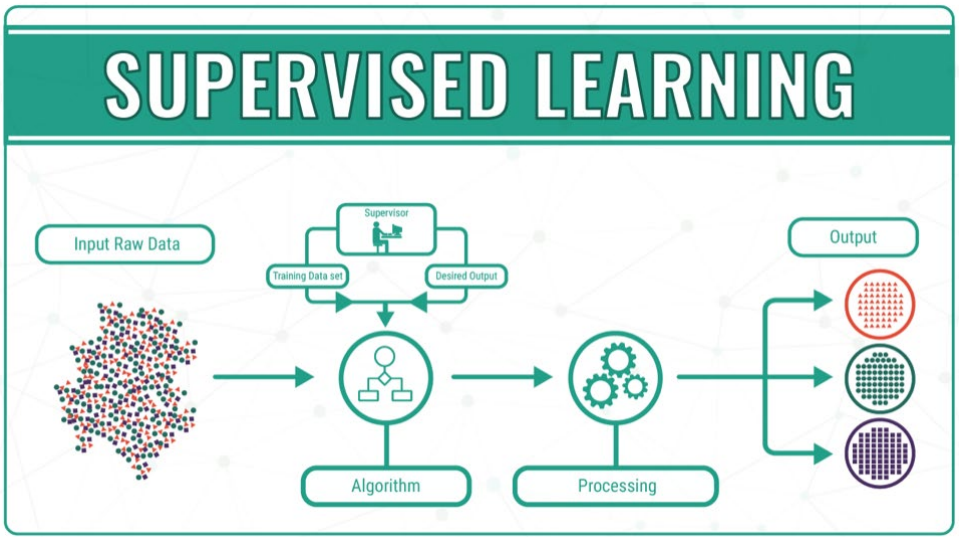

Figure 3. Process of operation of supervised learning. Source: ExperiencIA Oracle.

The process is known as supervised learning, since by knowing the responses of each example of the training set, it is possible to correct the function generated by the algorithm. The training of the algorithm is supervised by correcting its parameters, depending on the results obtained iteratively.

2.2. Unsupervised Learning

This type of learning is the other basic approach to **Machine Learning** (**ML**). Unsupervised learning has unlabeled data that the algorithm must try to understand for itself.

The goal of this type of learning is to let the machine learn without help or directions from data scientists, that is, without supervision and without a training dataset. In addition, the machine itself will adjust the results and groupings when there are more suitable results, allowing the machine to understand the data and process it in the best way (see Figure 4).

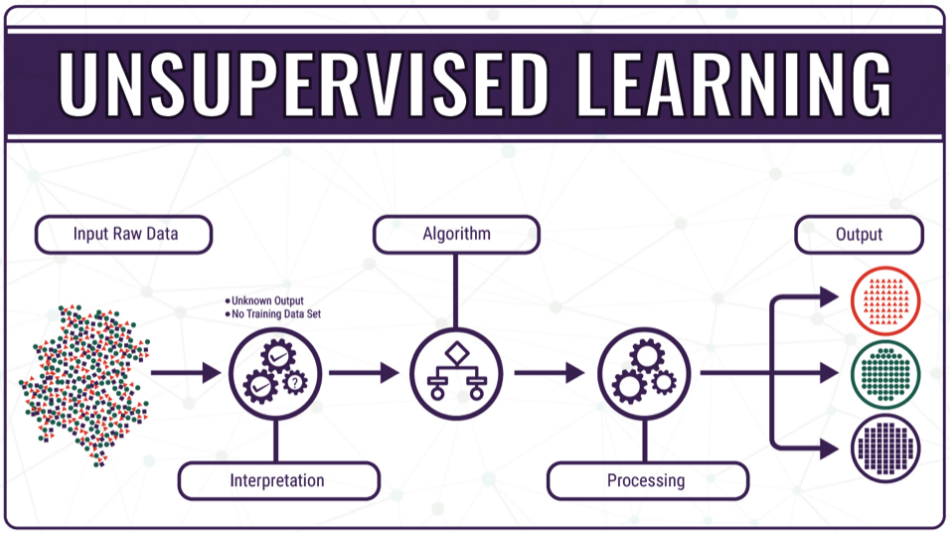

Figure 4. Process of operation of unsupervised learning. Source: ExperiencIA Oracle

Unsupervised learning is used to explore unknown and unlabeled data. It can reveal patterns that might have been overlooked or examine large data sets that would be too much for a single person to address.

2.3. Semi-Supervised Learning

Numerous investigations are currently being conducted with semi-supervised learning methods. These **Machine Learning** techniques use both labeled and unlabeled training data: typically, a small

amount of labeled data alongside a large amount of unlabeled data (Zhu and Goldberg, 2009). That is, they seek to improve the prediction models that are obtained by using exclusively labeled data by exploring the structural information contained in the unlabeled data.

We can say semi-supervised learning tries to combine the two traditional approaches of data mining (supervised learning and unsupervised learning) to keep the best of each of them.

3. Classification Algorithms

Classification algorithms are those we use when the expected result is a discrete label. That is, they are useful when the answer to the research question lies within a finite set of possible outcomes.

These algorithms generally work on the information delivered by a set of samples, patterns, examples, or training prototypes that are taken as representatives of the classes, and they retain a correct class label. This set of correctly labeled prototypes is called a training set, and it is the knowledge available for the classification of new samples. The objective of supervised classification is to determine, according to what is known, which class a new sample should concern, considering the information that can be extracted (see Figure 5).

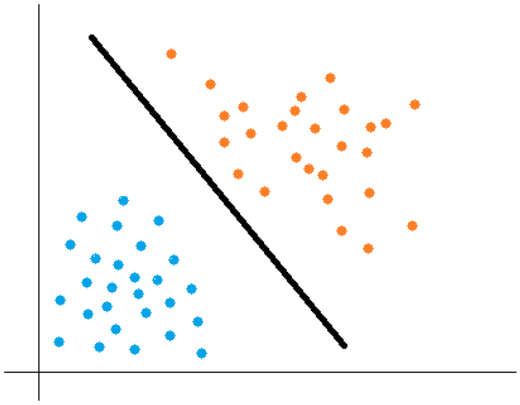

Figure 5. Classification algorithm. Source: own elaboration

Classification is very similar to the learning process of people, since we possess the ability to classify food, books, animals, planets, that is, everything around us.

4. Clustering algorithms

Clustering algorithms are responsible for grouping the objects in a dataset according to their similarities. In this way the objects that are within a cluster or group have more similarities between them than differences (see Figure 6).

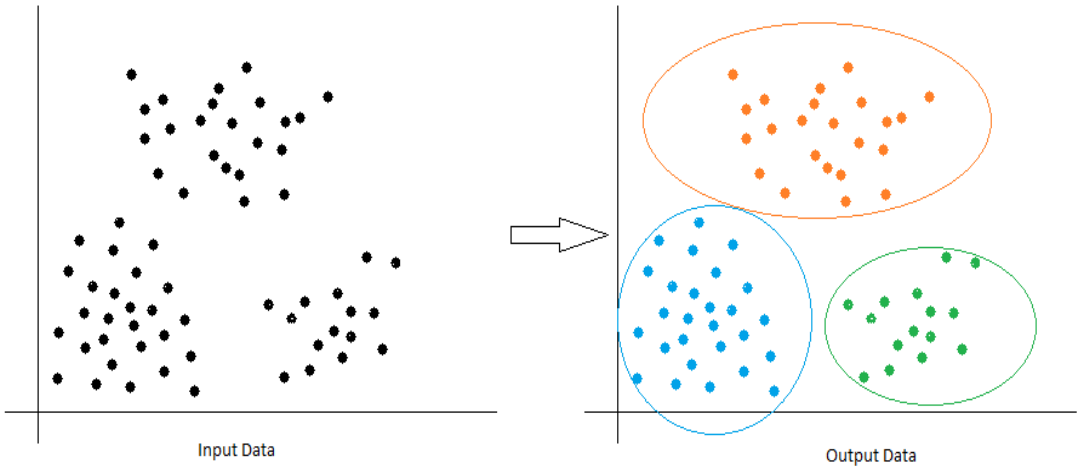

Figure 6. *Clustering* algorithm. Source: own elaboration

These algorithms work with unlabeled data, so it is the algorithm itself that analyzes the data to find the optimal number of groupings for the input data set since we do not have prior knowledge about the characteristics of the data and its classes.

The groupings performed by the algorithms can be of two types:

1. **Hard cluster**: each piece of data belongs exclusively to a group.
2. **Soft (diffuse) cluster:** the data can belong to several groups in different degrees, that is, the same data can have a degree of belonging of 60% to group 1 and 40% in group 2.

5. Regression Algorithms

Regression algorithms are a subfield of supervised learning whose goal is to establish a method for the relationship between a certain number of characteristics and a continuous target variable.

These are algorithms that establish a line to provide the trend of a set of data, that is, the purpose of these algorithms is to relate a number of characteristics and a continuous objective variable (see Figure 7).

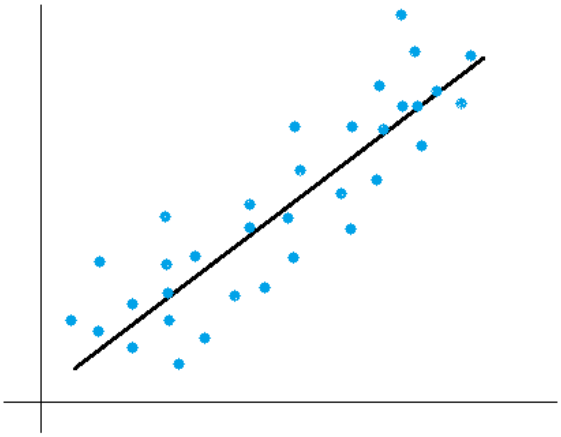

Figure 7. Regression algorithm. Source: own elaboration

This technique is useful for predicting outcomes that are continuous values, that means that the answer to the research question is presented by a quantity that can be flexibly determined based on model inputs rather than being limited to a finite set of labels as in the case of classification.

6. KNIME

KNIME is an open-source application that allows us to apply to our own datasets or to sample datasets:

1. Statistical methods.
2. **Data mining** algorithms or **Machine Learning**.
3. Visualization techniques.

Being an open-source software has many advantages, its code belongs to the community of users and developers, which guarantees that it will always be a free tool. In contrast, private software belongs exclusively to a company and this company can allow its free use, but also charge a high price or demand the payment of a monthly subscription.

It is a tool designed to be simple to use. The most important concept in the use of the tool is workflow. A workflow is a sequence of steps configured by the user. Formally it is a set of nodes joined together with arrows. A node encapsulates different jobs that can be done with the data, there are nodes for many tasks. A workflow might have a node to load a dataset from an Excel file, then a node to select attributes (columns) from that dataset, and then another node to display statistics for the selected attributes (see Figure 8).

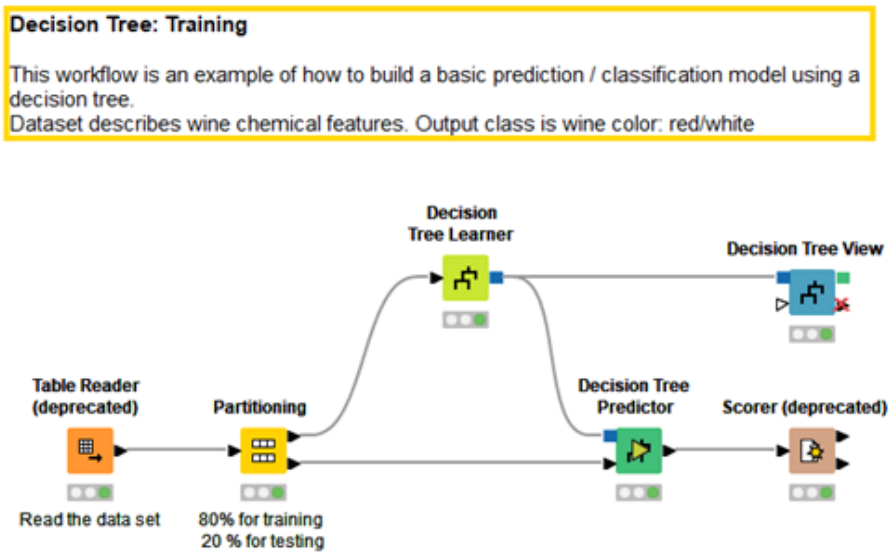

Figure 8. Example of a workflow in KNIME

The fundamental features why KNIME is an easy-to-use tool are the following:

1. It is a "Visual Programming" tool. Data analysis can be done intuitively by setting up the process simply by *clicking* the mouse. The "nodes" that we need are placed, without the need to know their name or how they are configured, since at all times we have help.
2. There are nodes to apply any procedure or technique you want, in addition to being an open-source tool, users themselves can create their own nodes. There are nodes for:
   a) Load data from files or databases.
   b) Create, modify, or delete rows or columns from the dataset we are working with.
   c) Calculate statistics means, percentiles, correlations etc.
   d) Combine data from different data sources.
   e) Build and evaluate **Machine Learning** models such as: classification, regression, or **clustering**.
   f) Visualize the data using bar charts, pie charts, scatter charts, and also other more advanced chart types.
   g) Generation of reports.

6.1. Installation

KNIME is a Java application, which means that you will need to have the Java virtual machine installed before you can install and run the program.

To install the software, we must go to https://www.knime.com/downloads, once there we will download "KNIME Analytics Platform" choosing the corresponding version for the personal computer we have: Mac, Windows 32 bits (old computers), Windows 64 (modern computers) or Linux.

6.2. The Workspace

The workspace is the folder or directory of our computer where all the projects carried out with KNIME are stored. It will be necessary to choose a workspace before starting the program (you can also leave the folder that appears by default when installing).

6.3. Examples of use

Examples are available in the additional material where some key KNIME concepts are reviewed, although these concepts are much better learned if the student performs them on their own computer while following the slides.

Summary

In this IV.1-unit, basic concepts related to Data Mining have been addressed, as well as some simple data mining techniques to apply to research in the field of early care.

Glossary

Clustering: is a data mining technique, which is generally used with unlabeled data, which allows data to be grouped according to their similarities or differences.

DM: Data Mining, is a set of techniques and technologies that allow you to explore large databases, with the aim of finding repetitive patterns that explain the behavior of this data and that these can be used to draw conclusions.

ML: Machine Learning, is a discipline in the field of Artificial Intelligence that gives machines the ability to "learn", from the analysis of data tries to identify patterns and support decision making.

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Resources

Software

KNIME

https://www.knime.com/downloads

Comprehension questions

Answer (true answer is in bold)

Question 1. What kind of learning do we use if we employ an algorithm that makes predictions and has been trained with an input dataset considering that each in each record/example/instance we have input variables and an output variable?

a) **Supervised**
b) Unsupervised
c) Deep learning
d) Data Prophecy

Question 2. What are classification algorithms used for?

a) To predict real numerical responses such as temperature changes or precipitation
b) To depending on the similarity of the data, create clusters and identify patterns
c) **To predict the category of one or more never-before-seen data**
d) To know the trend of a dataset

Question 3. What kind of learning is used to discover patterns in data that is not labelled?

a) Supervised
b) **Unsupervised**
c) Deep learning
d) Data Prophecy

Question 4. Which of these claims about *clustering* algorithms is false?

a) Group data based on its similarities
b) Work with unlabelled data
c) **All algorithms allow a piece of data to belong to more than one group**
d) They are used to find patterns within the data since we do not know their characteristics

Question 5. At what stage of a data mining process are algorithms applied to data?

a) Problem definition
b) Data preparation and collection
c) **Modelling and evaluation**
d) Deployment

Question 6. In Data Mining, what is the name of the discrete attribute whose value you want to predict?

a) **Class**
b) Instance
c) Attribute
d) Algorithm

Question 7. The programming language in which KNIME is developed is:

a) **Java**
b) Python
c) R
d) MATLAB

Question 8. The states in which we can find a KNIME node are:

a) Three options (Pending, Execution Successful, and Error).
b) Four options (Pending, Successful Execution, Warning, and Error)
c) **Four options (Not configured, Pending, Execution successful, Warning / Error)**
d) Five options (Not configured, Pending, Execution Successful, Warning, and Error.)

Question 9. Which is correct with respect to KNIME nodes and workflows?

a) Workflows connect to each other to form nodes.
b) A node is a complete sequence of steps that allows a complete processing of the data.
c) **A workflow is composed of a series of linked nodes.**
d) A node can in turn be composed of more nodes.

Question 10. Which of these nodes is fake?

a) The “Statistics” node calculates statistics of the attributes.
b) The “Scorer” node can be used to evaluate the success rate of a classifier.
c) **The “Column Filter” node can be used to create new attributes.**
d) The “Column Filter” node can be used to delete attributes.

MODULE IV.2 OBSERVATION AND EVALUATION TECHNIQUES BASED ON THE USE OF SMART RESOURCES

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I. INTRODUCTION

This part of Module IV refers to data preparation in the qualitative research setting. It also includes information about how to prepare data for further processing. In addition, you will work specifically on think-aloud protocol analysis techniques.

II. OBJECTIVES

1. Prepare data and apply data processing techniques within the framework of qualitative research.
2. Learn and apply techniques for analysing think-aloud protocols.

III. CONTENT SPECIFIC TO THE TOPIC

1. Before registration, recording and data extraction

Research, whether quantitative or qualitative, must be based on research questions or hypotheses that guide study. Qualitative research has to carry out a refined and rigorous description of the contextual situation of a fact, situation or behaviour to be analysed (Anguera, 1986). For this reason, this type of research must also be systematic and start from categories that are observable and measurable in order to be able to later treat these data with different techniques.

1.1. Direct or indirect techniques for gathering information

Qualitative research can be based on several criteria:

a) **Hypothetico-deductive**, advantages include organisation and guidance from the beginning of the entire research process and disadvantages include the loss of flexibility.
b) **In-depth data recording**, advantages include the collection of data in context and disadvantages include difficulty in systematising the collection of information. The **categorisation of the information** plays an essential role here.
c) **Information collected from documentary sources or direct records** (videos, manuscripts, etc.). The most commonly-used observation techniques are systematic observation, which can be participant or non-participant, interviews, content analysis and case studies (Anguera, 1986; Sáiz and Escolar, 2013).
d) **Criterion of prior observational content**. Choice of the object or field of observation.

In this type of research, **direct or indirect research techniques** can be used, the former referring to interactive contextual situations and the latter to contextual observational analytics involving the use of observational techniques with previously defined indicators.

1.2. Categorisation of information

For good categorical analysis, it is necessary to start from a prior idea that answers the questions "What should I observe? Why observe? What interests me most in all the data I have recorded?". Contextual qualitative observation can provide the researcher with a lot of information that may not be relevant to the object of study. Therefore, the object of observation should be delimited a priori. This delimitation can shed light on the process of categorisation or taxonomy of categorisation that is most appropriate to the object of study at the time. Categorising means naming, classifying a series of data into a set of categories. In short, it means ordering the data in relation to criteria that are either previously defined or are defined from the information recorded.

1.3. Data reduction

Categorisation of information facilitates reduction of data recorded in a "raw" form. However, this categorised data needs to be analysed in order to be interpreted. This analysis can be quantitative or qualitative (flow charting or ranking) or a combination of both. The recording possibilities are very varied depending on the contexts. Different events can be recorded in a successive continuum of data, or a progressive behavioural analysis of a single subject—or a set of subjects, etc.—can be recorded. This means, it is essential to delimit the object of the research and the context of action, and underscores the importance of defining the research questions. The study of all information can be done from complex sequential behavioural analyses. These can be represented in a scattergram and its representation in a polar coordinate system, i.e. vectorial. Reliability and validity indicators must also be considered. These concepts are not handled in exactly the same way as in the context of qualitative research but are specifically related to the rigour of the categorisation process. According to Anguera (1986) in qualitative research, different types of **validity** can be distinguished:

a) *Apparent validity*, choice of answers related to the object of the study.
b) *Instrumental validity*, analysis of the instrument used to record and collect information, similar to concurrent and predictive validity.
c) *Theoretical validity*, which relates to the relationship between what is observed and the theory that supports it.

Triangulation

Triangulation is a technique used to analyse the degree of agreement or consistency of an observational analysis. It involves the use of different observational procedures on the same event or situation. It aims to increase the validity of conclusions about an observational fact. A study can be triangulated on:

1. The data according to variables of time, space and person.
2. The researcher, several researchers observing the same event.
3. Theory, different approaches to the same fact or situation to be observed or instruments (empirical observation with opinion instruments such as surveys).

In relation to **reliability**, according to Kirk and Miller cited by Anguera (1986) p.13, a distinction can be made between:

a) *"Quixotic" reliability* refers to a single method of observation. It results in a continuously invariant measure (sentences, facts or behaviour).
b) *Diachronic reliability*, which is the stability of an observation over time. It relates to repeated measurements for the recording of a time-invariant event.
c) *Synchronous reliability* implies similarity of observations with respect to relevant features.

Replicability and generalisability

It is clear that the argument between qualitative and quantitative research makes no sense, they are complementary methodologies. It is also clear that the replication of a study—as well as generalisation—is

related to finding similar results in different samples with similar characteristics. This is an indicator of the generalisability of a study's results.

In short, first you must define what you want to study and why. These questions include the variables to be analysed. All research questions indicate dependent and independent variables. The independent variable would be the one that is hypothesised to produce some change in the dependent variable. It is important to specify all these elements, as they will be the basis for the preparation and subsequent processing of the data.

An example of a qualitative observation process is provided below by following the steps proposed by Carreras (1991), applying those steps to two research examples.

1.4. Example

Analysis of a research in a prototype 1

Step 1. Definition of the problem to be investigated.

Specify the object of the research by answering the questions: what to study, what for, and how.

Example: To find out the type of cognitive and metacognitive strategies that children aged 3-6 years use when solving problems in natural environments (family, school, etc.).

Step 2. Behavioural parameters to address the formulated problem.

Next, the parameters must be specified, i.e. the observable behaviours that will make the variables defined in the research objectives explicit. Once they have been specified, the procedure for measuring them must be developed. They may be primary measures, analysing frequency, duration, latency, or intensity, with frequency and duration being the most-commonly used. Secondary measures involve the categorical operationalisation of results found in primary measures, where frequency can be analysed, and the order of occurrence will be applied either to the complete recording or to the recording intervals produced after random sampling.

Example: analysis of interactive behaviours in children with suspected Autism Spectrum Disorder (ASD) in the academic context. The categories in this example would be the different types of interactive behaviours in 2-3 year olds (eye contact, following instructions, proto-imperative and proto-declarative behaviours).

Category recording can analyse frequency (number of occurrences of the behaviour and the categories associated with it), duration measured in time units of the category (time unit), latency—the time from one behavioural category to another, and intensity—which is analysed when using Rating Scales. Scales may include ordinal, nominal, interval or ratio scales.

Example: Rating Scales of intervals or ratios, a Likert-type scale (see Table 1).

Table 1. An example of rating scales.

Strategies to be observed **Planning processes**	**1**	**2**	**3**	**4**	**5**
Performs actions without a goal that cannot be regulated by the adult's voice					
Performs brief functional actions regulated by the adult's voice					
Performs autonomous long process activities without pre-planning					
Performs long process actions without an antecedent-consequent hierarchical structure					
Performs complex, time-consuming actions with a structured pre-planning process					

Once results have been collected, they are analysed. Whenever closed measurement instruments are used, quantified data are produced (e.g. Likert-type scale from 1 to 5). Data can also be obtained from open-ended responses (i.e. in which the subject states their opinion, or describes the behaviour of others).

These results can then be quantified and statistical techniques (parametric or non-parametric) used for analysis.

Step 3. Sampling strategy for the parameters to be studied.

As the examples above show, many parameters and variables can be studied on the same observation. What to analyse is determined by the research question.

Example: task solving behaviours in symbolic play activities. These behaviours will be observed in therapeutic intervention sessions.

Likewise, from this possibilities approach, it will be possible to carry out random sampling of different timepoints in order to specify the timing of the observation. For example, on Monday at the beginning of the symbolic play session, on Tuesday in the middle of the symbolic play session, on Wednesday at the end of the symbolic play session, on Thursday at the beginning of the symbolic play session and on Friday at the end of the symbolic play session.

Step 4. Method of data recording and practice in the selected field

Observation may include video, audio, observational recording by the observer on paper records, or all of these.

Example: Video observation, a paper-based observation by a non-participant observer, and a paper-based observation by a participant observer will be chosen. With these three recording methods, triangulation can then be carried out.

Step 5. Most appropriate statistical tests to analyse the data.

The choice of techniques for analysing the data recorded in the observational process will depend partly on the type of records and partly on the design chosen by the researcher.

Example: In the case of this analysis, parametric, non-parametric and strictly qualitative statistical analysis techniques such as frequency analysis could be used.

Analysis of a study in a prototype 2

Step 1. Defining the problem to be investigated

To analyse the opinion of early care professionals about the use of the Flipped Classroom methodology in content updating training processes.

Step 2. Behavioural parameters to address the formulated problem.

The variables that are significant in addressing the research problem posed are isolated. In this case they would measure early care professionals' opinions about professional updating through the Flipped Classroom methodology.

Step 3. Sampling strategy for the parameters to be studied.

Professionals' satisfaction with their Flipped Classroom experiences will be analysed in various subjects, in various years, and in various degrees. In this case—and depending on the availability of work—random or convenience samples could be applied. The use of one or the other will guide generalisation of the results.

Step 4. Method of recording the data and practice in the selected field.

Observation consists of recording the occurrence or non-occurrence of a fact or event. However, qualitative research also allows for categorical recording. Therefore, the responses to the open-ended response can be quantified and categorised. The categories will be established according to the theory underpinning the research, in this case it refers to aspects that have been most useful for learning, aspects that have not been useful, and aspects that should be introduced.

Another factor to take into consideration is the frequency of observation, in this case the number of times the scale of satisfaction with the Flipped Classroom activity is applied, which for this study will be

each time the professionals watch one of the *ad hoc* prepared videos. This will allow an analysis of the satisfaction rate in each analysis group, and subsequently an inter-group comparison, as well as an individual analysis of satisfaction in each of the videos for each of the groups.

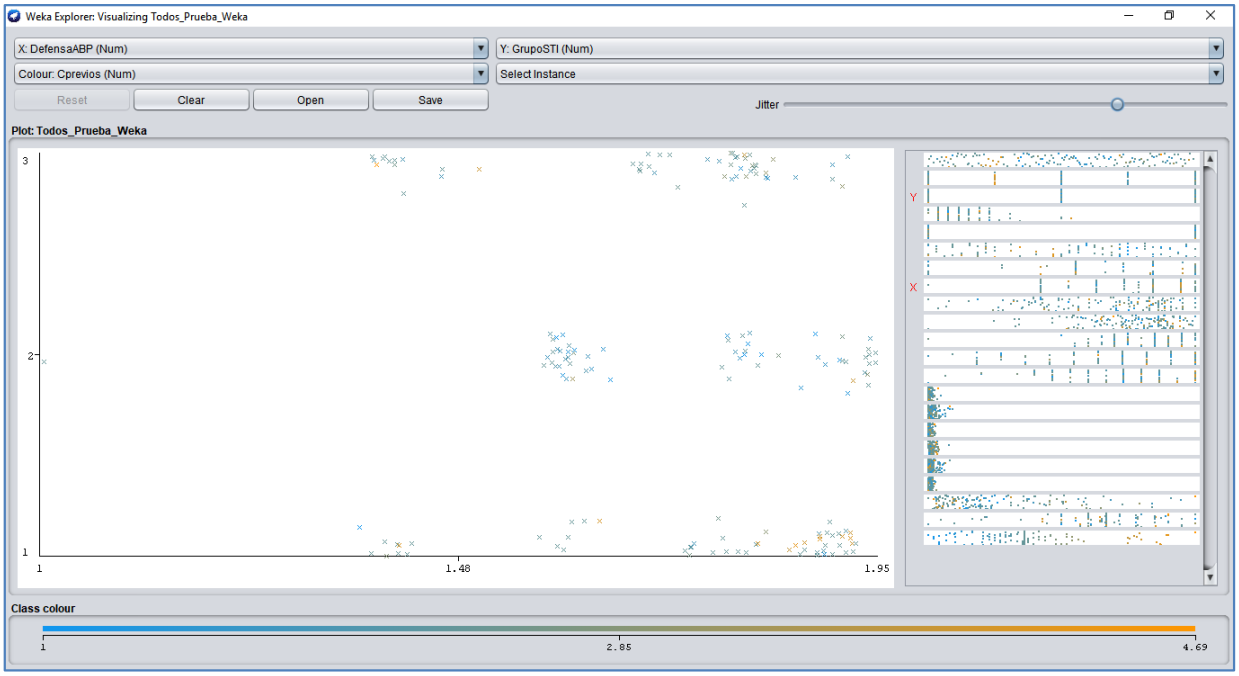


Figure 1. Example of a dispersion analysis of variables performed with Weka.

Step 5. Most appropriate statistical tests to analyse the data.

In this example, we are going to analyse the satisfaction of early childhood professionals who follow a refresher training activity. To that end, a scale with 10 closed Likert-type questions has been created, which also includes three open questions analysing aspects to be increased in, eliminated from, or added to the training activity. The independent variable in this case would be the instructional action through training videos and the dependent variables would be the professionals' satisfaction with different elements that could be aligned in evaluation clusters, for example: materials, evaluation procedures, and attention of the teacher towards the participant(s). After this analysis of the study variables, the research hypotheses can be defined. These hypotheses include the relationship between the dependent and independent variables.

2. Data Preparation in Qualitative Research: Recording Information

As outlined above, the possibilities for recording guide the collection of information. Most qualitative studies work with information that is collected using the transcription method, either from audio or video material. Nowadays there are many resources that make it easier to record and transcribe information, these include:

Audio records

Google Docs

To use Google Docs for free, all you need is a Google account associated with an email address. Once logged in from any browser, e.g. Chrome, open a new document and in the "Tools" menu, select the "Voice typing" option. Immediately a microphone icon will appear and you can click on it to start dictating.

One of the strong points of Google Docs is that once the text has been transcribed, it is also possible to edit it without using the keyboard, by means of numerous voice commands. Although for the moment, as the company itself indicates, these functions are only available in English.

https://www.google.es/intl/es/docs/about/

Dictation

Created by Amit Agarwal, a technology columnist, this is one of the most popular dictation tools available today. It allows you to save the result in a .txt file from which you can then copy and paste text into another document.

https://dictation.io/

Speechnotes

Speechnotes can be added as a Chrome extension, and can also be downloaded as an App for Android devices.

It has a very clean, intuitive design with a central part in which the text is transcribed flanked by two columns that are of great help: to the right are the commands and shortcuts that can be used to facilitate dictation and on the left are all the actions that can be performed with the final text: save, send by email, upload to Google Drive, and print, among others.

https://speechnotes.co/es/

Personal Speechlogger

This is very similar to **Speechnotes** as they share the same developers, Speechlogger Personal, and it also has an *app* version for Android devices. Its creators present it with two competitive advantages over similar tools: automatic punctuation and the possibility of translating transcribed texts into several languages. Thanks to the latter function, Speechlogger Personal can be used for translation and communication in other languages.

https://speechlogger.appspot.com/es/

Video registration

Camtasia

This is an easy-to-use tool that includes many options. It has video editing features, such as cutting and pasting shots or adding different kinds of transitions. In addition, it can export to all formats AVI, SWF, MP3, MP4, GIF, etc.

https://www.techsmith.com/video-editor.html

Jing

This is a very simple tool that only allows basic *screencasts* (screen capture and audio) and has no video editing functions. However, it is a quality product with an interface that, in addition to being intuitive, has an attractive design for the user. However, it can only work in SWF format.

https://jing.softonic.com/

Adobe Captivate

This software allows you to create high quality, complex videos with effects. It uses its own peculiar capture method, since it does not capture screenshots as such, but combines static backgrounds with vector movements, for example of the mouse. The results are of impeccable technical quality and look very appealing.

https://www.adobe.com/es/products/captivate/education.html

Camstudio

This is *open source* software that allows you to record your screen in AVI format and add audio to it. It does not allow you to edit the resulting videos, so they have to be recorded from video.

http://camstudio.org/

Screencast-O-Matic

This is a free online tool that allows you to create simple video tutorials. It supports three of the most commonly used formats: MP4, AVI, FLV movie.

https://www.redeszone.net/2015/04/26/screencast-o-matic-manual-de-uso-gratis/

Debut Video Capture

This is very comprehensive free software that provides many editing options, such as adding our own images or others taken with the computer camera, editing shots, inserting transitions and other effects, etc. However, it has a steep learning curve to use all of its functionality.

http://www.nchsoftware.com/capture/index.html

Active Presenter

This is a screencasting and eLearning program for Microsoft Windows that can be used to create software demonstrations, software simulations, and tests. It allows the export of image series, HTML slide-shows, documents (PDF, Microsoft Word, Excel), Microsoft PowerPoint presentations, videos (AVI, MP4, WMV, WebM), Flash videos and interactive simulations (AJAX, Adobe Flash). For e-learning or m-learning, Active Presenter can package the contents in SCORM compatible files. For software simulations you can use mouse movements, right or left clicks or keystrokes.

It can also be used to convert Microsoft PowerPoint presentations to any of its output formats with the loss of some effects and animations and conversion between quite a few video formats indirectly.

https://atomisystems.com/activepresenter/

Movie Maker

Software that allows editing of videos, facilitates personalisation of recordings that have been made with the programmes described above.

https://www.movavi.com/es/support/how-to/windows-movie-maker-review.html?gclid=CjwKCAjwrqnYBRB-EiwAthnBFqSrGwdx6sAT7QFibtm82LFT-6fek9nP2K-loR1QwpH-3AZbey3DFRoCeRAQAvD_BwE

ScreenFlow

An editor and *screen recorder* for Mac.

https://www.telestream.net/screenflow/overview.htm

iMovie

A video editing programme available for the Mac.

https://www.movavi.com/es/support/how-to/imovie-for-windows.html?gclid=CjwKCAjwrqnYBRB-EiwAthnBFieMmF7XXYa1BjNSDHXha4pcxslCvtVYhG_N_NMafvlYsQVrrW2PNxoCiMMQAvD_BwE

Filmora

An easy-to-use video editor programme.

https://filmora.wondershare.es/

In short, there are currently many tools available to users that make it easy to record the information they wish to study. These programmes also allow this information to be transferred to different types of records (Word, Excel, MP4, etc.).

3. Data preparation in qualitative research: data processing

Transcription of information

Most qualitative research works with data that has been recorded through audio or video recordings, records of opinion through open-ended *online* questionnaires that can be the subject of conversation recording. A few decades ago, this type of recording involved time-consuming data collection, transcription and categorisation. Nowadays, certain software (ATLAS.ti, NVivo; MAXQDA, etc.) allow this process to be carried out more quickly. However, the researcher must check the results in order to clean up the records. In other words, the information relevant to the object of the research must be selected from among all the information recorded. In addition, the confidentiality of the recorded and transcribed data must be ensured at all times. To this end, the real names of the participants should be omitted (Gibbs, 2012).

Examples of transcriptions of information are presented below.

Example 1

Transcription of information through audio recording, a technique used in the task analysis procedure. Taken from Sáiz (2000) p. 60.

Transcript of an interaction between a therapist and a student in the resolution of a task:

- **Therapist:** "I am going to explain the task to be done. First I do it and you listen to it, then you do it and I help you a little bit and then you do it on your own, okay? do you understand?
- **Girl:** "The girl nods".
- **Teacher**: "Look at today's homework, we have to put a yellow sticker, a green sticker and then a red sticker, what is the homework we have to do today? We have to stick a yellow, a green and a red sticker.
- **Girl:** "yes".
- **Therapist:** "How are we going to do it? We have to think it through. First we put the yellow, now the green and then the red. How am I doing, am I following our plan? Well I've followed the plan. I'm going to do it again, first I put the yellow, then the green and then the red. How did I do it? Very good.
- **Therapist:** "Now you have to do it by yourself. Come on, I'll help you. What do you have to do today? Do you have to put the...? "
- **Girl:** "Yellow".
- **Therapist:** "Then the..."
- **Girl:** "The green one".
- **Therapist:** "You have to put them next to each other (the girl has put them in a row), just like the model, it's OK, we take it off and start again".
- **Therapist:** "Now which one do you have to put".
- **Girl:** "red".
- **Therapist:** "Now what do you need to do, you need to put..."
- **Girl:** "The yellow one".
- **Therapist:** "Then the..."
- **Girl:** "green
- **Therapist:** "All right, you have to always look at the model and now you have to put the..."
- **Therapist:** "The red one is very good. And now which one do you have to put, the..."
- **Girl:** "Yellow, I know all the colours, orange and everything".

- **Therapist:** “How are we doing?”
- **Girl:** “good”.
- **Therapist:** “After the yellow one, which one goes?”
- **Girl:** puts green without verbalising
- **Therapist:** “All right and now”.
- **Girl:** “puts red without verbalising”.
- **Therapist:** “How did we do?”
- **Girl:** “Good”.
- **Therapist:** “So far I have helped you a little bit, but now you have to do it by yourself, okay?”
- **Girl:** “Yes” (she is doing it by herself)
- **Girl:** “Look how well I’m doing”.
- **Girl:** “I dropped it, it’s a bit crooked, but it doesn’t matter”.
- **Therapist:** “Very good, you’ve finished, you’ve done very well”.

Transcripts should always include the name of the evaluator, the date, time and duration of the recording. In this way it is possible to compare and collate recordings of the same subject in different observations.

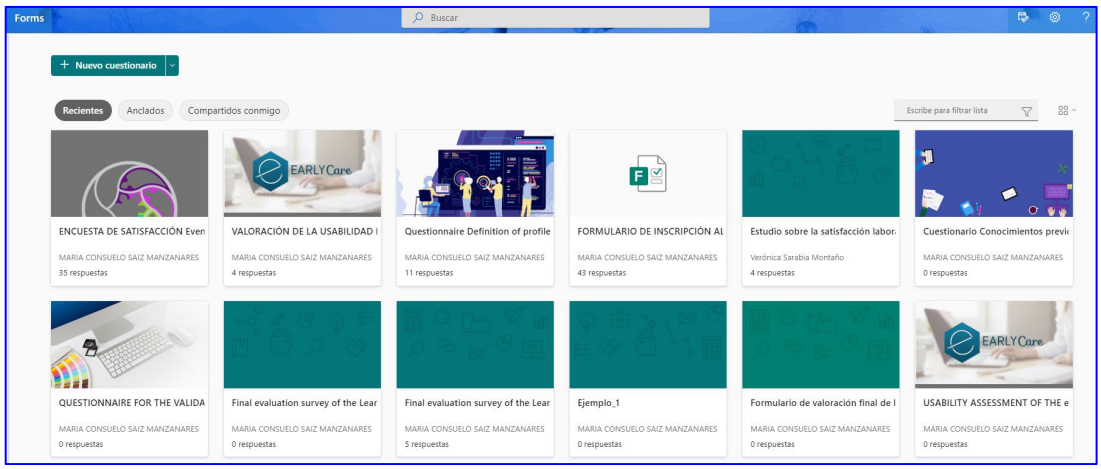
Ejemplo 2

Information can also be collected from online surveys with open-ended questions. This collection of information is automatic and can be carried out with free tools such as Google Survey or linesurvey. You can also use the Microsoft Forms tool within the Office 365 package. These systems allow you to download data in different formats such as .csv, .xlsx, .xls, .ods and others.

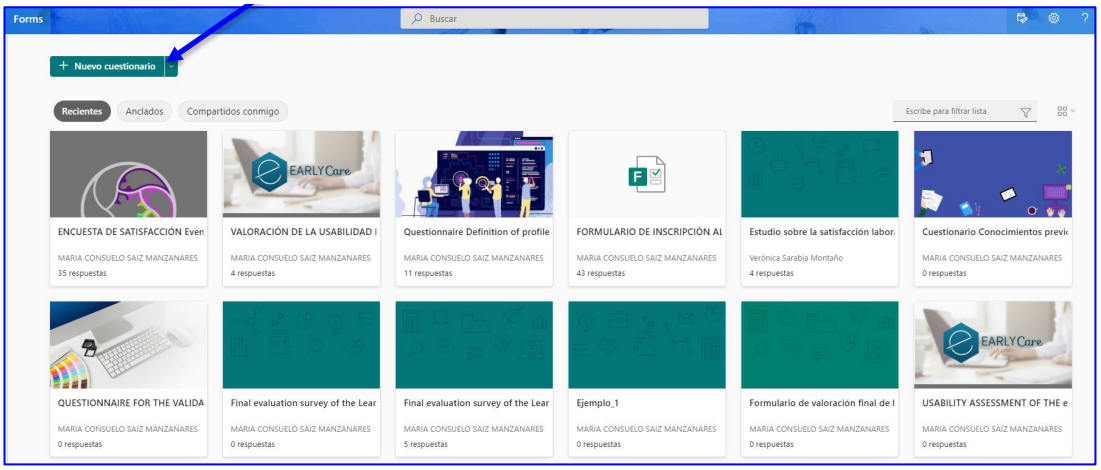
Next, we present the steps for creating a survey in Microsoft Forms, data collection, data learning analytics and qualitative data collection.

Microsoft Forms

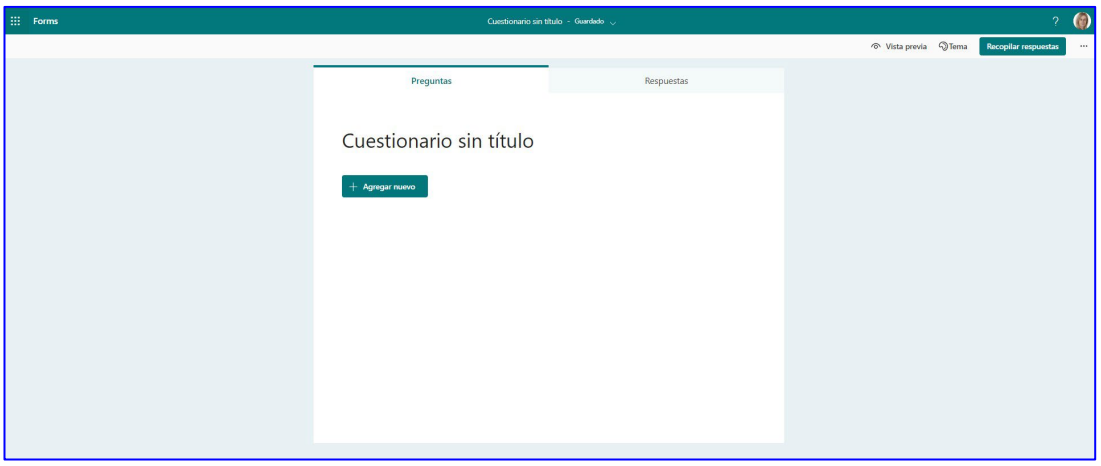
Step 1



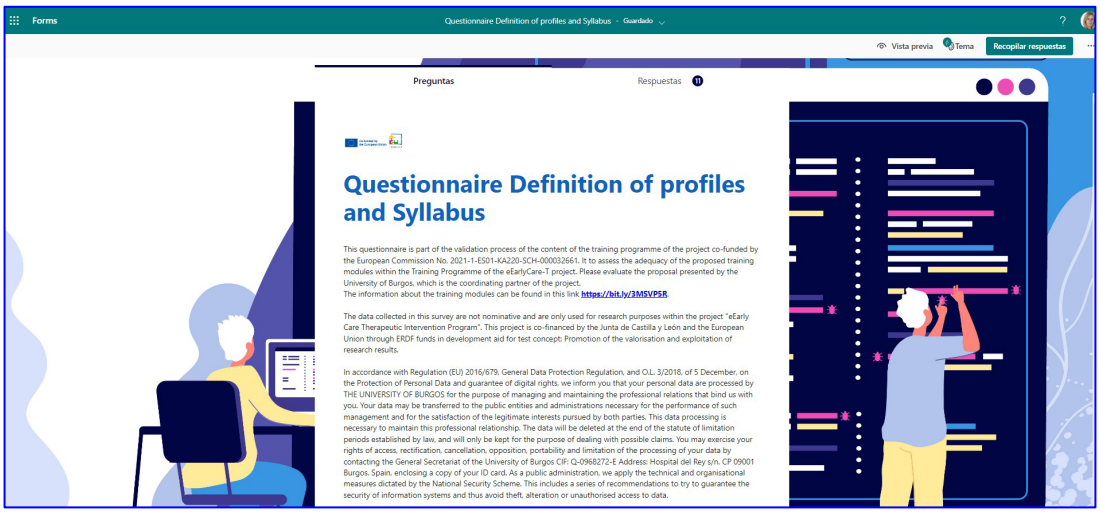
Step 2



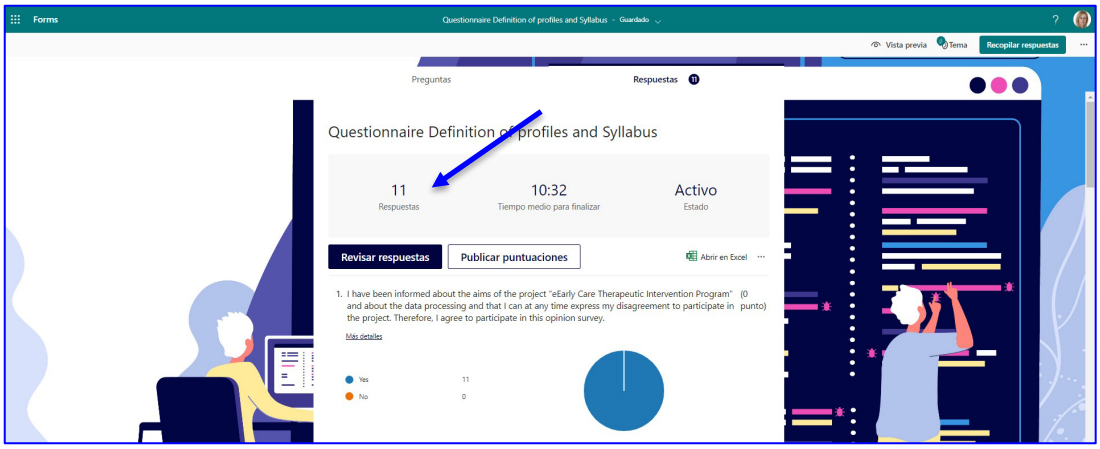
Step 3



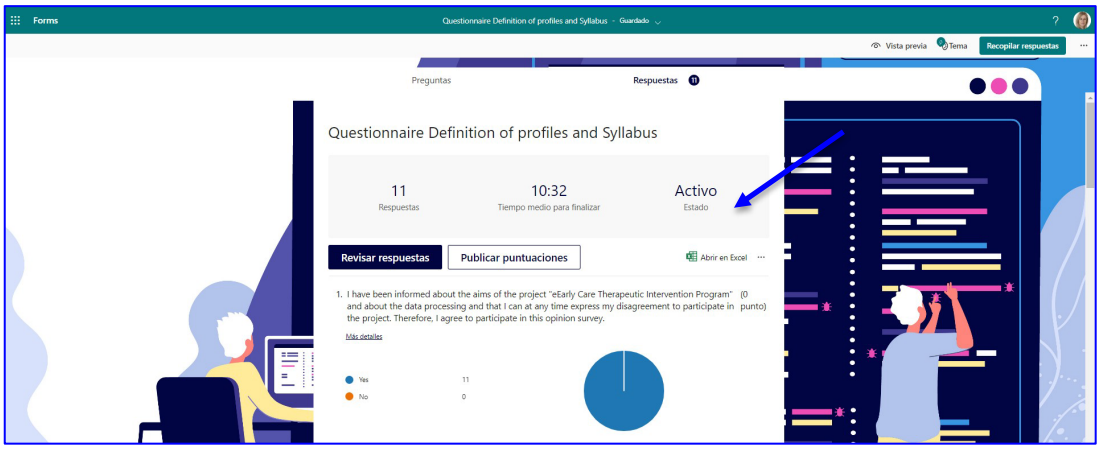
Step 4



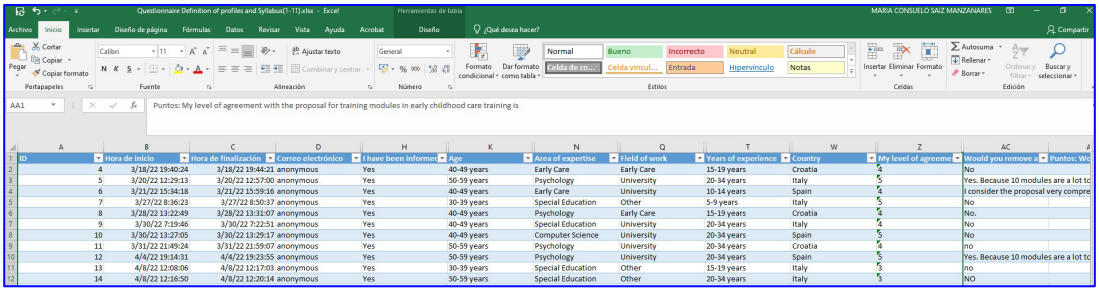
Step 5



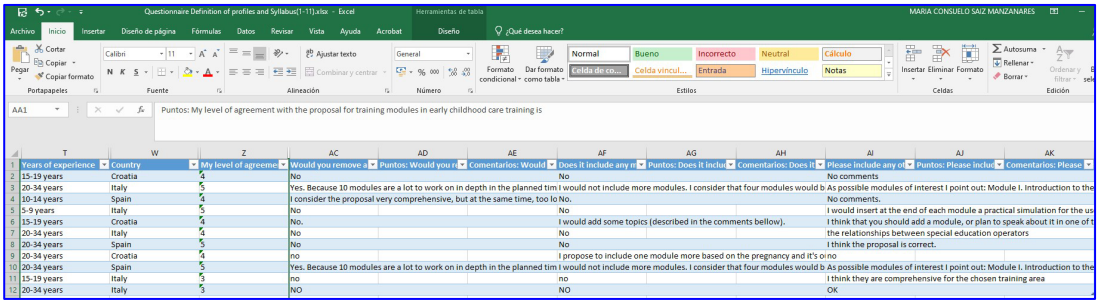
Step 6



Step 7



Step 8



Summary

Data preparation is an essential aspect of both qualitative and quantitative research. In particular, the researcher has to make a prior research design including the research question(s), which must be precise and clearly include the variables to be studied. These must be measurable. Likewise, it has to be specified which of them are going to be dependent and which will be independent variables. Specifically, in qualitative research, elements for the collection of systematic information have to be used, supported by different sources such as audio, video, etc. This module presented various techniques that can be used as a guideline. Next, the information collected must be categorised using categorisation processes that are directly related to the previously defined variables. Categorisation will allow frequency analysis of the elements under study, and at this stage the data collected must be cleaned and specified. The qualitative evaluation instruments are also subject to finding the reliability and validity indicators of these instruments. In the field of qualitative research, the use of triangulation is essential. The ultimate goal is to ensure the generalisability of the research results.

In addition, this module particularly emphasised the presentation of the think-aloud protocol analysis methodology, which consists of the collection of interaction dialogues between the user and the child in order to record these interactions. The protocol analysis techniques are based on categorisation, from the analysis of the use of metacognitive strategies at different levels of complexity. In addition, examples have been provided for the creation of surveys through different *online* methods, such as Microsoft Forms, that allow surveys to be created in an open-response format.

Glossary

Scattergram: A scatter diagram or scatter plot that uses Cartesian coordinates to show the values of two variables for a set of data.

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Resources

Web

Google Docs	https://www.google.es/intl/es/docs/about/
Dictation	https://dictation.io/
Speechnotes	https://speechnotes.co/es/
Personal Speechlogger	https://speechlogger.appspot.com/es/
Camtasia	https://www.techsmith.com/video-editor.html
Jing	https://jing.softonic.com/
Adobe Captivate	https://www.adobe.com/es/products/captivate/education.html
Camstudio	http://camstudio.org/
Screencast-O-Matic	https://www.redeszone.net/2015/04/26/screencast-o-matic-manual-de-uso-gratis/
Debut Video Capture	http://www.nchsoftware.com/capture/index.html
Active Presenter	https://atomisystems.com/activepresenter/
Movie Maker	https://www.movavi.com/es/support/how-to/windows-movie-maker-review.html?gclid=CjwKCAjwrqnYBRB-EiwAthn-BFqSrGwdx6sAT7QFibtm82LFT-6fek9nP2K-loR1QwpH-3AZ-bey3DFRoCeRAQAvD_BwE
ScreenFlow	https://www.telestream.net/screenflow/overview.htm
iMovie	https://www.movavi.com/es/support/how-to/imovie-for-windows.html?gclid=CjwKCAjwrqnYBRB-EiwAthnBFieMmF7XXYa1BjNSDHXha4pcxslCvtVYhG_N_NMafvlYsQVrrW2PNxoCiMMQAvD_BwE
Filmora	https://filmora.wondershare.es/
Microsoft Forms	https://www.microsoft.com/es-es/microsoft-365/online-surveys-polls-quizzes
linesurvey	https://www.limesurvey.org/es/

Comprehension questions

Answer (true answer is in bold)

Question 1. Qualitative research can use

a) Direct techniques.
b) Indirect techniques.
c) Reproductive techniques.
d) **Both a and b.**

Question 2. Categorisation of information means

a) Data reduction.
b) Data sorting.
c) **Both a and b.**
d) Interpretation of data.

Question 3. Face validity can be defined as:

a) analysis of the recording and data collection instrument, it has similarities with concurrent and predictive validity.
b) **choice of responses related to the object of the study.**
c) relates to the relationship between what is observed and the theory that supports it.
d) All of these.

Question 4. Diachronic reliability:

a) refers to a single method of observation. It results in a continuously invariant measure (sentences, facts or behaviours).
b) implies similarity of observations with respect to relevant traits.
c) **consists of the stability of an observation over time. It relates to repeated measurements for the recording of a time-invariant event.**
d) None of the above.

Question 5. The following definition refers to "is a technique used to analyse the degree of agreement or consistency of an observational analysis. It involves the use of different observational procedures on the same event or situation. Its aim is to increase the validity of conclusions about an observational fact."

a) **Triangulation.**
b) Observational analysis.
c) Observational fact.
d) Observational procedures.

MODULE IV.2.1 EARLY DEVELOPMENT INVENTORY: NEW PORTAGE GUIDE

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I. INTRODUCTION

New Portage Guide (NPG) (2006). Wisconsin Portage Project**.**

It is a development assessment instrument. It contains goals that are based on patterns of normal growth and development. It allows to carry out an evaluation process through observation from birth to 6 years.

The New Portage Guide (NPG) components include a comprehensive method for:

- collect information through essential observations,
- plan individualized teaching strategies,
- record progress and
- share information with families.

The age ranges covered by the NPG include:

CHILDHOOD (INFANT/CHILD):

- Early Childhood, from Birth to 9 Months
- Mobile Childhood, 9 to 18 Months
- Child, 18 to 36 Months

PRESCHOOL:

- Three to Four Years
- Four to Five Years
- Five to Six Years

The age range indicates the approximate age at which most children show that they have achieved the goals listed. Each child progresses at their own rate of development. Many children can develop the skills in the order they are listed. Other children, however, may skip goals and proceed unpredictably or in some cases may not have achieved certain goals in their age range. Each age range is color-coded, and each age range includes all five areas of development (Larson et al., 2006).

II. OBJETIVES

Know how the New Portage Guide works and its practical application in the context of Early Intervention.

III. SUBJECT-SPECIFIC CONTENT

1. Materials contained in the scale

1.1. User's Guide

The User's Guide (Figure 1) provides an overview of the materials and their organization, describes in detail the individual components of the NPG, and provides full instructions for using the NPG. In addition, it describes the planning process through observation, the division by colors of the set of activities and routines and the participation of parents in the planning process (Larson et al., 2006).

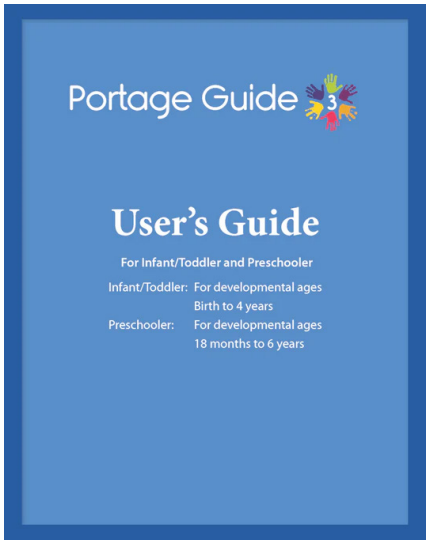


Figure 1. *User Guide Cover*
(https://the-portage-project.myshopify.com/collections/all)

1.2. Observation and Planning Table (TOP)

The Observation and Planning (TOP) Chart guides observation of children through five areas of development (noted later in point 2).

Figure 2. *Cover of the Observation and Planning Table*
(https://the-portage-project.myshopify.com/products/portage-guide-3-infant-toddler-complete-kit-english?pr_prod_strat=collection_fallback&pr_rec_id=7d508471f&pr_rec_pid=2129817281&pr_ref_pid=2129824193&pr_seq=uniform)

The TOP is divided into two age ranges:

- TOP Infant-Boy. It covers from birth to three years and includes the range of 3 to 4 years for children who, according to their development, are functioning beyond 36 months.
- TOP Preschool. It covers from 3 to 6 and includes the range of 18 to 36 months for those children who, according to their development, function under 3 years of age.

The ***Observation and Planning Chart*** is designed to collect information about the development of each child. The assessment data, collected by systematically observing children during the most usual activities, is used for weekly planning, and to add the necessary data for the report (Larson et al., 2006).

To complete the TOP, the child's name and date of birth must be written on the cover (Figure 2), since the TOP form can serve as a record over different years. The cover has different spaces to indicate the professional and the year in which the program is completed (Larson et al., 2006).

It is good to become familiar with the ***developmental indicators*** (items) (Figure 3) of the different areas of development for the different age traits. By becoming familiar with the indicators, it will be easier to observe abilities in groups. Developmental milestones are located on the left and are numbered sequentially on each age range sheet (Larson et al., 2006).

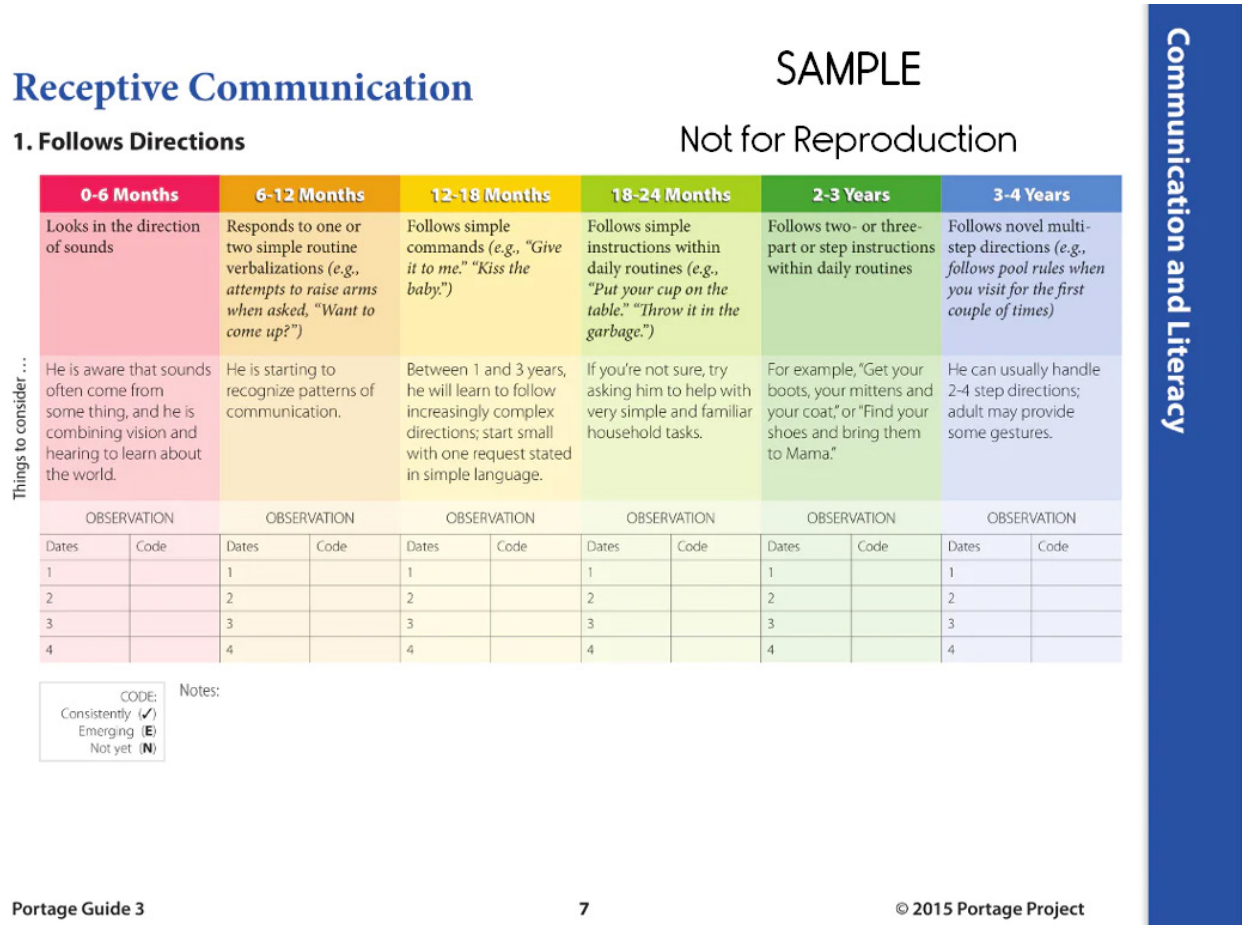


Figure 3. *Example of Development Indicators*
(https://the-portage-project.myshopify.com/products/portage-guide-3-infant-toddler-complete-kit-english?pr_prod_strat=collection_fallback&pr_rec_id=7d508471f&pr_rec_pid=2129817281&pr_ref_pid=2129824193&pr_seq=uniform)

Each developmental indicator has an *Aspects to Consider* section (Figure 3) that makes it easier for the early care professional to observe developmental aspects to obtain knowledge about the child and build relationships. The score code and observation date column are on the right side (Figure 4). The areas of development are indicated on the left side of the page and are separated by colored bars and spaces. (Figure 3) (Larson et al., 2006).

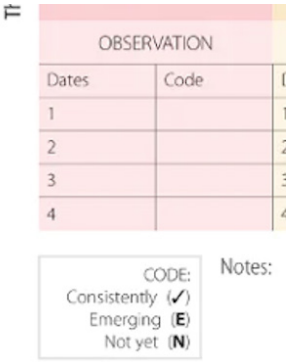


Figure 4. *Point codes and observation date*
(https://the-portage-project.myshopify.com/products/portage-guide-3-infant-toddler-complete-kit-english?pr_prod_strat=collection_fallback&pr_rec_id=7d508471f&pr_rec_pid=2129817281&pr_ref_pid=2129824193&pr_seq=uniform)

*Start the **evaluative observation*** using the age range that is approximately one year below the chronological age of the child or children in the group. For example, if you are with a child or a class of children between 18 and 36 months, you begin to observe in the range of 9 to 18 months. This process ensures that the child can perform all the above skills. In addition, starting with skills that the child can surely achieve, the evaluation begins with positive results, it encourages the child, her parents, and the professionals as well. Just as some children's development will be in the lower range (birth to 9 months), some will be in the 3-4 year range. TOP gives the flexibility to move through the age ranges in each area of development for each child (Larson et al., 2006).

When qualifying the observation sheet, you must *use the observation code or key found* in the upper right corner of the TOP (Figure 4).

These annotations can be made while observing children in their natural environment, participating in individual, group, or routine play activities. You can often make arrangements in the environment or facilitate the child's participation in activities or routines that allow more than one indicator to be observed. It is important not to annotate an item with a , unless the professional alone or together with a family member is sure that the child has achieved the item. If you are unsure, it is best to rate the item O or N and provide additional opportunities for the child to practice (Larson et al., 2006).

The observation date is recorded in the Observation Date column (Figure 4), next to the evaluation item. There are four opportunities to record observations during a program year. It is interesting to use a different colored pen for each period to make it easier to review the data (Larson et al., 2006).

At the bottom of each assessment page there is a comment box (Figure 3) where you can write down information specific to an assessment item or the child's achievement or additional information. For example, print the letters that the child can identify. When the item is scored with "O", the space can be used to write an anecdotal note about the observation, making sure to write down the date (Larson et al., 2006).

The child can be observed and evaluated in each area of development in the most convenient order. However, for *the initial evaluation observation* it is advisable to start with the motor area since the motor activities are easier to observe. This will facilitate the observation/assessment process. During the initial observation, the child's abilities are assessed, starting with any area of development until the child reaches at least 75%, or three-fourths of the abilities, within the area of development being assessed. If you are signing up in the last indicators of development of an area of development in a certain age range, it goes to the next age range for that area of development and continues to evaluate (Larson et al., 2006).

The evaluation should conclude when the child is unable to master at least 50% of the skills ("O" or "N" scores) within an age range for that area of development. It is reasonable to think that if the child cannot reach these indicators, she will not be able to reach the indicators of a higher age range. It is possible that the upper limit of abilities that a child achieves will vary in all areas of development. For example, a 4-year-old may consistently master indicators in the 4-5 year age range for Communication, Sensory Organization, and Social Emotional Development and consistently fail to achieve any of the 5-6 year age range indicators.

On Intentional Motor Activity and Exploration/Approaches to Learning, however, this child can consistently achieve most of the indicators in the 5-6 year range. This process helps to know the learning of each child and suggests areas of acquisition of new learning. (Figure 5) (Larson et al., 2006).

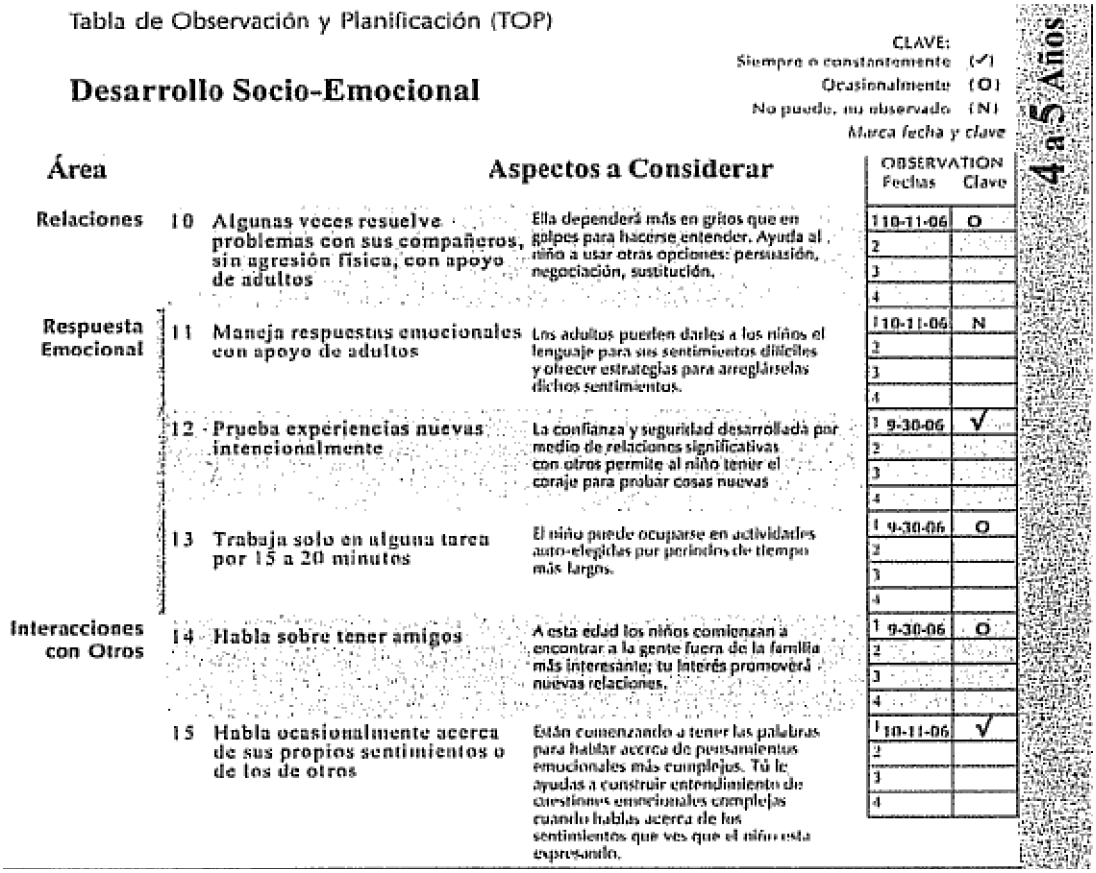


Tabla de Observación y Planificación (TOP)

Desarrollo Socio-Emocional

CLAVE:
Siempre o constantemente (✓)
Ocasionalmente (O)
No puede, no observado (N)
Marca fecha y clave

4 a 5 Años

Área		Aspectos a Considerar		OBSERVATION Fechas	Clave
Relaciones	10	Algunas veces resuelve problemas con sus compañeros, sin agresión física, con apoyo de adultos	Ella dependerá más en gritos que en golpes para hacerse entender. Ayuda al niño a usar otras opciones: persuasión, negociación, sustitución.	10-11-06	O
				2	
				3	
				4	
Respuesta Emocional	11	Maneja respuestas emocionales con apoyo de adultos	Los adultos pueden darles a los niños el lenguaje para sus sentimientos difíciles y ofrecer estrategias para arreglárselas dichos sentimientos.	10-11-06	N
				2	
				3	
				4	
	12	Prueba experiencias nuevas intencionalmente	La confianza y seguridad desarrollada por medio de relaciones significativas con otros permite al niño tener el coraje para probar cosas nuevas	9-30-06	✓
				2	
				3	
				4	
	13	Trabaja solo en alguna tarea por 15 a 20 minutos	El niño puede ocuparse en actividades auto-elegidas por períodos de tiempo más largos.	9-30-06	O
				2	
				3	
				4	
Interacciones con Otros	14	Habla sobre tener amigos	A esta edad los niños comienzan a encontrar a la gente fuera de la familia más interesante; tu interés promoverá nuevas relaciones.	9-30-06	O
				2	
				3	
				4	
	15	Habla ocasionalmente acerca de sus propios sentimientos o de los de otros	Están comenzando a tener las palabras para hablar acerca de pensamientos emocionales más complejos. Tú le ayudas a construir entendimiento de cuestiones emocionales complejas cuando hablas acerca de los sentimientos que ves que el niño esta expresando.	10-11-06	✓
				2	
				3	
				4	

Figure 5a. *Completed TOP example*

Traslation Figure 5a:

Observation and Planning Table (TOP)

Social-Emotional Development

Area ---------- Aspects to Consider ------- OBSERVATION (Key Dates)

Relationships ---- 10. ---- Sometimes resolves problems with peers, without physical aggression, with adult support

emotional response

11. Manage emotional responses with adult support

12. Intentionally try new experiences

13. I work alone on some task for 15 to 20 minutes

Interactions with Others

14. Talk about having friends

15. Talks occasionally about his own feelings or those of others.

Tabla de Observación y Planificación (TOP)

Desarrollo Socio-Emocional

CLAVE:
Siempre o constantemente (✓)
Ocasionalmente (O)
No puede, no observado (N)
Marca fecha y clave

Área		Aspectos a Considerar	OBSERVATION Fechas	Clave
Desarrollo del Juego Social	16 Participa en juegos de fantasía con 3 ó 4 niños por periodos largos	Florece el juego de fantaseo con otros. Los niños comparten ideas entusiásmadamente y usan su imaginación en el juego.	1 10-23-06	O
			2	
			3	
			4	
	17 Toma turnos y entiende la necesidad de compartir	Ella puede esperar su turno pacientemente en la mesa de juego y no necesita recordatorios para compartir materiales con otros niños.	1 10-23-06	O
			2	
			3	
			4	
Auto-Expresión Creativa	18 Responde a la música con movimientos más complejos	Los niños conocen las palabras de las canciones y son capaces de coordinar el canto con una secuencia de acciones o movimientos.	1 9-30-06	
			2	
			3	
			4	
	19 Dibuja imágenes sencillas y fáciles de reconocer o utiliza objetos pequeños o herramientas para crear cosas	Al inicio de un proyecto el niño no sabe que es lo que él va a crear. El le dará un nombre al final.	1 10-11-06	
			2	
			3	
			4	

Comentarios:

Figure 5b. *Completed TOP example*

Traslation Figure 5b:

Observation and Planning Table (TOP)

Social-Emotional Development

Area ---------- Aspects to Consider ------- OBSERVATION (Key Dates)

Social Game Development

16. Engages in make-believe games with 3-4 children for long periods of time

17. Take turns and understand the need to share

Creative Self-Expression

18. Respond to music with more complex movements

19. Draw simple, easy-to-recognize images or use small objects or tools to create things

Observations:

All areas of development should be assessed to get a picture of the developmental milestones the child is consistently performing, the milestones the child occasionally performs, and the developmental milestones the child is not yet performing. This information is basic and is used to plan activities and interactions that will enhance the development of each individual child (Larson et al., 2006).

Likewise, it is important for early intervention professionals to interview parents so that they can share their perspective on the child's development. With this information, the Child and Family Relationship Planning document can be started. Parents will have the opportunity to set goals and develop an individual plan for their child with the early intervention professional. This process includes sharing observations of the child's strengths in each area of development (Larson et al., 2006).

Observation and data collection is a continuous process in early stimulation programs. Each program will establish specific observation periods to collect data with the TOP (autumn, winter, spring, and summer) (Larson et al., 2006).

When the second and third observations are being made within the annual program, the evaluation begins with the last "O" and "N" previously registered and establishing the progress of each child, when changing to ✓ where the child is performing the skill at the time. The items where the child has more "O" and "N" than ✓ (50%) they will become the development indicators to work on in the following planning and individual approach (Larson et al., 2006).

1.3. Set of Activities and Interactions

The set of Activities and Interactions are two books that correspond one to the TOP of Infant/Child and the other to the TOP of Preschoolers (Figure 6).

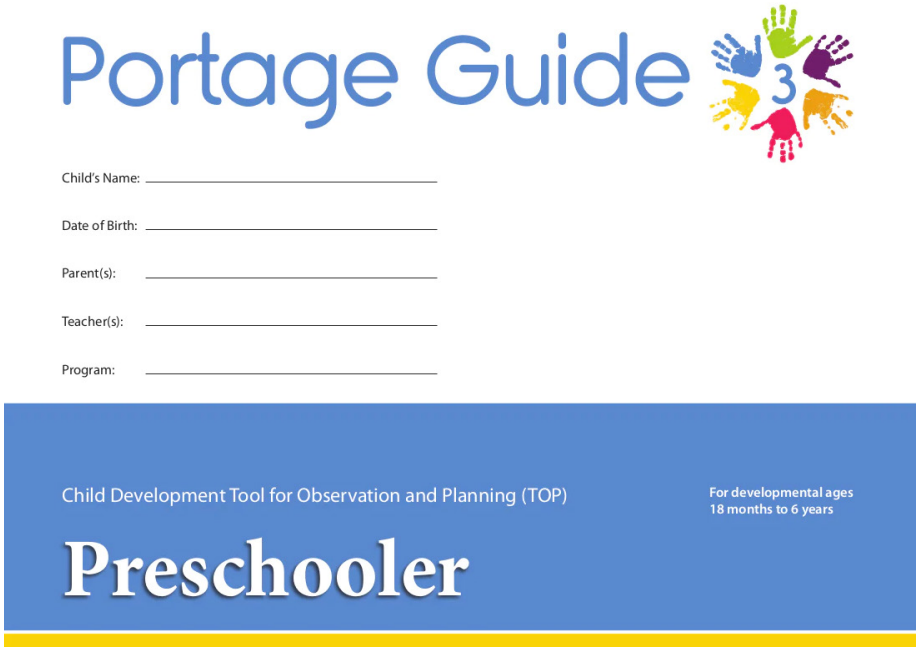


Figure 6. *Activities and Interactions book cover*
(https://the-portage-project.myshopify.com/products/portage-guide-3-preschooler-complete-kit-english)

The assessment process provides a framework about the child's development, and the activity and interaction sheets offer the early care professional innovative ideas, activities, and strategies for building skills through the daily routine that can be extended and individualize according to the place of intervention and the style of the professional (Larson et al., 2006). These ideas can be incorporated into weekly plans

The Activities and Interactions sheets are organized in the same way as the TOP. There are 6 age ranges per color, birth to 9 months, 9 to 18 months, 18 to 36 months, 3 to 4 years, 4 to 5 years, 5 to 6 years. As mentioned, there is a spiral bound book for Infants/Children and another for Preschoolers (Larson et al., 2006).

Each activity in the book is numbered and color coded to correspond to the milestone listed in the TOP.

For example, if you decide to work with a child on item 1 in the 18-36 month range, we can move to the Activity and Interaction Sheets section of the book and find the activity for item 1. At the top of each sheet is the name of the area to develop, the skills and the indicator and the corresponding number. At the bottom of the sheet are the color tables and the age range (Larson et al., 2006).

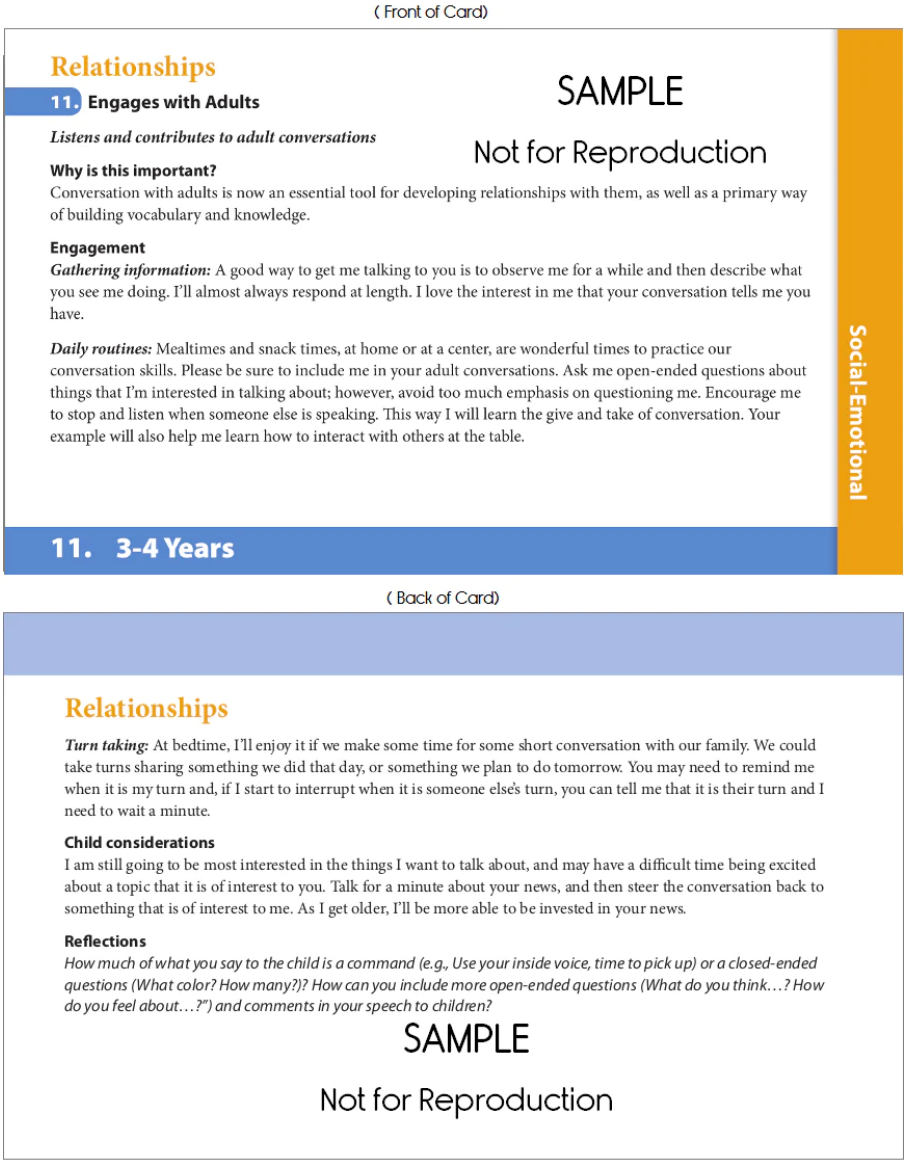


Figure 7. *Sample Activity and Interaction Sheete*
(https://the-portage-project.myshopify.com/products/portage-guide-3-preschooler-complete-kit-english)

Each Activities and Interactions sheet includes:

Why is this important?

This phrase explains why the skill, milestone, or behavior is important in a child's development. Interactive Activities are strategies used by the professional and/or by the parent or guardian to increase their relationship and interaction with the child (Larson et al., 2006).

Interactive Activities and Daily Routine Activities are written as if the child is speaking, e.g. When we are playing, please allow me to take my time to adjust my body to throw the ball. My movements are slow when learning a new or difficult skill. This style is used to give the child's perspective on the behavior or skill (to see it from her point of view) (Larson et al., 2006).

Interactive Activities are used in all age ranges, but there is a strong emphasis on these strategies in the first three years. Interactive strategies include: tapping, alerting, zooming, pausing, relating, taking turns, positioning, following the leader, imitating, gathering information, reinforcement, describing child's play, novelties, reading child's cues, and pacing (Larson et al., 2006).

Daily Routine Activities are activity ideas for the professional that you can use in daily classroom activities. The proposed ideas are a starting point in planning and individualization for children and are not

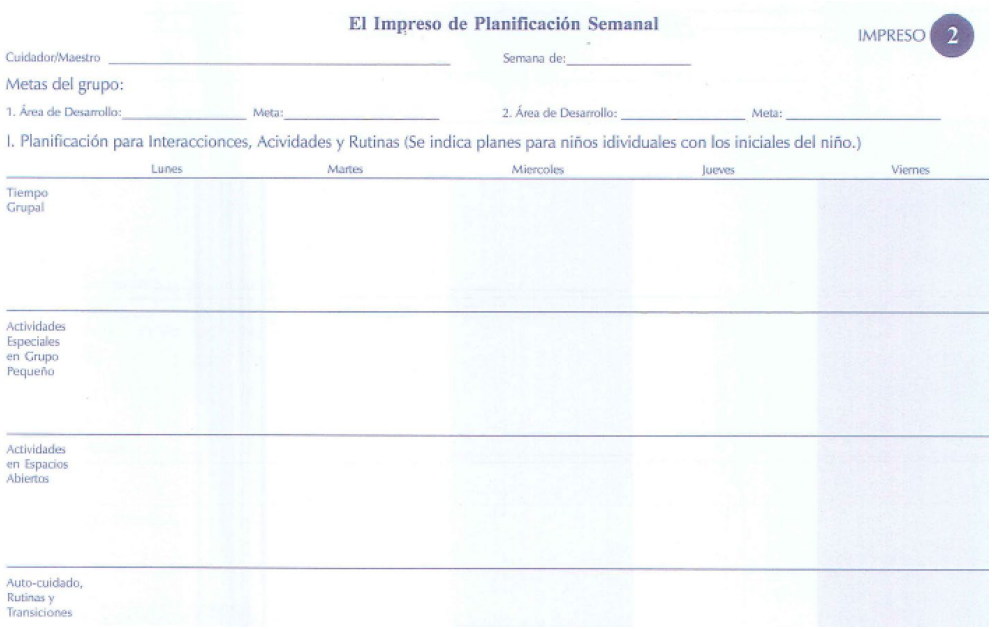
complete planning resources. These activity ideas may be adapted and expanded based on the experience of the early intervention professional and additional resources available to them (Larson et al., 2006).

1.4. Support material

Support materials include a variety of handouts that support the planning process once the assessment has been completed.

1.4.1. The Weekly Planning Form (Form 2)

The team of early intervention professionals uses the results of the evaluation and the information given by the parents when they create their weekly plans, using the Weekly Planning Form found at the end of the TOP (Figure 8) to develop weekly group plans (Larson et al., 2006).



El Impreso de Planificación Semanal

IMPRESO 2

Cuidador/Maestro _____ Semana de:_____

Metas del grupo:

1. Área de Desarrollo:_____ Meta:_____ 2. Área de Desarrollo: _____ Meta: _____

I. Planificación para Interaccionces, Acividades y Rutinas (Se indica planes para niños idividuales con los iniciales del niño.)

	Lunes	Martes	Miercoles	Jueves	Viernes
Tiempo Grupal					
Actividades Especiales en Grupo Pequeño					
Actividades en Espacios Abiertos					
Auto-cuidado, Rutinas y Transiciones					

Figure 8. *Weekly Planning Form*

Traslation Figure 8:

This image is part of the Spanish version of the Portage Guide. The English version can be found at Portage Guide 3: Preschooler - Complete Kit (English) https://the-portage-project.myshopify.com/products/portage-guide-3-preschooler-complete-kit-english

However, a comment is placed with the main translation:

Weekly Planning Form

Caregiver/Teacher _____ Week of: _____

Group goals:

1. Development Area ---- Goal: _____ 2. Development Area ---- Goal:

1. Planning for Interactions, Activities and Routines (Indicated plans for individual children with child's initials)

Monday Tuesday Wednesday Thursday Friday

Group Time

Special Small Group Activities

Activities in Open Spaces

Self-care, Routines and Transactions

These are reproducible sheets that, together with the evaluation instrument, help the early intervention professional to plan daily and individualized activities for each child. This print is located on the back of each TOP (Larson et al., 2006).

The Weekly Planning Worksheet details plans for daily activities, routines, and transitions using the activity sheets and your own planning ideas. Use information from the Group Handout (Figure 9) to plan these activities. *For example*, based on the information collected on the Social-Emotional Development form, some Social Play Development activities will need to be planned. As well as incorporate necessary adaptations for certain children (Larson et al., 2006).

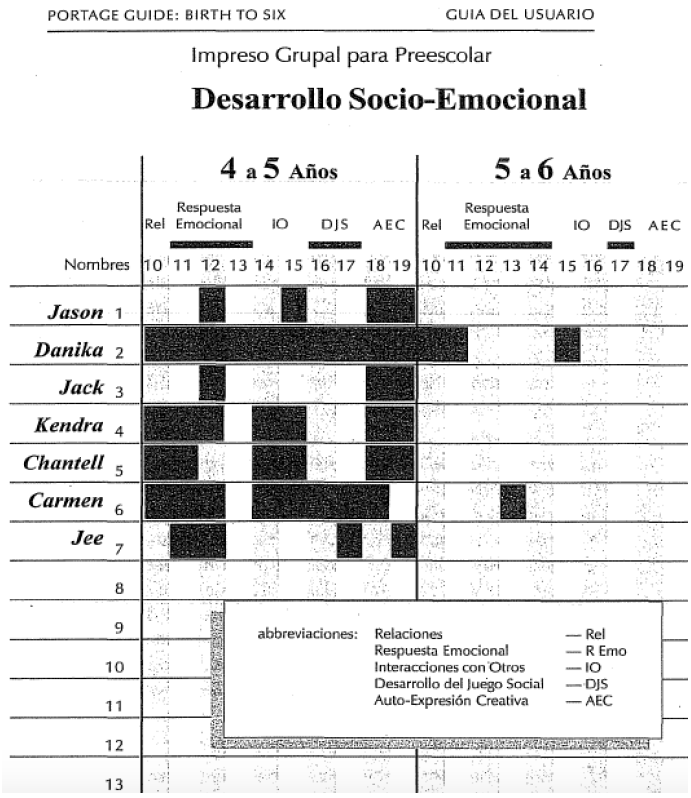


Figure 9. *Example of use of the information of the Group Form*

Traslation Figure 9:

USER'S GUIDE Group Print for Preschool

Social-Emotional Development

4 to 5 years ---------Role ----Emotional Response ----IO ---- DJS----AEC

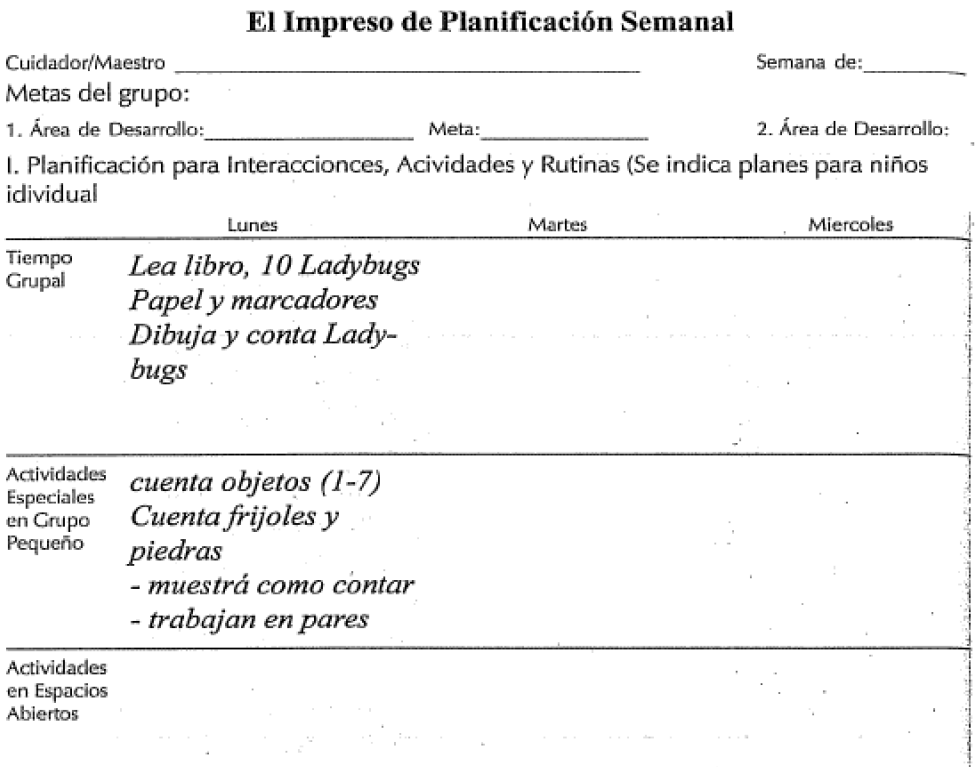
5 to 6 years ---------Role ---- Emotional Response ----IO ---- DJS----AEC

Names

abbreviations - Relations ---Rel

- Emotional Response ---R Emo
- Interactions with Others ---IO
- Social Game Development ---DJS
- Creative Self-Expression ---AEC

For example, during the small group activity, plan to pair ID and KA (children's initials) with a partner, who can model turn-taking behaviors (Figure 10). (Larson et al., 2006).



El Impreso de Planificación Semanal

Cuidador/Maestro _____ Semana de:_____

Metas del grupo:

1. Área de Desarrollo:_____ Meta:_____ 2. Área de Desarrollo:

I. Planificación para Interaccionces, Acividades y Rutinas (Se indica planes para niños idividual

	Lunes	Martes	Miercoles
Tiempo Grupal	*Lea libro, 10 Ladybugs* *Papel y marcadores* *Dibuja y conta Lady-bugs*		
Actividades Especiales en Grupo Pequeño	*cuenta objetos (1-7)* *Cuenta frijoles y piedras* *- muestrá como contar* *- trabajan en pares*		
Actividades en Espacios Abiertos			

Figure 10. *Example of use of the Weekly Planning Form (1)*

Traslation Figure 10

This is a non-editable image of a registration example in the Spanish version. A

The Weekly Planning Form

Caregiver/Teacher ---------- Week of:

Group goals:

1. Development Area: ------ Goal: ------ 2. Development Area:

I. Planning for Interactions, Activities and Routines (Individual child plans indicated)

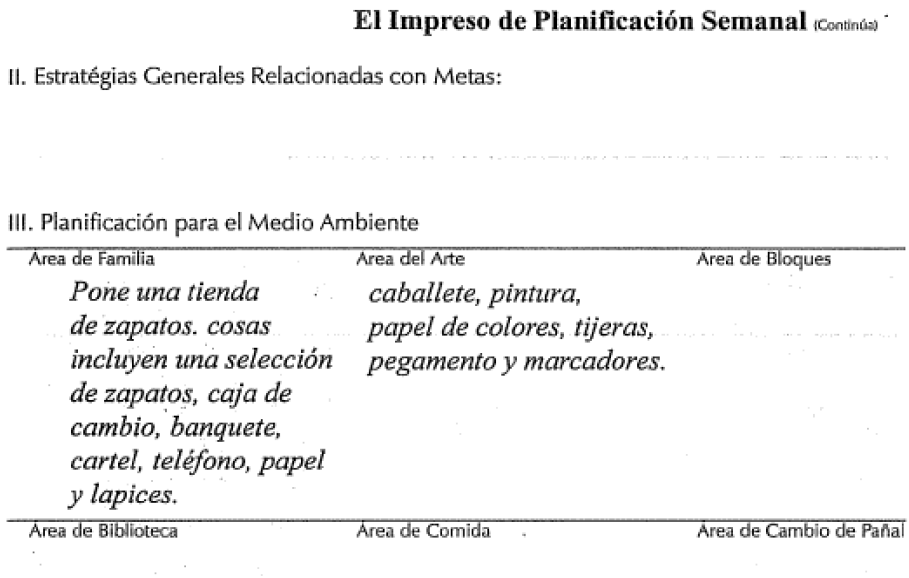
Monday Tuesday Wednesday

Group Time: *Read book, 10 Ladybugs, Paper and markers, Draw and count Laybugs*

Special Small Group Activities: *Count objects (1-7), Count beans and rocks, show how to count, work in pairs*

Activities in Open Spaces

On the back of the Weekly Planning Form, you can write environmental changes based on the needs of the group of children. Use the suggestion to ensure that there are one and a half to two things per child to do in each learning center. In the Family Experience area where four children can play, there are about six to eight items to play with, choosing those that are of interest to the children (Figure 11) (Larson et al., 2006).



El Impreso de Planificación Semanal (Continúa)

II. Estratégias Generales Relacionadas con Metas:

III. Planificación para el Medio Ambiente

Area de Familia	Area del Arte	Area de Bloques
Pone una tienda de zapatos. cosas incluyen una selección de zapatos, caja de cambio, banquete, cartel, teléfono, papel y lapices.	*caballete, pintura, papel de colores, tijeras, pegamento y marcadores.*	
Area de Biblioteca	Area de Comida	Area de Cambio de Pañal

Figure 11. *Example of use of the Weekly Planning Form (2)*

Traslation Figure 11:

The Weekly Planning Form (continued)

II. General Strategies Related to Goals:

III. Planning for the Environment

Family Area

Set up a shoe store, things include a selection of shoes, change box, banquet, poster, telephone, paper, and pencils

Art Area

Easel, paint, colored paper, scissors, glue, and markers

Block Area

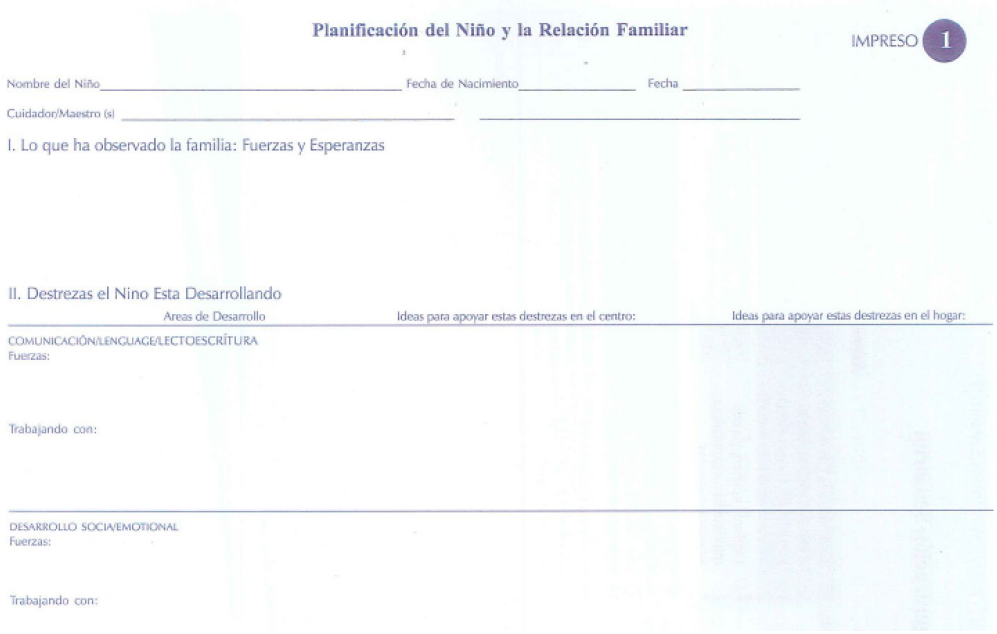
Library area

Food Zone

Diaper Changing Area

1.4.2. The Child and Family Relationship Planning document (Print 1)

This is a form designed to share evaluation information between parents and professionals to establish annual goals and plans. This form is located on the back of each TOP and can be photocopied to use in your programming (Figure 12) (Larson et al., 2006).


Planificación del Niño y la Relación Familiar

IMPRESO 1

Nombre del Niño_____ Fecha de Nacimiento_____ Fecha _____

Cuidador/Maestro (s) _____ _____

I. Lo que ha observado la familia: Fuerzas y Esperanzas

II. Destrezas el Nino Esta Desarrollando

Areas de Desarrollo | Ideas para apoyar estas destrezas en el centro: | Ideas para apoyar estas destrezas en el hogar:

COMUNICACIÓN/LENGUAGE/LECTOESCRÍTURA
Fuerzas:

Trabajando con:

DESARROLLO SOCIA/EMOTIONAL
Fuerzas:

Trabajando con:

Figure 12.*Cover of the Child and Family Relationship Planning document*

Traslation Figure 12:

Child Planning and Family Relationship

FORM 1

Child's Name ------- Date of Birth -------Date

Caretaker/Teacher(s) ---------

I. What the family has observed: Strength and Hope

II. Skills the Child is Developing

Areas of Development ------ Ideas to support these skills at the center ------ Ideas to support these skills at home:

COMMUNICATION/LANGUAGE/LITERACY

Forces:

Working with:

SOCIAL-EMOTIONAL DEVELOPMENT

Forces:

Working with:

1.4.3. The poster NPG

It is a poster that visually exposes areas of development and strengths across all age ranges. On one side of the poster, the evolution of development in each category is exposed for the *Infant age* range, and on the other side of the poster the same is exposed, but for the *Preschool age* range (Larson et al., 2006).

1.4.4. The Group Form (GSF)

It is an instrument that provides the development of all the children in its group and assists in the planning of activities and interactions in the groups of children (Figure 13) (Larson et al., 2006).

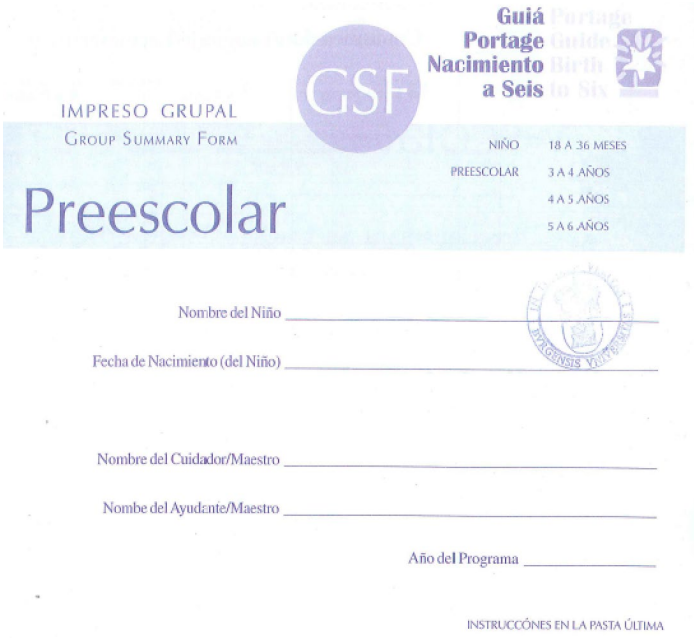


Figure 13. *Cover of the Group Form*

Traslation Figure 13:

PORTAGE GUIDE BIRTH TO SIX MONTHS

GROUP PRINT ---- PRESCHOOL

CHILD 18 TO 36 MONTHS

PRESCHOOL 3 TO 4 YEARS, 4 TO 5 YEARS, 5 TO 6 YEARS

Child's Name -------

Date of Birth (of the Child) -------

Caregiver/Teacher Name -------

Helper/Teacher Name ------

Program Year -------

INSTRUCTIONS ON THE LAST SHEET

The Group Form gives a visualization of the development of the group and helps to determine the indicators with which the planning of the activities, learning centers, routines and interactions for the week would begin. After each observation period, the form should be used to compile the of children (the skills they always and consistently perform) in each area of development (Figure 14) (Larson et al., 2006).

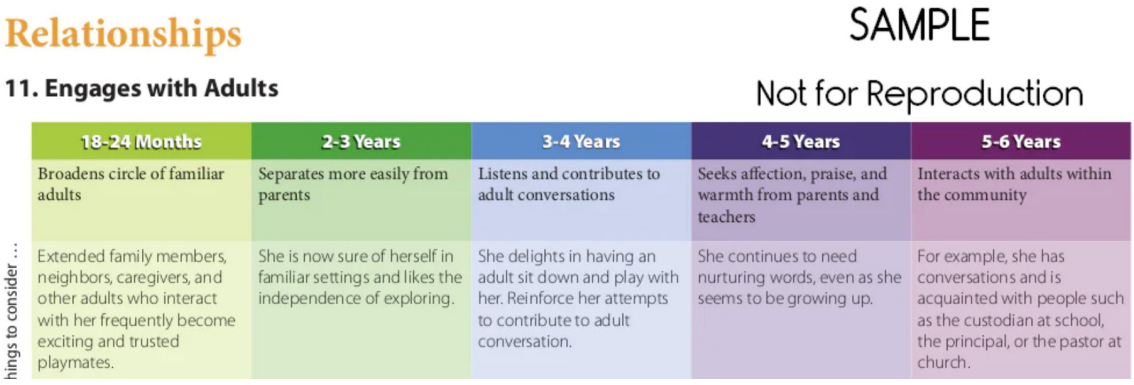


Figure 14. *Group Form Indicators*
(https://the-portage-project.myshopify.com/products/portage-guide-3-preschooler-complete-kit-english)

The instructions for use are:

- Write the child's name on the left side of the sheet
- With a text mark, each box that corresponds to the marked development indicators (items) of the child's TOP evaluation is highlighted
- Update as children achieve new behaviors by highlighting texts on the group sheet

This sheet once completed can be used for planning. Locate indicators and skills that are not highlighted, indicating that they cannot perform the item, or it has not been observed, Os and Ns (Figure 15) (Larson et al., 2006).

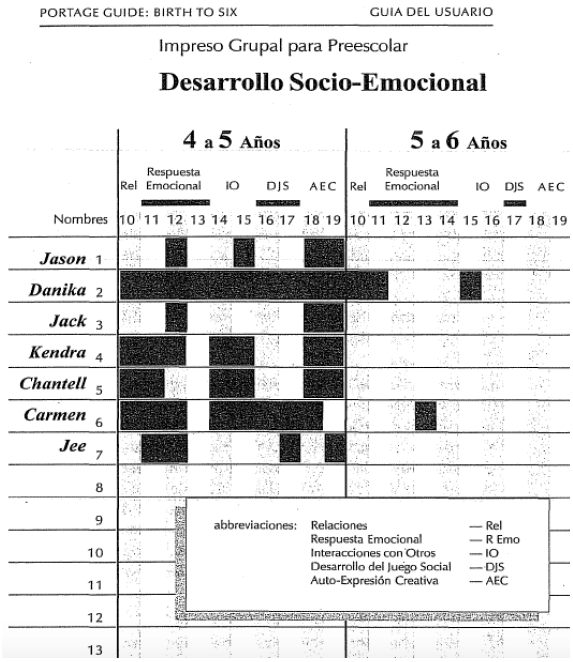


Figure 15. *Example of filling in the Group Form*

Figure 15 Traslation:

USER'S GUIDE

Group Print for Preschool

Social-Emotional Development

4 to 5 Years

Role ---- Emotional Response ----IO ---- DJS----AEC

5 to 6 Years

Role ---- Emotional Response ----IO ---- DJS----AEC

Names

Abbreviations:

- Relations ---Rel
- Emotional Response ---R Emo
- Interactions with Others ---IO
- Social Game Development ---DJS
- Creative Self-Expression ---AEC

This completed sheet can be used to begin planning. Indicators and abilities that are not highlighted are located, indicating that the item cannot be performed or has not been observed, "O" and "N". Then group activities will be planned that give children the opportunity to practice those skills.

The visual image also helps to see gaps in learning and points out the need to individualize certain activities (Larson et al., 2006).

2. Skills measured by the New Portage Guide

The New Portage Guide measures 5 areas of development. Each of these areas contains more specific sub-skills or behaviors. Dividing the areas does not mean that they are isolated from each other, in fact, it is inevitable that all the areas coincide. On the other hand, behaviors already present in one or more areas of development often serve as prerequisites that enable the child to be successful in another **área** (Larson et al., 2006).

Each area of development has a set of more specific categories/skills (ver Figure 16).

SKILLS BY AREAS OF DEVELOPMENT	
COMMUNICATION/LANGUAGE/LITERACY 1. Communication 2. Speech and Language 3. Initial Reading	**SOCIAL-EMOTIONAL DEVELOPMENT** 1. Relations 2. Emotional Response 3. Interaction with others 4. Social Game Development 5. Creative Self-Expression
EXPLORATION/APPROACHES TOWARDS LEARNING 1. Perceptual Development (Discrimination, Cause and Effect) 2. Exploration (Birth to 9 months) 3. Permanence of Object (9 to 18 months) 4. Critical Thinking 5. Beginning Mathematics - count - numerical concept (more, less, little, one more) - compression (matching, one-to-one correspondence, quantity, time) 6. Science	**INTENTIONAL MOTOR ACTIVITY** 1. Gross Motor (locomotion, balance, coordination, movement skills) 2. Fine Motor (reaching, grasping, letting go, hand manipulation skills) 3. Independence/Self-Care 4. Initial Writing
	SENSORY ORGANIZATION 1. Senses - auditory (hear) - gravity and movement (vestibular) - muscles and joints (proprioceptive) - touch (touch) - visual (to see) 2. Self-regulation (internal and external)

Figure 16. *Areas of development with the set of categories/skills*

Each of these categories or sub-skills contains in turn a certain number of development indicators (items, behaviors) numbered consecutively throughout the different areas of development and categories/skills (Larson et al., 2006) (Figure 17).

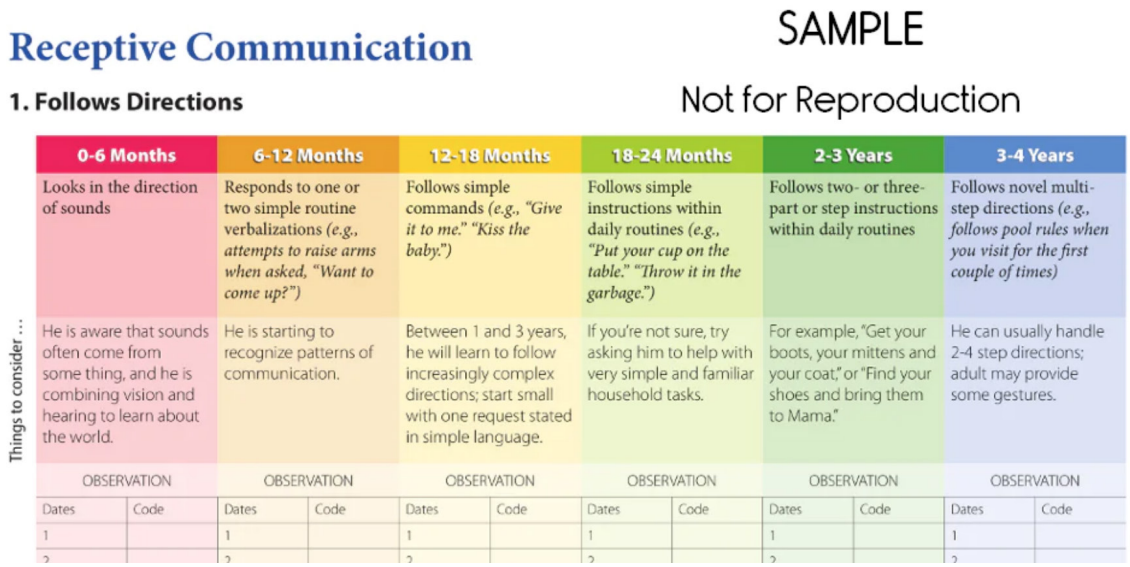


Figure 17. *Example of development indicators in the Communication/Language/Literacy area* (https://the-portage-project.myshopify.com/products/portage-guide-3-infant-toddler-complete-kit-english?pr_prod_strat=collection_fallback&pr_rec_id=7d508471f&pr_rec_pid=2129817281&pr_ref_pid=2129824193&pr_seq=uniform)

The developmental milestones or items are only a sample of the representative skills that children from birth to six years of age typically achieve, but do not contain all the behaviors that the child will develop. Behaviors identified in a specific category can be related to other skills, so it is very important to look at the full range of behaviors as you observe children. Some areas of development will have categories with greater weight in a certain age range than in another, this is because this is the age in which the child experiences great progress. For example, in speech and language there will be fewer targets in the Birth to Nine Months range and instead more targets in the 18 to 39 month range (Bluma et al., 1976; Larson et al., 2006).

The five development areas are:

2.1. Communication/Language/Literacy

One of the great achievements for a child from birth to six years of age is the development of language (verbal or signed) and *the ability to communicate* with others. The child begins to *learn speech and language* by listening and observing when people communicate around him. He begins to make sounds, then to babble, and finally the words begin to appear. The understanding of vocabulary and language precedes the use of this, gestures or the signal system allows you to communicate with others. We use spoken or signed language to understand the written language that provides the foundation for all interactions through *literacy*. Literacy development includes picture and print recognition, early reading skills used in communication (Bluma et al., 1976; Larson et al., 2006).

2.2. Socio-Emotional Development

This area of development underscores the importance of parent-child and child-caregiver/teacher interactions. It includes the child's ability to separate from familiar adults and interact with peers and adults through social play, familiar routines, and community experience. As the child develops social skills, she discovers that she can cause changes in the environment (causes things to happen in her world). Behaviors in all areas of development are initiated and strengthened using appropriate social interactions. Emotional development includes growth in his sense of self, emotional response, creativity in self-expression and self-control (Bluma et al., 1976; Larson et al., 2006).

The New Portage Guide brings together the areas of social and emotional development as there is significant overlap. As the boy's relationships develop and grow with family members and caregivers/teachers, he gains more confidence in himself and her abilities. What will make it easier for him to generalize these behaviors at a given moment when he meets a larger group of people (Bluma et al., 1976; Larson et al., 2006).

2.3. Exploration/Approaches to Learning

The Area of Exploration/Approaches to Learning refers to a child's thinking or cognitive ability to remember, discover through their senses, process, solve problems, evaluate ideas, organize, and use information to develop critical thinking or reasoning. At the beginning of the child's life, his responses are only imitations of other (Larson et al., 2006).

Later the child will give his own response and identify the best response to the information he knows and remembers. The development of specific concepts that require critical thinking or reasoning included in these areas are science and early math skills such as counting, number concepts, and comprehension (Bluma et al., 1976; Larson et al., 2006).

2.4. Intentional Motor Activity

Intentional Motor Activity refers to the child's ability to coordinate gross and fine body movements, including *pre-writing* development (Larson et al., 2006).

It also includes *self-care* skills and skills leading to *independence*.

Some examples of *gross motor skills* include crawling, running, jumping, and throwing a ball. Some *fine motor activities* are refinements of gross motor skills. For example, pick up an object and change the position of the hand, from using the whole hand to using the pincer to pick it up. Finger pinning is a very important fine skill and is necessary for putting together puzzles and using markers and pencils. Some age ranges have a limited number of fine motor skills; however, this will be balanced with broader self-help and early writing skills, which also require the use of fine motor skills, but are more complex because of their natural use (Bluma et al., 1976; Larson et al., 2006).

Motor skills are important for two reasons:

- provide a way to express skills in the other areas of development, such as self-confidence and the creation of interpersonal relationships;
- and on the other hand, research on brain development supports the connection between motor skills, social development, and cognitive and language development.

2.5. Sensory Organization

Sensory Organization includes the process of receiving, integrating, and organizing sensory information that helps children make sense of the world in which they live and leads to self-regulation of their body functions and behaviors. Young children take in information using all their senses: touch, hearing, smell, sight, and movement. As they develop, children learn to control both themselves and their environment through organized responses to this sensory input (Bluma et al., 1976; Larson et al., 2006).

Early writing skills are part of the development of literacy skills and although they are described in the activities with a motor purpose, this does not mean that they are only motor skills (Bluma et al., 1976; Larson et al., 2006).

3. Results that can be obtained

The knowledge of child development obtained through this guide is useful for early care professionals to determine and evaluate different aspects of the child regarding its development and provides the possibility of proposing and developing activities that lead to the acquisition of skills, abilities, and abilities in children (Bluma et al., 1976; Larson et al., 2006).

On the other hand, it helps to know different characteristics of the development of children aged between 0-6 years, considering the following aspects: linguistic, motor, social, cognitive, socio-emotional and those related to personal autonomy (Larson et al., 2006).

Through the NPG:

- Characteristics of a child of a certain age can be identified through direct interaction.
- Allows the child's behavior patterns to be observed and recorded based on the information collected from different records.
- Subsequently, the results obtained can be analyzed and interpreted.

Resume

The New Portage Guide (NPG) is a developmental assessment instrument. Contains goals that are based on normal growth and development patterns. It allows carrying out an evaluation process through observation from birth to 6 years.

The age ranges covered by the NPG include: CHILDHOOD (INFANT/CHILD): Early Childhood, from Birth to 9 Months; Mobile Childhood, 9 to 18 Months; Boy, 18 to 36 Months; and PRESCHOOL: Three to Four Years; Four to Five Years; Five to Six Years

The NPG has a series of documents:

1. The User's Guide provides an overview of the materials and their organization, describes the individual components of the NPG, and provides complete instructions for their use. In addition, it describes the planning process through observation, color-coding the set of activities and routines, and parental involvement in the planning process (Larson et al., 2006).
2. The Table of Observation and Planning (TOP) guides the observation of children through five areas of development that are: * Communication / Language / Literacy; * Social-Emotional Development; * Exploration/Approaches to learning; * Intentional Motor Activity; * Sensory Organization. The Observation and Planning Chart is designed to collect information about each child's development. The assessment data, collected by systematically observing the children during their most usual activities, is used for weekly planning, and to add the necessary data to the report (Larson et al., 2006).
3. The set of Activities and Interactions are two books that correspond one with the TOP of Infant/Toddler and the other with the TOP of Preschoolers.
4. The Activity and Interaction sheets are organized in exactly the same way as the TOP. There are 6 age ranges per color, Birth to 9 Months, 9 to 18 Months, 18 to 36 Months, 3 to 4 Years, 4 to 5 Years, 5 to 6 Years. There is a spiral-bound book for Infants/Toddlers and one for Preschoolers (Larson et al., 2006). Each activity in the book is numbered and color-coded to correspond to the milestone listed in the TOP.

The NPG has a series of supporting documents:

1. The Weekly Planning Form is found at the end of the TOP and is used to develop weekly group plans (Larson et al., 2006). The early care team of professionals uses the results of the evaluation and the information given by the parents when they create their weekly plans, using this handout.
2. The Child Planning and Family Relationship document (Form 1). It is a form designed to share evaluation information between parents and professionals in order to establish annual goals and plans. This form is found on the back of each TOP and is photocopiable for use in your programming (Larson et al., 2006).
3. The NPG poster. It is a poster that visually exposes areas of development and strengths across all age ranges. On one side of the poster the evolution of development in each category is exposed for the Infant age range, and on the other side of the poster the same is exposed, but for the Preschool age range (Larson et al., 2006).
4. The Group Form (GSF). It is an instrument that provides for the development of all children in their group and assists in planning activities and interactions in groups of children (Larson et al., 2006).

In summary, through the NPG, early care professionals can: a) identify characteristics of a child of a certain age through direct interaction; b) observe and record behavior patterns of the child based on the information collected from different records; and subsequently c) analyze and interpret the results obtained.

Glossary

Observation and Planning Table: Document that allows collecting information on the development of each child. The data from the assessment, collected by systematically observing the children during their most usual activities, is used for weekly planning, and to add the necessary data to the report.

Interactive Activities: Strategies used by the professional and/or by the parent or guardian to increase their relationship and interaction with the child.

Daily Routine: Learning situations that boys and girls carry out daily, in a stable and permanent way.

Development Indicators: Skills such as taking the first steps, smiling for the first time and waving "bye-bye". From birth to 5 years, children should meet developmental milestones in how they play, learn, talk, act, and move.

Evaluative Observation: Observation techniques allow the evaluation of learning processes at the moment they occur; With these techniques teachers can notice the knowledge, skills, attitudes and values that students have and how they use them in a given situation.

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Comprehension questions

Answer (true answer is in bold)

Question 1. The New Portage Guide (NPG) is about an instrument:

a) **Developmental assessment with goals that are based on patterns of normal growth and development.**
b) Developmental assessment with goals that are based on patterns of dysfunctional growth and development.
c) Evaluation of development through observation from birth to 8 years.
d) Cognitive evaluation with objectives that are based on patterns of normal growth and development.

Question 2. The Portage Guide Observation and Planning (TOP) Table:

a) Covers from birth to three years and includes the range of 3 to 4 years for children who, according to their development, are functioning above (TOP Infant-Child).
b) It covers from 3 to 6 and includes the range of 18 to 36 months for those children who, according to their development, function below 3 years of age (TOP Preschool).
c) It is designed to collect information on the development of each child.
d) **All the previous answers are correct.**

Question 3. When completing the Observation and Planning Table (TOP):

a) Begin evaluative observation using the age range that is approximately six months below the child's chronological age.
b) **It is good to become familiar with the developmental indicators (items) of the different areas of development for the different age traits.**
c) It is important to carefully select the age range in each area of development for each child, otherwise difficulties may arise in moving through the ranges.
d) All the previous answers are false.

Question 4. The evaluation through the observation sheet must conclude:

a) When the child is unable to master at least 25% of the skills ("O" or "N" scores) within an age range for that area of development.
b) When the child is unable to master at least 75% of the skills ("O" or "N" scores) within an age range for that area of development.
c) **When the child is unable to master at least 50% of the skills ("O" or "N" scores) within an age range for that area of development.**
d) When the Early Intervention specialist deems it appropriate.

Question 5. In the data collection through the observation sheet:

a) All areas of development should be evaluated to get a picture of the development indicators that the child is constantly performing.
b) The indicators that the child performs occasionally should be evaluated.
c) The development indicators that the child has not yet achieved should be evaluated.
d) **All the above answers are correct.**

Question 6. In the observation and data collection:

a) It is important for early intervention professionals to have interviews with parents, so that they can share their perspective on the child's development.

b) With the information collected from the parents, the Child and Family Relationship Planning document can be started.

c) Parents will have the opportunity to plan goals and develop an individual plan for their child with the early intervention professional.

d) **All the above answers are correct.**

Question 7. The Activity and Interaction sheets are organized in exactly the same way as the TOP. Specific:

a) There are 6 age ranges per color, birth to 9 months, 9 to 18 months, 18 to 36 months, 3 to 4 years, 4 to 5 years, 5 to 6 years.

b) It has a spiral bound book for Infants / Children and another for Preschoolers.

c) Each activity in the book is numbered and color coded so that it corresponds to the developmental milestone listed in TOP Generalization of learning.

d) **All the above answers are correct.**

Question 8. In relation to the Group Form sheet:

a) Gives a visualization of the development of the group and helps to determine the indicators with which the planning of the activities, learning centers, routines and interactions for the week would begin.

b) After each observation period, the form should be used to compile the children's (the skills they always and consistently perform) in each area of development.

c) This sheet once completed can be used for planning. Locate indicators and abilities that are not highlighted, indicating that they cannot perform the item or it has not been observed, Os and Ns.

d) **All of the above answers are true.**

Question 9. The New Portage Guide measures 5 areas of development. Each of these areas contains more specific sub-skills or behaviors. These five development areas are:

a) **Communication/Language/Literacy; Socio-emotional development; Exploration/ Approaches to learning; Intentional Motor Activity; Sensory Organization.**

b) Cognition; Socio-emotional development; Exploration/Approaches to learning; Intentional Motor Activity; Sensory Organization.

c) Communication/Language/Literacy; Socio-emotional development; Exploration/Approaches to learning; Intentional Motor Activity; Muscle development.

d) All the previous answers are false.

Question 10. Through the New Portage Guide (NPG):

a) Characteristics of a child of a certain age can be identified through direct interaction.

b) It allows the child's behavior patterns to be observed and recorded based on the information collected from different records.

c) Subsequently, the results obtained can be analyzed and interpreted.

d) **All the above answers are correct.**

MODULE V. COGNITIVE, SOCIAL, COMMUNICATION, LANGUAGE AND COGNITIVE DEVELOPMENT

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I. INTRODUCTION

Module V refers to the study of the most representative milestones of human development between 0-6 years old. It also addresses how they relate to early intervention strategies from the point of view of primary and secondary prevention.

II. OBJECTIVES

a) To learn the most representative milestones of human development between 0-6 years of age.

b) To learn strategies for early intervention between 0-6 years old.

III. CONTENT SPECIFIC TO THE TOPIC

1. Introduction

In the last two decades, analysis of the progression of human development has made significant progress with respect to when certain skills, especially cognitive, communication and problem-solving skills are acquired. This is due to advances in technological instruments for measurement and observation. This progress has allowed developmental psychology to bring forward the time of acquisition of certain skills or abilities. However, Piaget's scheme (1952) remains valid as a reference point for the progression of human development.

Experimental data (Goswami, 2008) show that infants from birth exhibit perceptual and action skills. These skills enable them to develop a sense of their environment and interaction with themselves. For example, infants will acquire perceptual awareness of their own bodies when looking in the mirror. Just as when they hear their heartbeat, breathe, feel pain, hear their own voice, or move. Babies develop self-perception by experiencing multimodal or cross-modal sensations of their own body (stillness, movement, silence, the noises it produces, hunger, pain, feelings of comfort, joy...). Before the age of two months, infants have a very limited repertoire of social responses and their social interactions lack reciprocity. At around nine months, a major change occurs. Infants begin to show anxiety in the presence of strangers, or a tendency to include adults in the exploration of physical objects. The most common form of interaction of parents or foster caregivers with their babies is repetition and mirroring of their emotions: face-to-face interactions and *feedback* of emotions. Emotional mirroring is a source of self-knowledge because it gives babies the chance to see and objectify how what they feel inside affects others, it is externalised and the subject of social interaction reflects it back to them. Adults offer infants "emotional simulation" through responses in face-to-face exchanges. Understanding of oneself goes hand in hand with understanding of others. According to Gibson (1979), perceiving the environment means co-perceiving oneself. At these moments, self-perception is inseparable from the perception of objects. Any perception involves the point of view of the perceiver. Thus, the perception of objects will entail self-perception and will also produce co-perception. Knowing something about something is inseparable from knowing something about oneself (co-cognition). Essential to this whole perceptual process is the development of object permanence and the permanence of oneself in the environment. Babies plan in relation to a series of planned goals, searching

for and deploying increasingly precise strategies to achieve those goals. Although the perceptual capacities of new-borns are still emerging, they provide an essential basis for the construction and expression of the first physical knowledge. Babies move from being mere active spectators attending to sounds and images to being active transformers of the world of objects, with direct action and exploration that they themselves initiate (important transition from the first to the second year of life). Between birth and 6 months infants develop new ways of apprehending physical objects and move from predominantly oral exploration at around 2 months to a complex combination of manual, oral and visual inspection at around 4 months of age together with the onset of correct and systematic hand-eye coordination.

2. The most representative current theories of human development

Below, we summarise the most representative theories of human development from an up to date perspective.

2.1. Theory of the Origins of Mind (Donald, 1991)

The symbolic and acculturated mind of human beings evolved from the episodic mind of non-human primates which resolved time-bound (immediate) situations to a mind that would transcend the immediate, a mimetic mind capable of producing conscious and intentional figurative acts and of adding awareness and planning. With language and conventional signs, we would speak of a mythical mind of a symbolic and acculturated nature. The evolution of the episodic mind would characterise the level of cognition of the human mind. The mind at the beginning, more primary, would operate in the here and now. Later, as it acquired symbolisation, it would be able to plan and reflect on its own cognition. It would also be able to represent to itself the mental state of people and situations in the world (how they are, how they were, how they should be and how they will be). In human development, the first ontogeny goes from 2 to 9 months, from the mimetic mind to the symbolic mind (Gómez, 2007).

2.1.1. Learning and development

Babies have an early propensity to learn. From birth they learn to use their own bodies to produce or reproduce an effect on the environment. Classical and operant conditioning have been explained by Piaget's (1952) development of secondary circular reactions, which reflect behavioural plasticity. Early learning experiences give rise to new forms of behaviour and conditioning in early childhood and contribute to the infant's development. Infants are not susceptible to every stimulus; they learn what motivates them and what they can learn. Learning through conditioning depends on developmental changes:

- The baby's repertoire of actions.
- Postural and motor contacts.
- Their reasons for communicating.
- Their motives for learning.

Conditioning plays an essential role in shaping emotional life and is an important vehicle for behavioural change, learned responses and good and bad habits. It is part of the survival of the new-born. Actions that have pleasant consequences tend to be repeated. Events that are associated with pleasure are also often sought. Actions that have painful consequences tend to be eliminated. Human beings tend to avoid events associated with pain (Thorndike's law of effect, 1932). In motivation, pleasure is the basis of the law of effect, maximum pleasure and minimum pain. The human brain has developed its own reward system and manufactures its own pleasure through highly addictive inducing chemicals that eliminate pain.

Reference can be made to two explanatory theories, the infant development theory which understands development as a continuum (successive phases) and the theory which understands development as a discontinuous process (key transitions). Next, the mechanisms underlying developmental processes will be explored. An outline of the process of change is shown in Table 1.

Table 1. Analysis of the change process.

What changes	How it changes	Why it changes
Evolutionary processes	Mechanisms	Maturational development Contextual stimulation

Processes and mechanisms require evolutionary explanations that go beyond mere description. In any causal explanation there is always an element of judgement. Causal mechanisms interact and in this interaction physiological, psychological and cultural mechanisms will converge. Prediction in research terms refers to developmental correlations between phenomena observed at different levels and domains of functioning. There is a correlation between the development of particular brain regions and world-specific behaviours, and between the development of the frontal cortical lobe and the emergence of object permanence (Diamond, 1990). As well as a developmental relationship between different ways of attending to visual stimuli in early childhood and later cognitive skills or patterns of intellectual functioning (Colombo, 1993). To summarise, we can say that in the first year of life and human development there are two revolutions; at two months and at nine months, the beginning of symbolisation.

2.1.2. Theories of Infant Development

Other theories of development speak of the indeterminacy of development. A distinction can be made between chaos theory and dynamical systems theory. For the latter, the baby's behaviour, like any other behaviour, would be the result of a complex interaction between a large number of systems functioning simultaneously and distributed on different levels. From a lower level of brain, muscular and skeletal or motivational functioning to higher levels of functioning (perceptual, emotional and cognitive). The application of this theory to infant functioning would not allow for a very causal explanation "The development of infant behaviour would essentially be a soft assemblage, the result of an interactive (fluid) process within multiple parallel and distributed systems at all levels of functioning. It would not be based on "hard" perceptions of modular structures or on a kind of "little men" or homunculi that would determine from the baby's head what would develop next. These changes are basically the expression of multiple control variables interacting chaotically at all times and at all levels of infant functioning" (Rochart, 2004 p. 276). In the midst of this chaos, researchers have sought constant developmental processes that manifest themselves at all ages regardless of developmental domains:

- Balancing.
- Self-organisation.
- The dynamic systems of child development.

Equilibration: the infant shares with other organisms the dynamic equilibrium between itself and the environment. Organisms in the process of equilibration go through periods of relative equilibrium followed by periods of disequilibrium that are accompanied by actions that are more or less designed to restore equilibrium (homeostasis). Infants are thus open-loop systems that continually reinvent themselves and develop new ways of adjusting to environmental perturbations; an open-loop system is a source of novel and internal transformations. Piaget (1952) proposed a constructivist model of development in which he pointed to successive, progressive stages to explain the actual processes underlying the transition from one stage to another, which he explained from the equilibration model. For him, in the development of the baby, there are processes of interaction between phenomena of assimilation and accommodation. Assimilation would be the capacity to incorporate objects or actions into already existing structures . Accommodation, would be the tendency to modify one's own actions in order to assimilate more objects and situations to those the infant already masters or knows. The forces of assimilation and accommodation are in constant co-activation and lead to novel behaviours, namely novel organisations of action and cognition. In development, both forces reach a certain kind of general equilibrium and each corresponds to the Piagetian phases of the infant's development. In each of the phases there are modifications of the assimilatory schemas through accommodation within a transformation of the general order of the phase. These are micro-changes as op-

posed to the macro-changes that occur in the passage from one phase to another (self-organisation). This balancing process implicitly assumes that infants' activity structures their development. However, there are other theories that sensory and motor systems may integrate, not as a result of laborious structuring, but due to peripheral causes such as time-linked parallel functioning of the manual, visual and postural systems. Thus, developmental patterns are self-organising. Increasingly, Early Childhood researchers point to the process of new self-organising forms to explain how babies develop (Thelen and Smith, 1994). Self-regulation arises from multiple, differentiated interactions between individual subsystems. Biological cycles express the existence of a self-organising process in nature in which the simple interaction of multiple systems at different scales of functioning creates a pattern. Some authors propose that the early development of functional actions—such as picking up things, crawling, and walking—are a self-organised assemblage that originates in the spontaneous movements that the body can perform. The patterns may vary (speed, amplitude and trajectory) but they all have a recognisable mark (kicking, crawling). Thelen and Smith (1994) and Goldfield (1995) explained this from a dynamical systems approach. For them the patterns of sensory and motor actions may appear very early in development as self-organisation. Each variable involved in an action pattern changes over time. New forms of behaviour, instead of being determined by a central command, could also emerge from multiple systems that develop side by side in constant interaction. New behaviours in infant development may correspond in part to organisational change driven by a series of stabilisers and destabilisers (Goldfield, 1995). The change would be partly peripheral and have a distributed causality. It would be neither prescribed nor centralised in the form of hidden cognitive or higher command structures (Smith and Thelen, 1993). The process of self-organisation thus plays its role in determining the infant's behaviour and development. However, neither the equilibration nor the self-organisation models offer strong ideas about any of the general principles guiding infant development, as they do not analyse what would cause or drive infant development.

2.1.3. From birth to two months of age

A child's behaviour at birth can be described as the expression of pre-adapted action systems that are adapted to take advantage of the resources of the living environment. These behaviours are a complex repertoire that will become increasingly more complex. The action system of the infant at birth is currently considered to be a flexible system open to learning (sucking, but also exploring objects), sucking is not automatic and depends on the behavioural states of the infant (sleeping, awake, hungry...) and on the quality of the oral stimulus (taste, texture), as well as on the behaviours explained below:

- Rooting (search).
- Orientation.
- Kicking.
- Continue with the view.
- Suctioning.

They are therefore complex, open systems. Children are born pre-adapted to take advantage of vital aspects of their environment (people, food and perceptual novelty). As we have already seen, there is an evolutionary co-design between certain facial expressions that denote specific emotions from birth. Perceptual mechanisms will enable the infant to perceive these expressions, understand them and interpret them as empathic expressions. Likewise, infants are born with a high degree of readiness to behave skilfully in the environment both in their physiological constitution and in their behavioural functioning. The main limitation of the newborn is to act in the here and now. At this point the infant does not yet show signs of planning or systematic study of the environment. The world of the newborn is neither contemplative nor conversational. It demonstrates comfort and well-being, but essentially does so involuntarily, in a world that moves from calm to intense agitation without anticipation or simulation of what will happen next. From the foetal stage, the infant learns and develops new skills that transcend its basic behavioural repertoire. In the pre-adapted action system there is plenty of room for behavioural plasticity. Newborns have little control over what they experience around and within themselves. After this phase, infants outgrow the directness and immediacy of the pre-adaptive action systems with which they come into the world. The newborn phase ends when infants begin to distance themselves from events and perceptual situations

in order to achieve greater control over them. They overcome immediacy and are able to reflect on it, at around six weeks of age. This is when the precursors of planning begin, with actions being carried out with an obvious goal in mind rather than an immediate response to situations in the environment. In other words, babies begin to develop intentionality. Towards the second month, children open up to the world around them, the first socially provoked smile appears. The appearance of the social smile is one of the first signs of the mental distance that differentiates intentional acts from automatic or random ones. As infants become less dependent on stimuli, they begin to adopt a conversational, contemplative attitude and thus spend more time awake and attentive (Wolf, 1987). With this new situation comes a new variety of planned action systems that are not simply linked to a stimulus, but are based on the deliberate coordination of means-ends to achieve intended goals:

- Reach a novel object.
- Remove something to see an object.
- Find new ways to get in touch with something.
- Reproduce an interesting perceptual event.

However, it should be noted that by 20 weeks of gestation the behavioural repertoire of the foetus is similar to that of the neonate, with sucking, grasping, eye movements, swallowing and kicking. There is therefore behavioural continuity between prenatal and postnatal development (Prechtl, 1987). These findings form the basis for the development of intentional action, which would be the first feature of early childhood cognitive development.

2.1.4. The nine-month revolution

The understanding of how babies relate to the people and objects around them begins. In this period, they will develop triadic competencies. At around nine months infants begin to try to understand others as intentional agents:

- They recognise people as like themselves.
- They plan their actions.
- They carry out actions deliberately.
- They begin to refer to other people socially.
- They keep in mind others' emotional expression while planning actions or trying to understand a novel situation in the environment.

Children's understanding that others make intentional plans takes their learning potential to new levels. The ability to cooperate and learn to share with others emerges and declarative gestures begin:

- Point things out.
- Follow your gaze.
- Attempting to control the attention of others.
- Try to share with others an interest in objects and events in the environment.

Children begin to involve others and others begin to involve the child in constructing shared topics of conversation about the things that surround their relationship. This is the transition from primary to secondary intersubjectivity. That is, a sense of shared experience in relation to objects and events in the world. It begins the child's interest in constructing a shared world to which one can:

- Refer.
- Discover.
- Learn.
- Understand.
- Clarify.

All this, in collaboration with others, is why all the main engines of cultural transmission are set in motion:

- Teaching.
- Cooperation in problem solving.
- Language.

The emergence of secondary intersubjectivity and language are synchronous and correlate in the development of triadic competences such as:

- The joint attention patterns.
- Declarative gestures.

Both of these (joint attention patterns and declarative gestures) herald the utterance of conversational words (Tomasello and Farrar, 1986). Here language development is understood from its pragmatic aspect, which requires the child to understand the other as an intentional agent and also as a potential agent who can jointly understand things in the world through arbitrary signs such as words. Thus understood, the development of language is referential and fulfils a communicative function depending on the remarkable advance of secondary intersubjectivity. Language heralds the end of early childhood in the preverbal period of child development.

2.2. Cognition and development of empathy in early childhood. Therapeutic implications

2.2.1. Physical cognition: the discovery of objects

For Piaget (1952), the early development of object exploration is the basic process by which children acquire physical knowledge and represent the world of objects beyond the immediacy of perceptual experience. Piagetian research suggested the possibility of some prior physical knowledge to guide infants in their self-initiated exploration of objects. In the origins of physical knowledge, infants show from birth an organisation of sensory modalities. From an early age they are able to perceive cross-modally and to adjust the different modalities. Prior to manual activities they show physical knowledge and reasoning, such as the systematic search for hidden objects that Piaget (1952) documented in his classic observations on object permanence. Infants from a very early age manifest an awareness of objects from the systematic visual attention they pay to them. For Piaget, infants only begin to recognise the quality of object permanence in objects from the age of nine months. However, Baillargeon (1993) indicated that these limitations could be explained more by motor competence than by cognitive limitations. The concept of the object is the result of a mental operation that can be separated from sensory experience. Babies therefore possess certain rudiments of the object concept. These will allow them to make predictions much earlier than the manual search for the object. In various experiments, Elizabeth Spelke (1985, 1991, 1998) has shown that babies, at least from the fourth month, seem to know that objects:

1. exist continuously in space and move along connected paths (from the principle of continuity).
2. occupy space exclusively, without the objects coinciding in the same exact place (principle of solidity).
3. move independently unless they are in physical contact with another object (principle of non-action at a distance).

Therefore, it can be concluded that from an early age, object representation is dynamic rather than static and involves mental activities. From birth, babies usually fixate more on moving objects than on static objects. They also develop the concept of number from an early age, considering two properties: cardinality and ordinality. In addition, from an early age, babies will perceive, memorise, classify and thus begin to conceptualise objects and things. They will understand objects as a series or a group of things (things that look alike, things that sound alike, things that have similar attributes...). Children's actions are a direct reflection of their cognitive competence. There are different types of knowledge that are related to the development of cognitive and metacognitive strategies (Flavell, 1985): "knowing how" versus "knowing what", it seems that both types of knowledge develop in parallel and not sequentially as Piaget said. Early

physical knowledge belongs to the knowledge of "knowing what", i.e. in Flavell's (1985) terms it would be conceptual knowledge. However, performance theory (which tries to explain the conceptualisation of the object) takes into account the idea that physical knowledge must be framed within functional limitations. For Gibson (1979), perception and action cannot be considered separately. Two types of physical knowledge would thus be understood as one pertaining to the direct perception and control of the practical things that can be done with objects ("knowing how") and the other to the indirect representation of what objects are and what happens to them ("knowing what").

2.2.2. Social cognition and empathy development

Social cognition can be interpreted as the process by which individuals develop the ability to observe, control and anticipate the behaviour of others. This capacity involves varying degrees of understanding, from the perceptual distinction of the characteristic features of emotional expressions, to the complex representation of intentions and beliefs (theory of mind). Social cognition involves reading affects, emotions and intentions; in addition to the characteristics that make people specifically different from objects. All of this is directed towards the understanding of a private or dispositional world. The sense of shared experience in terms of intersubjectivity (Trevarthen, 1989) implies a basic differentiation between self and others. The sense of shared experience ("empathy"), is a projective capacity for social understanding that is crucial for the understanding of others. Children develop social skills from a very early age, and people provide the infant with richer perceptual encounters than any other object in the environment.

2.2.3. Cognitive and language development in the pre-operational period

During the pre-operational period (from approximately 24 months to 7 years of age) the child consolidates a series of skills initiated in the sensorimotor period (from approximately 0 to 24 months) while acquiring new skills. In this period children have already acquired the ability to represent, although development is not yet complete as they will need other systems of representation such as language. In this period there will be significant development of language and particularly insertion of language into the actions of the subject and of others. From the Vygotskian perspective, language is a privileged vehicle of cognition and allows the subject to use words to represent concepts, inter-conceptual relations and interactive sequences with both objects and people. This acquisition facilitates the child's transition from the world of experimentation to the world of deduction. In addition, the latest developmental research has highlighted another important acquisition during this period, the development of theory of mind (Woodruff, Premack and Kennel, 1978; Woodruff and Premack, 1979; Wimmer and Perner, 1983). The first authors to introduce this concept were Woodruff and Premack (1979) in their work with non-human primates and later in work with humans (Wimmer and Perner, 1983). From this research, the mind could be defined as a set of desires, beliefs, emotions or intentions, with the interaction between them giving rise to mental states or mental representations (Astington, 2004). This is what is called metarepresentation, i.e. the ability to create representations about one's own representations and to infer representations about the representations of others, enabling the subject to develop hypothetico-deductive reasoning and therefore tools for learning and coping in real environments (Astington, 2004). The development of ToM is related to the development of language; these two aspects are directly related but not comparable (Rivière and Nuñez, 1996). The acquisition of language skills (morphosyntactic, semantic and especially pragmatic) enable the child to further develop conceptual systems of intentions, beliefs and desires, which is what is meant by ToM. It has been shown that the absence or inhibition of language can lead to not really understanding the world of representations of others. Many researchers believe that there is a critical phase in the acquisition of the ability to infer false beliefs for the development of a complex conceptual system, by means of which the subject can explain their own behaviour and that of others. This phase would be from 3 to 5 years of age (Rivière and Nuñez, 1996). Towards the age of three, the understanding of desires and beliefs will appear. However, children at this age will understand limited aspects of the desires and beliefs of others and their relationships with emotions (Bretherton, McNew and Beeghly-Smith, 1981; Wellman, 1995). By age 4 they will be able to begin to understand the false beliefs of others (Gómez, Sarriá, & Tamarit, 1993). Although the understanding of mental representation will still be partial, as well as the understanding that beliefs and desires are mental entities that are separate from reality. The development of the concept of mind must be

understood in its double meaning of mental entity and mental activity. This is why psychologists chose situations of deception as the most suitable for determining whether a subject has developed theory of mind or not. Peskin (1992) differentiates three developmental timepoints in tacit deception. First, at around 3 years of age, children seem to have difficulties in successful deception. At a second stage around 4 years of age, children do not yet employ tacit deception strategies as such, although they may be able to produce them according to experience, and a third stage in which the child can use deception in a more fluid way. Thus, it seems that by the age of 5 ToM will have started its development in an evolutionarily "normal" process that over the years will be refined with respect to its conceptual elements of power and recursion that can be observed in second-order ToM tasks. The development of ToM takes the form of solving different types of tasks. At an initial stage in the process of acquiring theory of mind, the child will be able to solve false belief tasks. In these tasks, a story is staged in which the main characters are two children, one of whom has an attractive object (e.g. a marble, a doll, a ball...) that they keep in a specific place (e.g. a box, a basket...). This child (whom we will call Juan) will leave and the other child (whom we will call Luis) will be left alone in the room, then Luis will take the object (marble, doll...) and will change where it is (put it in another box, in another basket...), then Juan will come back and we will ask the child of our experiment "Where will Juan look for the marble, (the doll...)? It is here that the experimental child must put themself in the place of the other child and differentiate between what they know has happened and what the protagonist actually knows. Later on, children will solve the second order task, in which they will have to infer the false belief of one subject about what another subject has. The experiment is similar to the previous one except that this time, as the first character, Juan, is leaving the room, he sees what is really happening through a window, so he will no longer have a false belief but a true belief. Now the questions that the child being tested are: "Where does Juan think the marble is?" (this question refers to a true belief) and "Where does Louis think Juan will look for the marble?" (this refers to a false belief). The second question involves a high degree of recursivity and is not answered correctly until at least 6 and a half years of age (Rivière and Nuñez 1996). Thus, the mind can be understood as a representational construct. Having a mind is equivalent to having representations and attributing mind implies attributing representations to others. Bearing in mind that intentional recursivity uses language on many occasions to try to modify the mental worlds of others. Thus, from this approach, ToM would be directly related to pragmatic skills and to the declarative function of language (Rivière and Nuñez, 1996; Happé, 1998). This capacity can be understood as an ability or set of cognitive skills that allow the interaction and communication processes between human beings and facilitate behaviours that are adaptive to the environment.

3. Outline of development in the sensorimotor period and strategies for early intervention

Table 2 below presents an outline of the most representative acquisition milestones in the sensorimotor period (zero to approximately twenty-four months), as well as early intervention strategies to develop the behaviours and/or competencies.

Table 2. Developmental milestones in the sensorimotor period and early intervention strategies (adapted from Sáiz-Manzanares, 2000 p. 122-123).

Developmental ages and their relationship to the stages of the sensorimotor period	Sensorimotor intelligence	Cognitive intervention strategies
Stage I (0-1 months)	- Development of reflexes. - Signs of accommodation of perceptual selection schemes (attunement to attachment figures). - Beginning of non-specific linkage.	- Desarrollar el seguimiento visual de - Develop visual tracking of objects. - Facilitate sucking-pausing relationships between mother and baby. - Enable breast-shaking or feeding-pause container relationships. - Implement rocking-pause relationships.

Developmental ages and their relationship to the stages of the sensorimotor period	Sensorimotor intelligence	Cognitive intervention strategies
Stage II (1-4 months)	- Primary circular reactions. - First adaptations acquired. - First scheme co-ordinations. - Beginning of the social smile. - Emergence of primary intersubjectivity. - Start of proto-conversations.	- Develop sucking and grasping coordination. - To facilitate vision-hearing coordination. - To develop phonation-audition coordination. - Enabling the elicitation of social smiles. - Facilitating the development of primary intersubjective behaviours. - Implement the development of contingency awareness. - Develop circular games. - Facilitate the development of proto-conversational patterns between infant and nurturing figures.
Stage III (4-8 months)	- Secondary circular reactions. - Full coordination of vision and grasping. - Beginning of the means-ends differentiation. - Anticipatory behaviours.	- Facilitating the development of vision-impairment coordination. - Enable the development of the beginnings of means-end differentiation. - Facilitate the development of the search for partially hidden objects. - Enable the development of anticipatory behaviours.
Stage IV (8-12 months)	- Coordination of secondary schemes. - Pursuit of ends using others as means. - Reciprocal assimilation of means-ends. - Progressive differentiation of means-ends. - First acts of practical intelligence. - Occurrence of intentional behaviours. - Beginning of the development of proto-imperative behaviours.	- Facilitating the pursuit of ends by using other schemes as a means. - Search for completely hidden objects that have just been hidden. - Enable situations in which the child has to communicate and reinforce intentional communication behaviours. - Facilitate the development of proto-imperative behaviours.
Stage V (12-15 months)	- Circular tertiary reactions. - New media are discovered by experimentation and known patterns are differentiated.	- Facilitate the search for the object in different places where it can be hidden.
Stage VI (15-18 months)	- Use of new media by mental combination. - Occurrence of proto-declarative behaviours. - Object permanence. - Start of the performance.	- Present problem situations in which the child has to develop mental combination. - Facilitate situations in which the child has to develop proto-declarative behaviours. - Facilitate the search for objects in all locations. - Facilitate the development of representative behaviour.

4. Outline of development in the pre-operational period and strategies for early intervention

Table 3 presents an overview of the cognitive characteristics of the pre-operational period and Table 4 presents an outline of the most representative acquisition milestones in the pre-operational period (approximately 2-6 years), as well as early intervention strategies to develop those behaviours and/or competences.

Table 3. Cognitive characteristics of the preoperative period according to Piaget (1952).

Juxtaposition	The child cannot make a logical account of an event or situation. He/she gives an account without causal relations.
Syncretism	Non-deductive reasoning. The child establishes relationships from unproven subjective schemes.
Perceptual appearance	The child is dominated by the external features of objects. Cannot make inferences from unobservable features.
Egocentrism	Confusion between self and non-self. The child takes his immediate perception as absolute and does not adapt it to the point of view of others.
Focus	The child focuses on only one aspect of the situation or one point of view.
States/transformations	The child hoes not relate the initial and final states of a process.
Irreversibility	You cannot mentally redo a process from the end to the beginning.
Transductive reasoning	The child establishes immediate associative connections between situations, from the particular to the particular.

Table 4. Developmental milestones in the pre-operative period and early intervention strategies

Developmental ages and their relation to the stages of the pre-operational period	Practical intelligence	Cognitive intervention strategies
From 2 to 3 1/5 or 4 years old	- Appearance of the symbolic function and beginning of the internalisation of action schemas in representation. - Appearance of symbolic function in different acquisitions: language, symbolic play, deferred imitation, beginnings of internalised imitation. - Initial plane of representation (difficulty in non-immediate space, non-present time and in carrying out causal actions).	- Facilitating role-play situations, e.g. games with puppets and marionettes. - Use language regulation from modelling and moulding in fiction games, in drawing activities. - Include pictograms sequentially representing the parts in the execution of an action. Such pictograms may be on cards or included on tables, table-top or mobile devices.
From 4 to 5 1/5 years old	- Representative organisation in static configurations	- Through games show the child how the processes of transformation of substance, quantity, etc. are carried out. Step by step and have them carry them out themselves in order to internalise the action schemes.
From 5 years 1/5 to 7 or 8 years old	- Intermediate phase between conservation and non-conservation. - The child achieves semi-reversible properties. - Semi-logical phase	- Show the child through games how the processes of transformation of substance, quantity, etc. are carried out. Step by step and have them carry them out themselves so that they can internalise the action schemes. Carry out the sequences from start to finish and from finish to start so that the child can mentally acquire the reversibility of the processes.

Summary

This module has presented a brief review of human cognitive development, analysing the most representative developmental theories to explain it. It should be pointed out that development, especially in the first part of the sensorimotor period, is overall development that includes perceptual as well as motor and communication development. Two important milestones were distinguished during this time, namely the two-month and nine-month revolutions. At twelve months, a new revolution takes place which is related to motor independence (standing and walking), as well as the beginning of language development. The latter is directly related to the ability to represent and later the ability to meta-represent. These are prerequisites for metacognitive development, which will be consolidated in the pre-operational period and which are related to the development of planning, hypothetic-deductive thinking and language. All of these facilitate the acquisition of problem-solving strategies beyond the here and now and the consequent development of the mind in what has been called the ToM.

Glossary

Intentional action: behaviour or behaviours performed with an objective or plan to achieve something.

Accommodation: the baby's tendency to modify its own actions in order to assimilate more objects and situations those it has already mastered or knows.

Mental activity: the cognitive and/or metacognitive processes that take place during information processing aimed at solving tasks or problems, or which occurs during one's own reflection on mental states or situations.

Conversational attitude: the tendency towards communication with other people and sometimes objects to which the interlocutor has given an animated component.

Affections: feelings about people or things, these can be positive or negative.

Assimilation: the ability to incorporate objects or actions into existing structures.

Self-perception: the ability to become aware of one's own perceptions.

False belief: the incorrect cognitive perception of a situation originating in the real world.

True belief: the correct cognitive perception of a situation originating in the real world.

Mental entity: a mental state or mental property. Mental states may include perception, experience of pain, belief, desire, intention, emotion and memory.

Equilibration: in Piagetian terminology, this is a process of restructuring, of homeostasis with respect to the processes of assimilation and accommodation.

Emotion: a feeling that appears when the person reacts to the environment, the emotion generates an affective state (positive or negative) that is accompanied by physical changes, as the emotion generates physiological changes.

Empathy: the ability to put oneself in another person's place in a given circumstance or situation.

Declarative gestures: signals in the form of gestures that the subject makes to communicate their desire to interactively share a situation, object, etc.

Intentions: thought directed to an end, intentional implies consciousness.

Primary intersubjectivity: according to Trevarthen (1989) this refers to the coordination between self and other from correspondences of form, synchrony and intensity. For example, around five months of life, the development of the social smile.

Secondary intersubjectivity: according to Trevarthen (1989), this is the ability to share feelings with "the other" or "others". Secondary intersubjectivity develops from nine to twelve months with the beginning of symbolic functioning. Trevarthen (1989) defines a developmental sequence from proto-conver-

sation (primary intersubjectivity), play to finally cooperative awareness of persons and objects (secondary intersubjectivity).

Frontal cortical lobe: a sector of the cerebral cortex that is phylogenetically modern and is only specifically detected in highly evolved vertebrates, in hominids and specifically in *homo sapiens*. The prefrontal lobes are home to higher-order executive functions, including attention, planning, sequencing and behavioural reorientation. The frontal lobes are heavily involved in motivation and behaviour. These lobes have important connections with the rest of the brain areas.

Microchanges: changes that occur within a phase.

Macro changes: changes that occur in the passage from one phase to another.

Metarepresentation: the ability to think or reflect on one's own representations, and requires a high degree of analysis.

Mental operation: operations that take place in the cognitive and metacognitive environment and are related to reasoning processes, specifically hypothetico-deductive.

Joint attention patterns: processes of attention between two people with respect to an action or situation. In human development these behaviours appear at around four months of age. This concept is related to the development of social smiling, primary intersubjectivity and proto-conversations.

Cross-modal perception: perception from the inclusion of information through various channels (auditory, visual, and tactile) and their interrelation in the processing of an object, situation or person.

Sensorimotor period: according to Piaget's theory (1952), this is the period of evolutionary development from approximately 0 to 24 months, when the development of representation and the beginnings of metarepresentation appear and the preoperational period begins.

Object permanence: the ability to know that an object exists even if it is not seen. According to Piaget (1952), acquisition would begin at around nine months, although current developmental theories indicate that acquisition is earlier, although the motor action of executing the search for the hidden object would correspond to this developmental age.

Behavioural plasticity: changes in behaviour or routines.

Pragmatics: the function of language that refers to the social or contextual use of language.

Early Childhood: UNESCO defines early childhood as the period from birth to eight years of age. Protoconversaciones: hace referencia al inicio de las pautas conversacionales antes de la adquisición del lenguaje. https://es.unesco.org/themes/atencion-educacion-primera-infancia

Protoconversations: the onset of conversational patterns prior to language acquisition.

Primary circular reactions: according to Piagetian theory, these refer to infant's thought processes related to different events that contain a pattern of realisation (following an object), actions on one's own body or that of others. They are the precursor to intentionality. They develop from one month to four months.

Secondary circular reactions: according to Piagetian theory, these refer to the infant's thought processes about different events that contain at least two patterns of behaviour. They are directly related to oculo-manual coordination, the beginning of means-ends differentiation and anticipatory behaviours. As well as the acquisition of the precursors of object permanence, these develop from the fourth month to eight months.

Tertiary circular reactions: according to Piagetian theory, they refer to the coordination of mental schemes, the search for means to an end and the progressive differentiation of means and ends. They are related to the first acts of practical intelligence and intentionality. Their chronology is from eight to twelve months.

Recursivity: according to Riviére and Nuñez (1996), this is related to the ability to have intentional mental states. It is related to type I functions, according to Bennett (1976), these structures are necessary to perform declarative or ostensive linguistic functions (i.e. transmission of propositional knowledge between minds). In humans, ostensive functions can be found at the end of the second year of life, although the development of ToM does not occur until at least the age of six.

Triadic or triangular relationships: relationships between the adult, the baby and an object.

Feelings: affective states provoked by an emotion towards people, objects or situations.

Social smile: the baby's smile that goes beyond that produced by physiological causes of satisfaction (food, sleep) and is aimed at seeking interaction with others. It begins at the end of the second month and is reached around the fourth month.

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Resources

Web

Developmental calendar from 0 to 18 months poster	https://bit.ly/3HyVoLy
Developmental Guidance from birth to 6 years	https://bit.ly/3xDBAlN
Diagnostic organisation for early care	https://bit.ly/3MYx47b
Early intervention	https://bit.ly/3xGj9wD
Technical recommendations for the development of early care	https://bit.ly/3xAM70Z
Ensuring Early Childhood Care in Europe in Spanish.	https://bit.ly/3OsGusL
EU Recommendations of the European Child Guarantee	https://bit.ly/3ycRC7T
The first news about your child with a disability	https://bit.ly/3HyjnuB
Sensory impairment in the autistic spectrum. Spanish Association of Autism Professionals (AETAPI) 2021	https://bit.ly/3OaFgCz
Information on disability	https://bit.ly/3xCgyUK

Comprehension questions

Answer (true answer is in bold)

Question 1. By two months of age, the baby can

a) **Rooting.**
b) Sit with support.
c) Sitting without support.
d) Say first words.

Question 2. At about nine months, the baby can:

a) Plan actions.
b) Recognise emotions.
c) Make protodeclarations.
d) **All of them.**

Question 3. Secondary intersubjectivity can be defined as

a) **co-ordination between self and other from correspondences of form, synchrony and intensity. For example, by five months of life the development of the social smile.**
b) the ability to share with "the other" or "others" feelings.
c) Both a and b.
d) Neither a nor b.

Question 4. Secondary intersubjectivity and language are

a) The same concepts.
b) **Synchronous.**
c) Asynchronous
d) Paired.

Question 5. Theory of Mind involves

a) Thinking only from one's own point of view.
b) Putting oneself in the place of the other.
c) Thinking what the other person can think.
d) **Both b and c.**

Question 6. Theory of Mind conjugates

a) **Desires, beliefs and intentions.**
b) The future.
c) The present.
d) The past.

Question 7. In "normal developmental" development at what age do primary circular reactions occur?

a) At 6 months.
b) **At 4 months.**
c) At 5 months.
d) At 7 months.

Question 8. What is the difference between protoimperative and protodeclarative.

a) Point out.
b) **To show.**
c) Communicate.
d) To speak.

Question 9. In normal developmental development, the first acts of practical intelligence are produced by

a) At 8 months.
b) At 12 months.
c) At 4 months.
d) **Both a and b.**

Question 10. The characteristics of the pre-operational period are:

a) Reversibility.
b) **Concentration.**
c) Deductive reasoning.
d) Causal reasoning.

MODULE VI.1 PSYCHOMOTOR DEVELOPMENT

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I. INTRODUCTION

This topic deals with psychomotor development and the changes that occur in the first months of life, showing how psychomotor development follows a series of laws and principles. It describes how psychomotor skills develop: muscle tone and postural control, locomotion motor skills, manipulative motor skills and graphic motor skills. It focuses on the changes that occur in psychomotor skills during their acquisition over the course of children's development.

II. OBJECTIVES

The objectives of this thematic unit are:

- To understand the concept of psychomotor development.
- Observe the development of psychomotor skills
- Understand psychomotor developmental milestones.

III. CONTENT SPECIFIC TO THE THEME

1. Concept of psychomotor development

The term psychomotor refers to psychomotor activity, which is a very confusing and ambiguous term, mainly due to the great variety of meanings with which it is used. Looking at etymology, the word psychomotor contains the term "psycho" which refers to psychological activity (cognitive and affective); "motricity" which refers to motor movement; by joining these two definitions, psychomotor can be understood as a relationship between psychological activity and motor function. This relationship is a direct consequence of the unity and totality of the human being, therefore, psychomotor activity is not only a motor activity, but also a conscious psychological activity that is triggered in certain motor situations (Justo, 2014).

Human development is a very complex process, during the first stages of life it is amazing how many changes occur in human beings from birth to adulthood. These changes are very significant, both quantitatively and qualitatively, occurring in the first years of life, although transformations continue to a lesser extent into old age. Development is a linear, continuous process, but milestones or high points can also be identified. These milestones are reached at approximately the same ages in all individuals in normal situations, although there may be differences due to genetic load and environmental changes in each person. Motor, affective, cognitive and social development are interrelated and conditioned by the environment development takes place in.

Psychomotor development can be seen as a continuous process from conception to maturity (García and Martínez, 2016). It is continuous development of the capacities to perform a series of bodily movements and actions, as well as the mental and conscious representation of these (Justo, 2014). Psychomotor development cannot be assumed to be something that simply happens to the child, but is something that the child will produce through their desire to act on the environment and to become increasingly competent. Therefore, the aim of psychomotor development is to achieve mastery and control of one's own body in the environment (Gil, 2003).

Psychomotor development is manifested through motor function, which is made up of movements oriented towards relationships with the world around the child. These motor functions are the beginning of

the child's development, to the extent that movements are the only psychological manifestations that can be observed in babies. Therefore, psychomotor development is a composite process closely related and conditioned by (according to Cabezuelo and Frontera, 2012):

- Motor development, skills linked to the musculoskeletal system, capable of increasingly complex and precise movements. Muscular activity is coordinated by the nervous system.
- Psychological and affective development, linked to brain activity that functions such as language, affective manifestations and social relations depend on.

The ultimate goal of psychomotor development is to achieve control of one's own body in order to achieve all actions that promote experiences at all levels.

2. Laws and principles of psychomotor development

Children's movements in their first weeks are mainly uncontrolled and uncoordinated, in the form of jerks affecting both arms and legs. As children grow, they exhibit a notably different picture, since their movements are voluntary and coordinated, and they control the position of their body and body segments (Gil, 2003). The transition from the first weeks to the achievements that occur in the second half of the second year follows laws and principles.

2.1. Main laws of development

These indicate that the body's muscles do not all mature at the same time, but according to the following laws (Cordoba, 2018, Gil, 2003):

- Cephalo-caudal law: first the muscles closest to the child's head mature and then the muscles further away from the head develop, i.e. movement control matures from the head to the feet. The child holds its head before it is able to sit upright and is able to use its upper limbs skilfully before it is able to use its lower limbs skilfully.
- Proximal-distal law: the child controls the movements of the body first in the areas closest to its body axis, whereas the areas furthest from this body axis are controlled later. Thus, the shoulder joint is controlled before the elbow joint, which in turn is controlled before the wrist joint, which in turn is controlled before the finger joints.
- Law from the general to the specific: children develop gross motor control before they develop fine motor control. Thus, children develop control over the whole of their arm before they develop the ability to pincer grasp with their fingers.
- Law of development of flexors and extensors: control of the muscles responsible for flexor functions occurs earlier than control of the muscles responsible for extensor functions. Thus, children acquire the ability to grasp rather than to pull objects earlier.

2.2. Five principles of development

The five principles of development were stated by Thelen in 1989:

- Motor development can only be understood in terms of the developing system, as movement is the result of the interaction of many subsystems.
- What determines how these subsystems come together is the task, not pre-existing genetic instructions. Tasks that require motor skills are context-dependent, and children draw on whatever components are available that are best suited to the task.
- Developmental processes are not linear. As small changes to one or two available components occur, the child reorganises the system to better suit the task.
- Action and perception form an inseparable circuit. This means that children can modify their actions to fit their perceptions.
- Variation is an important aspect of development. Children will change the way they approach specific tasks, partly because they can draw on different components.

3. Development of psychomotor skills

The different psychomotor skills develop in accordance with the laws and principles detailed above. These skills can be grouped for study into four conditions (Justo, 2014., Córdoba, 2018): 1) muscle tone and postural control; 2) locomotion motor skills; 3) manipulation motor skills; 4) graphic motor skills.

3.1. Muscle tone and postural control

Muscle tone is defined as the active tension of the muscle at rest that develops under the control of the central nervous system (Cordoba, 2018). Tone is the state of slight contraction that the muscles of our body are in. This contraction is not constant but variable and is harmonised continuously to allow the individual to be in a static position or in movement. Tone plays a very important role in psychomotor development, as the control of posture and mastery of fine and gross motor skills depend on tone. Tone develops in various ways (Alvarado-Ruiz et al., 2012); the tone of the limbs in newborns is high (hypertonia) so that the arms and legs remain flexed; axial tone is at low levels (hypotonia) (Córdoba, 2018., Alvarado-Ruiz et al., 2012).

There are two stages in the development of tonic control:

- First stage: this stage is global and uncontrolled. Newborns cannot distinguish body segments and use only those they need without control.
- Second stage: children progress in the development of the tonic control of body segments, this increased control will allow them to use only those structures that are necessary in each activity.

The most significant milestones in the normal development of muscle tone, according to Cordoba (2018), are:

- Hypertonia at birth, except in the neck and spine which are atrophied as a result of the prolonged intrauterine foetal position.
- From two to six months, hypotonia occurs, except in the neck and spine, which begin to acquire muscle tone.
- At six months, there is generalised stiffness throughout the child's body.
- Around the age of one year, the tone of the neck and spine is fortified until the bipedal position that will allow walking is possible.
- After the first year, tone control will increase to the level of coordination that will allow control of muscle tension and relaxation.

Figure 1. Motor milestones. Source: Shumway-Cook, 2019.

Postural control is the set of anatomical-functional structures aimed at maintaining the body's relationships with itself and with space (Justo, 2014). During the first years of life (Figure 1), children develop a repertoire of skills including independent crawling, walking and running, climbing and manipulation of objects in a variety of ways, the emergence of these skills requires postural control that supports primary movement (Shumway-Cook, 2019). Research on early development has shown that the simultaneous development of the postural, locomotor and manipulative systems is essential for the emergence and refinement of skills in all these areas (Justo, 2014., Shumway-Cook, 2019).

Traditionally, postural development has been related to a sequence of motor milestones, the most important milestones according to Shumway-Cook (2019) are shown below (table 1), it should be noted that the ages shown are approximate.

Table 1. Motor milestones.

Age	Procurement
1 month	Raise head
4 to 7 months	Supported sitting
4 to 7 months	Independent sitting
8 to 10 months	Trawl
8 to 10 months	Crawling
9 to 10 months	Pushing oneself upright

3.2. Locomotion motor skills

Independent locomotion may seem a relatively simple and automatic skill, however, it is a very complex task, the study by Adolph et al., (2012) found that children learning to walk performed an average of 2368 steps and 17 falls per hour; which is equivalent to 14000 steps and about 100 steps per day which indicates that to learn to walk children do a lot of practice.

Before being able to walk the child moves on the ground in a limited way, as locomotion is conditioned by the possibility of standing and balance, to achieve independent walking the child follows a series of phases detailed below (Shumway-Cook, 2019., Molina, 2020) (Figure 2).

- Phase 1 stepping reflex: alternating leg movements when holding the baby under the armpits.
- Phase 2 disappearance of the stepping reflex: 98-99% of infants lose this reflex as a result of inhibition by maturing higher neural centres.
- Phase 3 reappearance of the gait reflex: the onset of self-generated locomotion is resumed, similar to the gait reflex.
- Stage 4 assisted locomotion: children begin to take their first steps in an immature, unsteady, unstable, irregular and uncoordinated way, they manage to take their first steps with the support of their hands.
- Phase 5, 6 and 7 independent upright gait: the hands gradually move from an elevated protective position (phase 5) downwards and to the sides (phase 6) and the trunk and head assume a more upright posture (phase 7).

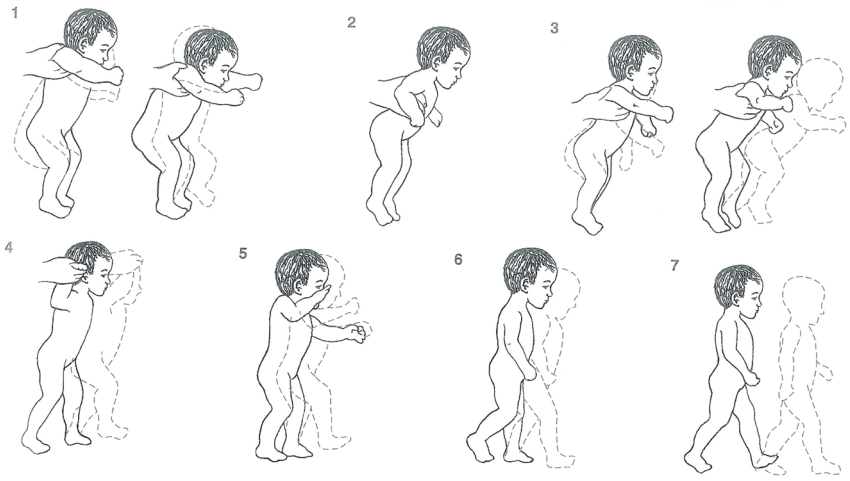

Figure 2. Phases of walking. Source: Shumway-Cook, 2019.

According to research, a 10-step gait, without hand support, without carrying objects with a functional purpose and without falling, is achieved by 3% of children at around 9.6 months, 50-70% at 13-14 months and 97% at 18.4 months; for this to happen, all the components of gait must be ready (Martín, 2014, Molina, 2020).

3.3. Manipulative motor skills

The development of manipulative skills such as grasping, throwing and catching is complex; they develop progressively over time through the association and maturation of different parts of the nervous and musculoskeletal systems with experience. It is the sight of an object at rest or in motion that triggers the precise execution of movements to catch, throw or grasp an object, just as the object triggers the precise, adjusted movements in vision.

- Grasping: refers to the execution of the use of the object, the upper limbs and the context in which the action is performed; it is a complex act, which needs visual localisation, the hand approaching the object and grasping the object. The literature describes three ways of hand approach that correspond to the progressive involvement of three joints: shoulder, elbow and wrist, and how this approach of the hand to the object evolves determines the development of grasping (table 3).

Table 3. Grasp development.

Age	Procurement
4/5 months	The child is able to direct a hand towards an object by "sweeping"; only the shoulder intervenes by grasping the object between the last two fingers and the palm.
6 months	The object is grasped by the last four fingers (without thumb), the approach to the object is lateral and parabolic, as the elbow is involved; at this age the child is able to hit a table with the object and release it voluntarily.
7 months	The grasp is palmar, the child can pass the object from one hand to the other and is able to keep the object they have if offered another one.
8 months	Radial-palmar grasp, the thumb acts as a stopper, allowing the child to strike objects against each other.
9 months	Fine grasping appears, the child can grasp small objects with the thumb and forefinger gripper. Hand approach involves: shoulder, elbow and wrist.

- Throwing: the ability to throw develops in children before reception, appearing at around 6 months, from the sitting position, and detaching from the object in their hands in a coarse manner, to full control of the movements involved in the throw. This process develops throughout the maturational process from the age of 2 to 7 years (table 4).

Table 4. Development of throwing skills.

Age	Procurement
2 to 3 years	The throw consists of an extension of the arm, without involving the trunk, with the feet fixed on the ground.
3 to 5 years	Without involvement of the feet, the throw is produced by a rotation of the trunk to one side to prepare and then to the other side to throw.
5 to 6 years	Feet start to get involved, there is more rotation to prepare for the launch
6 to 7 years	There is broad bodily participation. The lower limbs intervene in opposition to the upper limbs.

- Reception: this is the interruption of the trajectory of a moving object. The first trials are found in young children trying to intercept a ball rolling on the ground. In general, three stages in the acquisition of catching have been described: a) children under 3 years of age usually place their arms rigidly with their hands extended so that the ball falls between their hands. b) at around 4 years of age children open their hands to catch the object, although the movement of the hands is still a little rigid. c) at 5 years of age the arms remain relaxed next to the body before trying to catch the ball, the acquired behaviour is characterised by a balanced position of the feet, eyes, arms and hands that wait relaxed for the object.

3.4. Graphomotor skills

Graphomotor skills are very important, and are the ability to write or manipulate certain tools that leave an imprint or trace on a support (Córdoba, 2018). These traces may at first seem arbitrary and causal, but make sense as the child acquires skills.

Graphomotor skills develop through different stages that follow a common pattern, with some differences between individuals, through the following milestones:

- At one-and-a-half years old: the first graphic representations appear; the child is already able to pick up a writing utensil and make strokes on a support. At this stage, strokes are made with rapid, impulsive and uncontrolled movements.
- At twenty months: begins to use the elbow, so that scribbling takes on a different, clearer appearance.
- At the age of two and a half years: control of the wrist and finger pincer movement begins to develop and the line tends to become clearer.
- At the age of three years: Greater control of space appears, the child no longer goes off the paper, the child tries to close their lines.
- At four years of age: the child anticipates their productions, the relationship between drawing and paper is better.
- At five years of age: the child has the necessary characteristics to start pre-writing activities.

Psychomotor development is significant in the early stages of life. However, throughout life it changes to a lesser extent, and these changes are marked to a certain extent by those in the initial stages, therefore it is very important to know how psychomotor development takes place in order to detect alterations.

Summary

Psychomotor development can be seen as a continuous process from conception to maturity. It is therefore a continuous development of the ability to perform a series of bodily movements and actions, as well as the mental and conscious representation of these movements and actions, which in the early stages of life are of capital importance for an individual's development. This development takes place in the first weeks of life, following various laws and principles.

The development of the different psychomotor skills can be grouped for study into four conditions: 1) muscle tone and postural control; 2) locomotion motor skills; 3) manipulative motor skills; 4) graphic motor skills.

Glossary

Psychomotor development: continuous development of the ability to perform a range of body movements and actions, as well as the mental and conscious representation of these.

Muscle tone: active muscle tension at rest that develops under the control of the central nervous system.

Postural control: set of anatomo-functional structures aimed at maintaining the body's relations with itself and with space.

Grasping: execution of the use of the object, the upper limbs and the context in which the action is carried out.

Launch: ability to launch

Reception: interruption of the trajectory of a moving object.

Graphic motor skills: the ability to write or manipulate certain tools that leave an imprint or trace on a support.

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Resources

Web

https://www.aeped.es/

https://www.healthychildren.org/english/pages/default.aspx

https://www.analesdepediatria.org/

https://www.netflix.com/es/title/80117833

Comprehension questions

Answer (true answer is in bold)

Question 1. Psychomotor development can be considered a continuous process from:

a) conception to infancy
b) **conception to maturity**
c) conception to adolescence
d) from conception to the first three years of life.

Question 2. Psychomotor development is a composite process closely related to and conditioned by:

a) motor and affective development
b) Motor and psychological development
c) **motor, psychological and affective development**
d) Psychic and affective development.

Question 3. The cephalo-caudal law of psychomotor development consists of:

a) **The muscles closest to the head mature first, followed by those furthest away.**
b) The muscles furthest away from the head mature first, then those closer to the head.
c) The child controls body movements first in the areas closest to its body axis.
d) The child controls body movements first in the areas furthest from its body axis.

Question 4. Graphic motor skills are understood as:

a) The ability to write in a way that leaves an imprint or trace on a support
b) Manipulating certain utensils that leave an imprint or trace on a support.
c) **A and b are correct**
d) None of the answers is correct

Question 5. Phase 1 (stepping reflex) of the development of locomotion consists of:

a) **The movement of the legs alternately when holding the baby under the armpits**
b) Crawling movement
c) alternating leg movements without support
d) Jumping movement of the legs.

MODULE VI.2 DEVELOPMENT OF PERSONAL AUTONOMY

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I. INTRODUCTION

In this topic we develop the idea of personal autonomy and independence, highlighting the differences between the two concepts. We also address the concept of activities of daily living and include a brief classification of them before considering the importance of context and surroundings in the development of personal autonomy. Lastly, we look at the main activities of daily living, how they are defined, the tasks involved in each one, and more specifically, which are the most important chronological development milestones.

II. OBJECTIVES

The objectives of this unit are:

- To understand the concept of personal autonomy and activities of daily living.
- To understand the role that environments and contexts play in the development of personal autonomy.
- To learn the most important developmental milestones in the acquisition of independence in activities of daily living.

III. SPECIFIC CONTENTS OF THE THEME

1. Concept of personal autonomy and independence

The concepts of autonomy and independence are usually synonymous; however, they differ in the detail.

Personal autonomy refers to people's capacity to make decisions related to their life on their own initiative. For Bornas (1994), an autonomous person is "one whose self-regulation system functions in such a way as to enable him/her to successfully meet both internal and external demands placed on him/her".

In contrast, the concept of independence focuses on the capacity to carry out activities by oneself or with the help of support devices, not expressly mentioning the idea of higher abilities implicit in the concept of autonomy.

Thus, people may be independent in dressing (puts on clothes without help), but may not be able to select clothes according to the weather or an event, which would affect their autonomy; and conversely, some people may need to be dressed, but decide what to wear (limited independence, but retained autonomy).

Therefore, the concept of personal autonomy focuses more on the higher cognitive capacities that allow decision making, and independence is more about not being dependent on a third person in doing activities.

In early and late childhood, both autonomy and independence develop in parallel, and as children develop, they acquire the capacities they need that allow them to be independent and autonomous. Both skills continue to develop into adulthood.

2. The concept of activities of daily living

Activities of daily living (ADLs) are daily activities that are performed frequently that allow people to function with autonomy and independence (Pérez de Heredia Torres and Oudshoorn Giaccaglia, 2022). Different authors are not unanimous in how they classify these activities, but in general there are three main groups according to complexity and frequency: basic, instrumental and advanced activities.

Basic activities of daily living are about care of one's own body and basic needs such as feeding, grooming, showering, toileting, dressing, or moving from one place to another (Pérez de Heredia Torres and Oudshoorn Giaccaglia, 2022). They are performed every day and are considered the first level of occupational functioning. Independence in these activities is acquired little by little naturally. As people grow and develop, parents gradually give up the support they provide in these activities, so that children can take on a greater role and do them themselves. It is estimated that autonomy and independence in these activities is acquired around 9 years of age.

Instrumental activities of daily living are more complex activities, and therefore begin to be done in later infancy and childhood, but definitive acquisition takes place in young adulthood. They are also related to personal care, but focus on more complex aspects, such as food preparation, shopping, household management, clothing management or health management (taking medication, making appointments, etc.).

Finally, advanced activities are related to independent living and are even more complex, being typical of adulthood. Examples include money management, renting an apartment, organizing trips.

3. Role of environments and contexts in activities of daily living

These activities are done in contexts and environments which establish their characteristics and specific elements.

The environment and context correspond to the circumstances surrounding children. The environment can be defined as the physical and social environments surrounding children where they do their daily activities, while context refers to fewer tangible conditions that surround us, such as **culture**, socio-economic levels, and educational levels.

Various studies have emphasized differences in acquisition of these activities, influenced by both contexts and environments (Santamaría-Vázquez, Guijo-Blanco, 2016). For example, dressing is not the same depending on where one lives as the climate determines the type of clothes to wear, as does the **culture** one belongs to (for example the use of veil in Muslim **cultures**). Another example is the type of food one eats and the utensils used (cutlery, chopsticks, eating with hands, etc.).

Similarly, social contexts also influence the performance of these tasks. For example, family dynamics may encourage children's participation in tasks and therefore their development. In contrast, the dynamics may produce minimal participation, leading to slower development. Examples of this might include a parent who cleans a child's bottom because they do it badly and stain their clothes (if they do not practice, it will be more difficult for them to do it successfully), or who does not let them handle a spoon, because they spill food and eats less.

We must also consider the role played by the **physical environment**. If we talk about dressing, the **physical environment** would refer to the type of clothes that can be bought for the child to wear. In Europe, for example, it is difficult to find children's shoes with laces, and this limits the opportunities for children to acquire this skill. Circumstances such as having a bathtub or shower, the height of the toilet bowl, the type of faucet, and the length of children's hair, are examples of physical elements that can facilitate or limit children's independence in different tasks

4. Development of activities of daily living

It is difficult to establish typical developmental sequences for activities of daily living, when we have already seen the huge influence of contexts and environments on them. However, it is possible to establish some general lines of development for basic activities, establishing basic chronological milestones, but it

is important to emphasize that the periods indicated are large, because of the significant variation within a single country and the even greater differences that between different countries and **cultures**.

4.1. Development of feeding (eating)

Development of the skills to manipulate and keep foods or liquids in the mouth occurs according to the maturation of the oro-facial structures. The development of these skills is described by various authors, however, there are differences between children's abilities and dietary recommendations for children. For example, the World Health Organization (WHO) recommends exclusive breastfeeding until 6 months of age, but children may be able to eat other pureed foods earlier, since the development of oro-facial structures allows it.

The following is a summary of the main milestones and their age of acquisition (Schuberth L, Amirault L, Case-Smith J., 2010; Román Sánchez J, Sánchez S, Secadas F., 1997; WHO, 2010):

- 6-8 months: children are able to hold a bottle with both hands and drink. They can also hold a cookie in their hand(s) and bring it to their mouth. If presented with a spoon, they can pick up puree on the spoon.
- 9-12 months: they are able to eat soft food with their fingers (cooked ham, omelette).
- From 12 months: they begin to pick up spoons and bring it to their mouth. They grasp it in **palmar pincer grasp** and **pronation** of the hand, and gradually move to **tridigital pincer grasp**. Complete spoon handling (good grasp and no spilling) is established at around 3 years of age.
- 24 months: they drink alone from a normal cup (without lid or spout), although they pick it up with both hands.
- Between 24 and 30 months, they show interest in forks.
- 3 years. They handle spoons and forks and begin to use a (blunt) knife to cut omelettes, fish, etc.
- 4-5 years. They are able to spread butter or cocoa butter on bread.
- 6 years. They use a knife to cut meat.

4.2. Dressing-undressing development

Dressing and undressing is an activity that children begin to participate in from a very early age, starting simply by taking their socks off as a game, standing still or stretching out their arms to put on a jacket.

The different skills are acquired naturally little by little, but it is essential to give children the opportunity to do it alone. Rushing before going to school can mean parents not allowing children the space to do it by themselves, and therefore delay the acquisition of these skills.

The sequence of acquisition of the different milestones on the way to independence are as follows (Romero Ayuso DM, 2006; Romero Ayuso DM, 2006 (bis); Bluma S, Sherer, M., Frohman, A. and Hilliard, J., 1978; Mulligan S., 2006; Secadas F., 2009; Shepherd J., 2010):

- From the age of one, they cooperate by putting arms through sleeves and stretching legs. They can take off their shoes and socks, although only as part of a game (they enjoy taking them off).
- At two years old, they are able to pull down zippers, take off a coat if it is unbuttoned, undo Velcro-type fasteners, help pull up their pants, and are able to identify where to put their arms in shirts.
- At 3 years old, they put on socks (wrong heel), shoes (on wrong foot), and reach into sleeves without help. They need help to take off a sweater or T-shirt, and to button on the front (school gown). They can hook, unhook and use zips.
- Undressing is learned before dressing.
- 3 and a half years old. They handle hooks, untie bows and belts, put on gloves, shirts and coats.

- 6 years. They button almost everything, and begin to tie laces. It is important to note that although at 6 they would already have the skills to tie laces, it is really difficult to find children's shoes on the market with laces; they have been replaced by elastic bands, Velcro, etc., which means that this skill is delayed until the need to wear laces arises.

Outside of this stage (0-6) there are still a few more tasks to be acquired in later childhood:

- Full dress-undressing at around 8-9 years of age, which includes taking clothes out of the closet and the ability to select appropriate clothing for the occasion.

4.3. Development of grooming

Personal hygiene is a complicated activity due to the large number of tasks it includes: face and hand hygiene, combing hair, nail care, tooth care, and nose care, among others; therefore, acquiring independence in this activity will also take longer than the 0-6 stage.

The following table (Table 1) shows the main milestones in the development of this activity (Bluma S, Sherer, M., Frohman, A. and Hilliard, J., 1978; Hanson M., 1979; Mulligan S., 2006; Romero Ayuso DM., 2006; Secadas F., 2009):

Table 1. Milestones in the development of the personal grooming activity.

Age (years)	Milestones
1.5	Turn on the mixer tap, and leave hands in the water jet
2	Wash and dry hands with help
3-4	Hand and face washing are taken for granted
3	Wipes nose with a handkerchief when reminded
4	Blows their nose with a handkerchief when reminded
6	Brushes teeth without supervision (learning this requires many skills that are acquired from the age of 3 onwards)
7-8	Combs their own hair without help and can make a ponytail
9	Begins nailcare using nail clippers.

It is important to note again that for children to achieve autonomy, they must gradually participate in the tasks, going through phases in which the caregiver has to redo the task. Children will wash their hands, but the result will not be entirely good, and adults will think that they have to wash them again. But it is important for them to do it on their own, even if they do it badly, so that they can gradually improve their skills and abilities.

Bathing/showering development

Bathing and showering are an activity in which the child's participation is greatly delayed due to the dangers involved.

In the first few babies are usually bathed instead of being showered. If a home has a shower rather than a bath, babies are usually bathed in basins or sinks. Therefore, children have no role in this activity until 6 months of age, at which time they begin to participate, at most, by remaining seated. However, in accordance with what we have mentioned in the previous topic, although children aged between 6 and 9 months are able to remain seated without support, extreme care is taken in the bath to provide physical help to avoid accidents. Hence it is a little later on when children remain alone in a bath without physical help. Various products are available that offer this support and can help the baby to sit safely in the bath, such as small "potty" type chairs.

As children acquire a stable gait, parents stop using basins or other containers and the activity can be performed in the resources available in the house, whether the bath or shower. At this point, children help getting in and out of the bath or shower, with their parents' assistance.

The **physical environment** of the bathtub or shower again plays a crucial role in transfers, for example the presence of non-slip floors or bars for children to hold on to, are key points for parents to reduce the support they offer.

The following table (Table 2) describes the chronology of the most important tasks of this activity (Shepherd, 2010; Bluma S, Sherer, M., Frohman, A. and Hilliard, J. 1978):

Table 2. Milestones in the development of the bath-shower activity.

Age	Milestones
4 -5 years	They start to take responsibility: they lather the parts of his body that they can: arms, legs, belly, etc. Parents help with their back and hair. Begin to help in drying the body, but do not dry well at all, and parents have to redo part of the task.
8 years	Independent for bathing including hair washing and complete drying. Can prepare the bath water.

4.4. Bladder and bowel care development (sphincter control)

Until almost 24 months of age, it is the parents who control children's **sphincters**, limiting themselves to performing necessary diaper changes. However, from 18 months of age, children begin to give signals about their bowel or bladder needs, with gestures or words.

Bowel control is acquired earlier than bladder control, at around 18 months.

Bladder control is more difficult and there is great variability in the age of acquisition. In addition, there is evidence that girls acquire bladder control up to 6 months earlier than boys. Trying to give some age, 50% of boys and girls have daytime sphincter control at the age of two and a half years, and at night 80% have it at the age of 3 and a half years. However, the remaining 20% do not acquire nocturnal control until the age of 6 years.

As a final thought, there is evidence that putting children on the potty before 15 months of age has an influence on reaching bladder control earlier.

(Romero Ayuso DM, 2006; Marugán de Miguelsanz J, Lapeña López de Armentia S, Rodríguez Fernández L, et al., 1996; Schum TR, Kolb TM, McAuliffe TL, et al., 2002; Sesa S, Frassoni A, Sabulsky J, et al., 2001; Secadas F., 2009).

4.5. Toilet hygiene development

Toilet hygiene refers to children's ability, not only to clean themselves after urinating or defecating, but also involves handling clothes (putting them on and taking them off), being able to sit alone on the toilet bowl, flushing the toilet and washing their hands, hence it involves other activities such as dressing and personal hygiene.

The most important milestones in the 0-6 years stage are as follows (Romero Ayuso DM, 2006; Schum TR, Kolb TM, McAuliffe TL, et al., 2002; Bluma S, Sherer, M., Frohman, A. and Hilliard, J., 1978):

- Between 2.5 and 3 years of age, they begin to wipe only their "bottom".
- At 3 years of age, boys urinate standing up in the toilet and pull down and pull up their pants if they do not have buttons.
- Between the ages of 3 and 5, they begin to be able to flush the toilet. This variability depends on the flushing system, as sometimes force is needed, and even if children can reach, they may not be able to squeeze hard enough.
- Between 4 and 5 years of age, they are able to clean themselves properly after defecating. Using wet wipes makes it easier for them to clean themselves properly.

Summary

This topic addressed the concepts of autonomy and independence, as well as activities of daily living, it considered the role that environments and contexts play in the development of both, and reviewed the main developmental milestones in the acquisition of independence in basic activities of daily living in the period from 0 to 6 years of age.

Glossary

ADLS: Activities of daily living.

Culture: Set of beliefs, ideas, customs, traditions of a region, social class or time.

Physical environment: It is the strictly material and tangible part that surrounds the human being.

Sphincters: ring-shaped muscles that close and open certain natural ducts of the body such as the bladder sphincter (which regulates the opening and closing of the bladder) and the anal sphincter (which regulates the opening and closing of the rectum).

Palmar pincer grasp: grip with the whole hand.

Tridigital pincer grasp: grip with three fingers, as for example to pick up a fork.

Pronation: position of the forearm, with the palm of the hand downward.

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Comprehension questions

Answer (true answer is in bold)

Question 1. The basic activities of daily living are those which:

a) Acquired beyond the second childhood
b) **Relate to self-care and basic needs**
c) Include, among others, dressing and undressing and shopping.
d) All of the above.

Question 2. In the development of independence in daily activities:

a) The family can be a barrier to development if it does not provide opportunities for the child to be independent.
b) The characteristics of the objects and spaces where daily life activities take place can be a barrier.
c) The social group and culture to which the child belongs influence daily activities
d) **All of the above**

Question 3. The acquisition of independence in the activity of eating-feeding is completed at the age of:

a) 3 years
b) 4 years.
c) 5 years.
d) **6 years.**

Question 4. Regarding sphincter control:

a) Girls gain control before boys do.
b) Sitting the child on the potty is associated with earlier acquisition of sphincter control.
c) 20% of children without pathologies, acquire at 6 years of age in nocturnal bladder control.
d) **All of the above.**

Question 5. At 4-5 years, in bathing/showering, the child:

a) Begins to take responsibility: soaps up the body parts he/she reaches.
b) Parents help with back and hair.
c) Begins to help with body drying
d) **All of the above.**

Question 6. Acquisition of all tasks related to grooming is achieved by the age of:

a) a) 6 years.
b) b) 7 years.
c) c) 8 years.
d) **d) 9 years.**

MODULE VII.1 EARLY CARE AND INTELLIGENT RESOURCES APPLICATION: INTERNET OF THINGS AND ARTIFICIAL INTELLIGENCE

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I. INTRODUCTION

This module presents the main aspects of the Internet of things and artificial intelligence concepts. Both disciplines, that are independent, can be used together thus one can benefit from the other in some aspects of the human being's life.

In more detail, this module explains what these concepts are, some applications to healthcare and how their use can be beneficial for therapists and patients. More specifically, their use will be explained and their applications to early care.

II. OBJECTIVES

1. What Internet of things (IoT) is and its applications to early care.
2. To know the applications and uses of the Artificial Intelligence (AI) to early care.

III. SPECIFIC CONTENTS OF THE MODULE

1. Internet of things (IoT)

Internet of things, **IoT** hereinafter, is an emergent topic that has been evolving since more than two decades and it has a great relevance in the societies and consumers.

The **IoT** term usually refers to those scenarios where the connectivity and the computation capabilities extend to objects, sensors, and elements that are not usually considered computers. This makes possible to these devices to produce, interchange, and consume data with a minimal human interference (Rose et al., 2015).

1.1. History of Internet of things

Even though **IoT** was initially proposed in 1999 by Kevin Ashton to refer to those systems in which the real-life objects can be connected to Internet by sensors (Li et al., 2015), it was not until the new century when the miniaturization and the costs production cut made possible that this technology took off.

Although **IoT** term is, indeed, relatively recent it is not novel the task, since in the end of seventies decade existed ad-hoc equipment able to remotely monitor the electric network. In the following years, advances in the technology made possible that solutions called "machine-to-machine" (M2M) got popular. However, these technologies usually depended on proprietary communication networks (without specific standards). The broad adoption of Internet Protocol (**IP**) for the communications set the basis of what nowadays is called Internet of things (Rose et al., 2015).

1.2. Reasons that explain IoT popularity

In general, several factors have made possible that **IoT** has gained so much relevance along the last years. The confluence of technological advances and market trends made possible the connection of small devices in a cheap, fast, and easy way:

- Ubiquitous connectivity: high-speed and low-cost network connectivity makes possible that everything can be connected to networks (via the Internet).
- Widespread adoption of **IP**: the Internet Protocol has become the standard for networking, it provides solutions that can be incorporated into a broad range of devices in an easy and affordable way.
- Computing economics: the development of manufacturing of electronic equipment confirms the Moore's law, offering great computing power at lower price and consumption.
- Miniaturization: the miniaturization of electronic equipment makes possible to incorporate devices in almost everything, since household appliances to clothes.
- Advances in Data Analysis: it is closely related with the 3.2 section of the present document, the fast increase in computing power, storing, the development of new algorithms, among others, offer new opportunities for the analysis and exploitation of data.
- Cloud computing: the rise of cloud computing is unstoppable nowadays. Cloud computing consists in delegating expensive computation (hardly affordable by a small-size devices) to huge data centres. This makes possible for small devices to be responsible only for gathering data instead of the analysis of data.

1.3. Communications models of IoT

As it was previously explained, the basis and the fundaments of the **IoT** devices are how they communicate each other. In March 2015, the *Internet Architecture Board (*IAB) published a document that serves as a guide for the device networks and/or intelligent elements (RFC 7452), in the document four models used for **IoT** devices are published. Below are briefly explained each of them:

- Device-to-device: in this communication, the devices are connected each other without any intermediary (such as a server, for example). An example of this communication is Bluetooth technology.
- Device-to-cloud: in this case the devices are connected to a server that is on the Internet and it is the server the responsible of the communication between them. In this case, traditional networks (such as Wi-Fi) and standard protocols (such as **IP**) are commonly used. An example could be an intelligent thermostat.
- Device-to-gateway: it is similar, in some aspects, with the previous but in this case the devices are connected to a local gateway (via Bluetooth, for example) and it is the gateway itself which connects with the application service in the cloud (via **IP** for example).
- *Back-end data-sharing*: it can be seen as a more modularized device-to-cloud. In this case, the device connects with a service on cloud that interchanges information and uses services of the other providers on the cloud. In this case, the data of the user/device are shared with third parties for its analysis.

1.4. IoT applied to healthcare

The architecture of **IoT** devices applied to healthcare consists basically in three layers: capture layer, network layer, and application layer (Kelly et al., 2020; Sethi & Sarangi, 2017).

- Perception layer: as it was previously explained, the perception and identification technologies are the basis of IoT. Sensors are those devices able to capture changes on the environment, such as infrared, **GPS**, medical sensors...

- Network layer: data gathered by sensors must be shared between devices and/or applications. These data can be locally stored or uploaded to the cloud depending on the specific application. Examples of networks are *Bluetooth*, Wi-Fi, Zigbee, among others.
- Application layer: this layer is the one in charge of interpreting data, being the responsible of giving the processed data to user. Is in this point where **IoT** and **AI** are mutually benefited. The **AI** is able to process data (including those gathered by **IoT** devices or stored in medical databases), contextualize them, and give answers to the questions that arise in medical context.

An exhaustive compilation of **IoT** applications applied to healthcare is out of the scape of this document, for more information we recommend the following publications (Scarpato et al., 2017; Mishra & Rasool, 2019).

1.5. IoT applications to early care

As it has previously noted, regarding healthcare, the main objective of **IoT** for medical personnel and therapists is to provide a low-cost user experience and to improve the quality live of the patients (Islam et al., 2015). The **IoT** technologies provide connectivity to medical devices and services of healthcare reliable, effective, and intelligent (Nazir et al., 2019). Whereas **IoT** devices have been broadly accepted and popularized, and also, they are impacting gradually in how children and teenagers play, learn, and grow (Ling et al., 2022), the use an application of **IoT** technologies in early care is still scarce and almost inexistent.

One of the few applications of **IoT** related with early care was proposed by (de Vicente et al., 2016) in which they provide a new model of "Internet of toys" that aims to improve the health of children, strengthening the prevention and the attention disorder in childhood development. These toys have a spatial location system based on radio frequency identification (**RFiD**). Nevertheless, the **IoT** technologies have a great potential on early care such as the study of (Xing-Rong et al., 2021) highlighted. In it, they identify a group (*cluster*) of scientific papers that suggest that the promotion of the practice of smart education is needed to consider the students' attitude and the fathers and mothers ones, in the same way that it must be considered the early care of boys and girls.

2. Artificial Intelligence

The Artificial Intelligence (AI) is defined as the study of the computational methods that can make possible to sensing, reasoning, and acting (Winston, 1984). In a broader sense, it is usually assumed that **AI** studies the processes that make possible to computers to have behaviours that are observed in the human intelligence (Maddox et al., 2019). In general, it is considered that the main purpose of **AI** is to develop conceptual models, formal rewriting procedures of these models, and to develop programming strategies and physical machines that reproduce cognitive tasks of the biological systems that we consider intelligent (Mira & Delgado, 1995). In the last decade, the **AI** advances have overcome the humans in several tasks that were commonly assumed as intractable. The advances of the last times in the field have been reached thanks to the exponential increase of the available information (huge datasets to learn), combined with new algorithms and optimizations (Došilović et al., 2018).

A common problem of some **AI** methods and algorithms is their interpretability and their lack of transparency (Markus et al., 2021). Frequently, the best methods (the ones that achieve the best accuracy) perform as black boxes which for an input offers an output/prediction, but it is extremely hard or even difficult to determine how the system has found the solution. Because of this, the explainable **AI** is gaining special interest in the community, especially when these methods are used in medical issues and related with healthcare. For methods' interpretability and explainability two groups are usually found: integrated interpretability (based on transparency) and post-hoc (Došilović et al., 2018).

- Integrated (transparency-based): it is based in transparency, that is one of the features that makes possible the interpretability. Some models, such as decision trees, can be interpreted by themselves, but unfortunately other more complex methods (usually the ones that achieve the best results, such as neural networks or ensembles) are hard to understand.

- *Post-hoc*: it is based in interpretability, extracting information from trained models. These methods do not depend on how the model performs internally. The advantage of these methods is that they use the models already trained and treat them as black boxes. They offer predictions or explanations about how the method works by using other forms such as plots, text, examples... In this way, a single decision tree can offer a summary of how the predictions are being performed by models much more complex, as for example support vector machines (**SVM**).

2.1. Machine learning

Into the **AI** discipline, the machine learning (**ML**) is a subdiscipline that, using big datasets, can identify patterns between the input variables (Noorbakhsh-Sabet et al., 2019). Inside **ML** three groups are usually stablished: supervised learning, unsupervised learning, and reinforce learning. Datasets of supervised learning have several input variables and one (or more) output/target variable, its aim is to identify the relation between input variables and the output one for predicting the target variable of a never seen before instance/example. On the other hand, unsupervised learning datasets do not have any target variable, thus the aim of unsupervised learning is to find associations or hidden patterns between the examples of the dataset. Finally, reinforcement learning is inspired in conductist learning and tries to identify the actions that an agent must choose for maximizing its benefit or reward.

2.2. Artificial Intelligence healthcare related

AI is changing healthcare systems in several ways, the development that is suffering has been fostering by the huge data available and the application of new and more accurate methods (Schwalbe & Wahl, 2020). There is a myriad of **AI** applications healthcare related, focusing only on **ML**: the most common tasks of supervised learning are classification (predict the output variable of a certain categories) and regression (predict the output variable when this is numeric/continuous). Examples of supervised learning include cancer prediction from X-rays, anticoagulation therapy models, strokes damage identification... Regarding unsupervised learning, clustering is the task most popular. This can be used for profiling drug for patients.

2.3. Applications of AI to early care

AI can be applied in many aspects related with early care, since policy development to specific applications. Nevertheless, early care applications are still scarce (Sierra et al., 2022). In (Park & Hassairi, 2021) proposed how the machine learning can help to the development of education policies focusing on childhood, more specifically, early care. In their study, they analyse massive legal political documents on education in the USA for identifying those aspects more relevant for conducting education policies.

Recently, (Sierra et al., 2022) presented a proof-of-concept in early care that includes several **ML** algorithms. Their study tries to help, by comparing several algorithms, to the diagnosis and assignation of therapy and treatment on below 6 years-old children. The study was conducted on San Juan de Dios hospital, Sevilla (Spain). One of the most difficult tasks was the natural language processing (NLP) for extracting features from clinical history with which train the **AI** models.

Summary

This module has presented two concepts: Internet of things and Artificial Intelligence, that makes possible to understand how them work and their applications to early care.

Glossary

GPS: Global Positioning System.

AI: Artificial Intelligence.

IoT: Internet of things.

IP: Internet protocol.

ML: Machine learning.

RFiD: Radio frequency identification.

SVM: Support Vector Machine.

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RFC 7452

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Comprehension questions

Answer (true answer is in bold)

Question 1. Which one of the following definitions of Internet of Things (IoT) is more appropriate?

a) IoT aims at manufacturing small computers.
b) **IoT aims at incorporating computing capabilities to objects of daily use.**
c) IoT is based on isolated devices that are not connected together.
d) IoT emerged for giving an answer to big mainframes.

Question 2. Some of the success reasons for IoT are:

a) The popularity of smartphones.
b) The cost increase of cloud computing.
c) The inherent decentralization of networks such as Internet.
d) **The cost reduction of processors and their miniaturization.**

Question 3. Which one of the following networks/protocols is not frequent on IoT?

a) Bluetooth
b) **Frame Relay**
c) Internet Protocol
d) WiFi

Question 4. In machine learning, which one of the following is not a common task?

a) **Intelligent learning**
b) Reinforcement learning
c) Supervised learning
d) Unsupervised learning

Question 5. Identify which one of the following artificial intelligence applications on health is not properly matched:

a) Clustering -> Identify profiles on patients for treatments.
b) Regression -> Determine the drug dose that must be given to a patient.
c) Classification -> Identify damaged tissues from scanner images or CT scan.
d) **Classification -> To cluster patients for determining the fever that they will suffer from a patology.**

MODULE VII.2 EARLY CARE AND APPLICATION OF SMART RESOURCES: INTELLIGENT PERSONAL ASSISTANTS

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I. INTRODUCTION

This module introduces the concept and use of bots or intelligent personal assistants. Given the technological advances in artificial intelligence, networks and cloud computing, the use of conversational assistants that simulate people, helping us in everyday tasks such as managing the agenda, shopping, etc., is emerging.

Specifically, the fundamental concepts of bots will be reviewed, as well as their more particular applications in healthcare, finally pointing out their future applications in early care.

II. OBJECTIVES

The basic objectives of the following sub-module are as follows:

- To introduce its history and the concept of bot or intelligent personal assistant.
- To explain the different characteristics of bots.
- To detail the aspects or components of a bot and current solutions.
- To review their possible practical applications in healthcare.

III. SPECIFIC CONTENTS OF THE SUBJECT

1. Bots or intelligent personal assistants

Nowadays, the use of **bots** or **Intelligent Personal Assistants** (**IPA**) is becoming **widespread** in **all areas**, providing multiple types of services, from resolving doubts, searches, recommendation services, agenda management, booking and purchasing tickets, etc.

1.1. Foundations and historical precedents

Its theoretical foundation is based on the **Turing Test**, developed by Alan Turing in the 1950's. In simple terms, this test proposes that the computer must show "intelligent" behavior, such that it could deceive another human interlocutor in a conversation by pretending to be another human being. Once this is achieved, the Turing Test would be passed.

In 1966, Joseph Weizenbaum developed ELIZA for the IBM 7094. It was a psychotherapy bot that dealt with patients about their problems, generating strong emotional reactions, even though they were aware that they were dealing with a bot. The program analyzed keywords and based its response on them, and was probably the first program to pass the Turing Test.

A later step in this branch was the appearance of PARRY, a conversational agent simulating a paranoid patient with schizophrenia (Colby, 1975). These are the first examples of valid application to health issues, surpassing the Turing Test.

The proliferation and development of conversational agents receives a boost that is reflected in the creation of **competitions**. The Loebner Award is established as an annual platform for conversational bot competition. ALICE (Artificial Linguistic Internet Computer Entity) gains great attention in 1995, winning the award three times (2000, 2001 and 2004).

In 2010, Siri emerged as Apple's **commercial** solution integrated into its mobile devices, followed by Google Now in 2012, Alexa (Amazon) in 2014 and Cortana (Microsoft) in 2014. In 2016, a final hatching occurs with the integration of bots in social networks such as Facebook with its own messaging platform, which would be joined by API.ai, LinkedIn, Viber, etc. developments.

In more recent times, Amazon created its own competition - "Alexa Prize" in 2017 - with an approach similar to the Turing Test. The challenge is to create a "social bot" that converses coherently and engages a human, conversing on a topic for 20 minutes. The current benchmark is four-time Loebner Prize winner Mitsuku (Prize L, 2019).

In recent times, the application of these conversational bots in the health field has gained a lot of weight with situations such as the COVID-19 pandemic. As an example, in 2020 WhatsApp agreed with the World Health Organization (WHO) to complete a chatbot service to answer questions related to COVID-19. Although not exempt this type of solutions from risks and malicious uses, which have forced organizations such as UNICEF to define guidelines for good use and implementation (UNICEF, 2022a; UNICEF 2022b).

2. Definitions

A bot exposes software services through a conversational interface. These bots can be referred to as chatbots, conversational agents, conversational interfaces, intelligent personal assistants, and in many other ways, depending also on the interface used with the user (Shevat, 2017).

The concept of "**conversation**" is vital. Often in these bots, conversations are considered a single interaction (question/answer) (e.g. setting an alarm, checking the temperature or weather forecast, making a call, etc.) when in the real world, humans understand conversation to be a longer exchange of questions/answers that are related to each other. Although bots can also have long conversations on one topic, with several question/answer exchanges.

In the following Figure 1, an example of a simple conversation with a text-based chatbot, usually referred to as chatbots, is shown as an example of the expected operation. On the left are the automatically generated interactions of the software. On the right are the questions asked by a person. Without precise information, it should be indistinguishable whether the bot messages are generated by a program or by another person.

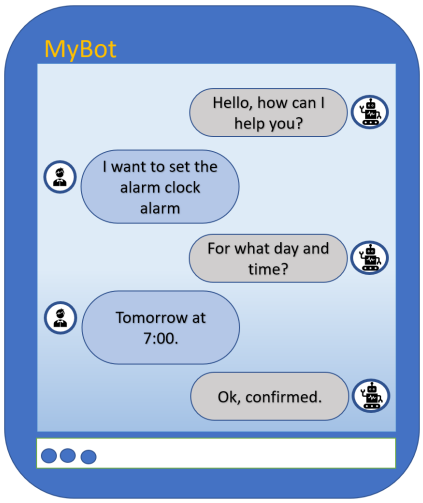

Figure 1. Example of interaction with a bot (Image: own elaboration)

The bot must be distinguished from the service it provides. The bot is only a means or interface to the service. Although this interface can be more or less complex.

Advantages of its use:

- Increased user engagement (loyalty) by making it easier for users to perform their tasks.
- Ease of use vs. web interfaces and mobile apps.

Disadvantages of its use:

- They are not the solution to every type of problem posed (at present).
- Fear of some risk of loss of privacy.
- With voice-based interfaces, there is a certain amount of social shaming.

2.1. Most common use cases

In practice, the most common successful use cases are:

- Productivity and training (coaching): focused on remembering tasks to perform, and management of personal or group tasks to complete. Also to help to follow diets, manage expenses, perform sports activities, etc.
- Alerts and notifications: replacing the use of email and notification apps. They can work with groups in a more productive way.
- Router to humans: finally redirects to a human interlocutor, but assigning the best person for the resolution, by means of a guided conversation.
- Customer services and answers to frequently asked questions: in support of the most common and recurring questions.
- Third-party integration: to integrate third-party services into the current product.
- Games and entertainment: with the basic objective to entertain and amuse.

Starting from these cases, we will identify different typologies.

3. Typology

By target:

- **Personal bot / private** bot**:** serves as a personal assistant, in a one-to-one conversation (e.g. setting an appointment in my personal calendar).
- **Team** bot**:** assists a group of people to achieve an objective (e.g. setting a meeting date and time for a group).

In practice, the personal model is more widespread for simplicity, and even in home bots, with devices such as Amazon Echo or Google Home, all users in the same household are treated without distinction, as if they were the same person.

By scope:

- **Domain-specific:** exposes a single service (product, brand or target).
- **Super bot**: exposes multiple services at the same time.

In this last category we find solutions such as Google Assistant, Amazon Alexa, Apple Siri, etc. that encapsulate several services. They basically group different functionalities in a modular way, so that they can be augmented transparently to the user. These modular functionalities are often referred to as skills.

By aim:

- **Business**: facilitate a business task or process. The goal is to solve an objective. Task and workflow oriented.
- **Consumer**: entertain while facilitating a commercial interaction. Aimed at a better and entertaining user experience.

By access:

- **Text**: the conversation is based on text entered by keyboard and display of the response on screen. They are often referred to as chatbots (e.g. with web platforms that include them such as Slack, Facebook Telegram, WhatsApp, WeChat, etc.).
- **Voice**: the conversation is based on the use of audio to ask and return the answer without the need to physically interact with the devices (e.g. Amazon Alexa, Microsoft Cortana, Apple Siri, Google Assistat as the de facto standard).
- **Multimodal**: combine both elements discretely - text or voice - and may additionally require touch interaction on screens or the combined use of other devices or artifacts (e.g. cameras, watches, devices, wearables, etc.).

In this case, the access modes are not exclusive, and you can have a bot that can be accessed in all of the ways mentioned above.

By integration:

- **Legacy system**: service existing software systems by offering new ways of interacting with pre-existing services..
- **New bots:** interfaces to new services or products created from scratch.

3.1. Evaluation and selection criteria

When choosing an applied technological solution, certain characteristics must be taken into account:

- Target audience.
- Business vs. consumer.
- Form of interaction (text vs. voice vs. multimodal).
- Devices required to interact.
- Associated costs of software hosting and hardware purchase.

Depending on the previous criteria, with more social or economic issues in mind, not all bot solutions are valid.

4. Generic aspects

You should be aware that behind a bot there is basically a **software** running on hardware platforms that host such software.

Although in each technological platform the **vocabulary used** may vary, a summary of the most common vocabulary with the basic concepts in a bot is presented in Table 1 below (Note: the vocabulary of DialogFlow and Alexa are used as references).

Table 1. Basic vocabulary in the construction of a bot.

Element	Definition	Use
Intent	Objective (or intention) that a customer has when asking a question..	Intents are defined as an agglutinator of the different actions. When a question is asked, the **NLU** system searches for the closest intent.

Element	Definition	Use
Utterance	Literal phrase entered by the user.	A set of alternative sentences that are equivalent to resolve an intent are defined. The **NLU** system interprets and resolves the intent match.
Entity	Type of data that can be extracted from the user's message or utterance.	They are used as variables that can be defined and take different values, in order to perform customized actions based on those values.
Context	Similar to a context in a real conversation, defining variables that determine the evolution or path of the conversation.	They are used to define and establish more advanced conversations, where there may be different paths in the conversation.
Fallback	Default intent when the input has not been recognized.	In the event that the chatbot is unable to recognize the user's input, a typical response action should be set. Ideally the number of times a fallback is executed will be reduced as the chatbot is trained and improved.
Event	They trigger the execution of an intent automatically without requiring user input.	It allows the automation of actions, such as launching an initial question when the user enters the website containing the chatbot.

In Figure 2, we can see how training sentences would be defined for an intent to communicate the due dates of an academic assignment:

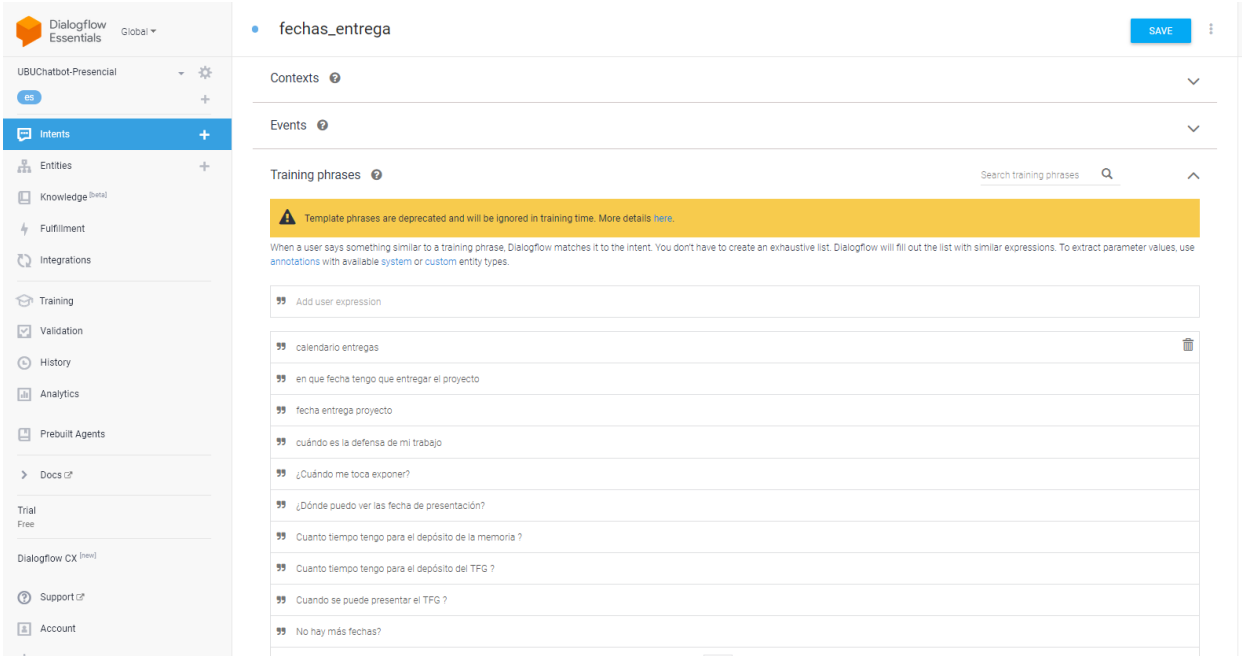

Figure 2. Definition of questions for an intent in DialogFlow

Once these training sentences have been set, the possible set of response sentences must also be set. In some cases, several equivalent responses are given, so that one is chosen randomly, giving the bot more variety. Or, as in the example in Figure 3, use more complex formats (i.e. JSON notation) to generate rich media content.

Figure 3. Enriched response for an intent in DialogFlow

As a result of the query to the bot, Figure 4 would show a screen presentation like the one shown below, where in addition to showing a plain text, a multimedia element is added, with a button as a hyperlink, which, once clicked, would open the content in a web browser:

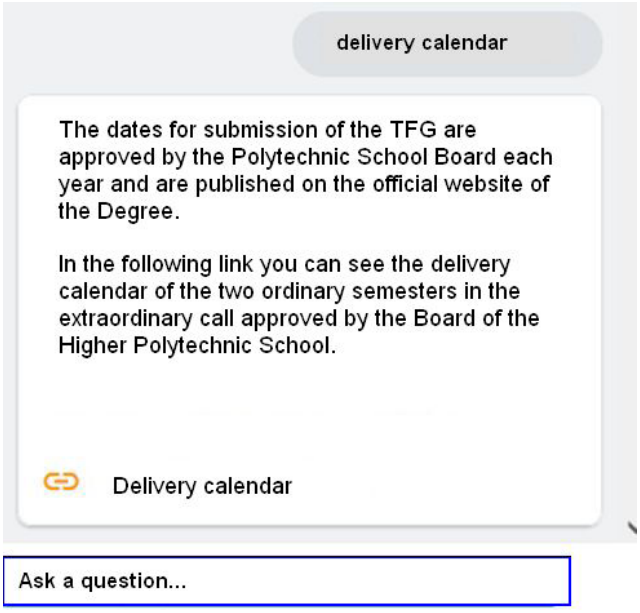

Figure 4. Chatbot display with rich content

Having presented the vocabulary and a basic example, other features are detailed:

- **User interaction style**: personality or tone with which it wants to communicate. The bot, as with people, must have its own recognisable personality, coherent over time.
- **Artificial intelligence**: fundamental basis of a bot that includes several elements.
  - Natural Language Processing (**NLP**): processes the sentence by analysing its structure.
  - Natural Language Understanding (**NLU**): extracts the meaning of the sentence, once its structure has been previously analysed.

  - Text To Speech (**TTS**): converts a text file to its corresponding sound.
  - Speech To Text (**STT**): it translates sound by generating the corresponding text.
  - Prediction models: models based on artificial intelligence techniques to predict the most appropriate response given a sentence. It associates the user's sentence (utterance) with the intention and the corresponding response.
  - Image recognition in multimodal systems: the analysis of the image and its recognition can make it possible to know what is in front of the camera (person) and what their state of mind is.
  - Conversation management: the system must manage the flow of questions and answers in an appropriate way, remembering the previous context, in order to reach the end of the conversation successfully.
  - Sentiment analysis: phrases can implicitly carry connotations that can vary their interpretation and the flow of conversation. For this purpose, sentiment analysis techniques are applied, weighing the positive, negative or neutral components of the sentence, affecting the subsequent response.

- **Conversation management:** how the conversation is managed, from the beginning to the achievement of the set objective.
  - Onboarding: how access to the bot is prepared, informing of its objectives and purpose, modes of interaction, functionality provided and how to get help.
  - Functional scripting: management of conversation flows or stories, trying to mitigate failure (loss of the optimal path or "happy path" in the conversation).
  - Feedback and error handling: enabling continuous improvement and a good user experience.
  - Help and support: in case of loss of the optimal conversation flow or "happy path".
- **Enriched interactions**: in bot using text-based interfaces, responses can be enriched with multimedia or web elements to help simplify the cognitive load of the conversation.
  - Files: uploading or downloading of files (e.g. work documents, shopping lists, etc.)
  - Audio
  - Video
  - Images, maps o charts.
  - Buttons: allows you to pre-set answers, speeding up the conversation.
  - Templates (platform-dependent)
  - Links
  - Text formatted with colours, styles, etc.
  - Emojis or reactions
  - Persistent menus
  - Typing indicators: to pretend that the bot is typing as if you were a human.
  - Commands: shortcuts with short commands to invoke actions in a similar way to text consoles.
  - Webviews: open a mini-view of a portion of a web page.
- **Context and memory**: remembering the previous context of the conversation, or recent conversations, which can completely change the flow of the current conversation. Humans do this naturally, but in the case of bots it is one of the most complex issues.
- **Discovery and installation**: making it easy to locate, download, install, and facilitate initial interaction.
- **Engagement methods:** methods to get the user to become a regular customer of the bot.

  - Notification of new content.
  - Guiding and assisting invocation: providing easy methods of initiating the conversation by teaching the user the process.
  - Subscription: allowing the user to define their interests, filter what they want, etc.
- **Monetisation:** generating revenue or other benefits from the use of the bot either directly or indirectly.

4.1. Conversation management: onboarding

A first issue is to prepare the user's **first contact** with the bot well, as a bad experience may mean that the user will not use it again.

The recommendations or heuristics to be followed are:

- State the purpose and context of the conversation: making it clear to the user or group of users. Present and introduce clearly what the bot does.
- Teach the user how to use the bot: explain how to interact with the bot, such as whether there is a way to activate it (e.g. wake word with voice-based interfaces), main functions, keywords or commands, etc.
- Configuration: request additional information from the user if required for the operation of the bot (e.g. preferences or customisation for the user).
- Prompt the user to get value from the bot: encourage or direct the first questions to start the conversation. Even providing an example of a simulated conversation.
- Establish the tone and personality of the bot: for consistency, the bot should maintain the same tone throughout the conversation. Ideally, it should have a "personality".
- Make the bot's entry into group conversations explicit: similar to introducing a new staff member, the bot should be introduced to everyone in an appropriate way. The bot should introduce itself to all members, announcing that it has joined.

4.2. Functional scripting

The conversation flow can be basically **task- or topic-driven**. In the first case, the aim is to find the optimal set of conversational interactions to find the goal (e.g. to book a ticket) or to complete a precise **task**.

A common way is to model the set of states and transitions that occur in the conversation. These are also called command-and-control systems.

Issues to consider in this type of bots are:

- In the responses, the possible set of responses can be closed in order to limit the conversation and achieve the optimal or **"happy path"**.
- If at some point the user does not give an expected input, a **divergent flow** is produced and **error handling** will have to be carried out.
- To extract information that may come in disorder, **entity extraction** is carried out. It consists of extracting elements (entities) from the question that have their own semantics to resolve the conversation flow.
- **Intent mapping and conversational control**: association between the different user inputs and the actions/responses to be given. While in classic graphical interfaces the user is given a closed set of menus, buttons, etc., in a bot it is offered in a different way. Either implicitly in the question itself or by closing a possible set of valid commands in the answer.
  - The possible actions that a user may require as a result of one or a set of possible inputs are called intents.

- **Shorthand**: if a context and memory of previous actions is maintained, questions can be shortened, using knowledge of the previous state.
- **Stories/flows**: allow branching and grouping of more common or repeating conversations (e.g. "user wants an unavailable product").
- **Conversation funnels**: as a user asks a question, the possible path of the conversation narrows. It is convenient to define these funnels to reduce the possible set of paths.

In **topic-driven flows**, the flow is less directed and even "circular" in character. Different aspects of a topic are talked about and discussed. They generally include more interactions than a task-driven bot, and their additional goal is to achieve a certain user engagement (e.g. a bot discussing a movie or series).

They are rather more complex to implement given their more abstract characteristics, applying the concepts already seen in task-driven bots (i.e. course correction, entity extraction, etc.).

4.3. Entity extraction

In a sentence (utterance), some of the terms used may have a certain special semantics, which can also condition the conversation later on. In the vocabulary of bots, this is called an **entity**, and it is very important that the bot is able to extract and remember them properly.

For example, let's say we ask:

"What is the temperature today in Madrid?"

In addition to answering the question, when analysing the sentence, entities of different nature can be detected, a concept to be solved such as **temperature**, a **date** with value "today" and a **city** or destination with value "Madrid". If subsequently the question were to be asked:

"And the forecast for the next few days?"

In this case the bot, if it has extracted the previous entities, no longer has to ask the user requesting additional information, since the question is no longer ambiguous, given that the initial time frame of reference was "today" and the city "Madrid", and we were asking for the concept of "temperature". Conversely, if the entities had not been extracted and stored in context, the bot would not have accurate information (i.e. it would have no memory of the thread of conversation), and would not know what we are talking about (e.g. forecast of what? on what dates? what place are we talking about? etc.).

Other typical examples are remembering or maintaining entities with requested quantities, favourite colours, ages, names, etc. in such a way that the conversation flows, remembering previous choices already made in the conversation thread.

4.4. Context and memory

In practice, many bots stick to the **question/answer** paradigm, for example in a simple FAQ resolution. For each new question, it starts from a new context, not remembering the previous conversation. However, for other types of conversations, it is necessary to remember the previously exchanged messages, which constitute a context.

Context

To apply the context, the intent and the set of entities previously associated in the conversation must be analysed. The associated variables can be global or long-term (e.g. relating to the user and previous conversations) or local to the conversation or short-term (e.g. day and time of booking, colour chosen, etc. in the current conversation).

When we move in the conversation to another intent, local variables may or may not be forgotten, depending on their usefulness, but global variables should not be forgotten.

Further inference of context through the use of pronouns must be resolved through **NLU** and is outside the scope of this module. Another way to infer context is through rich content that helps to capture intents.

Memory

It is a more general concept, relating to remembering intentions (intents) and entities, or even entire conversations from the more distant past, and is still under investigation.

4.5. Error handling

Mistakes in conversation are far more common than one would like. Both in real life, as well as what particularly occurs when conversing with a bot.

If you look at the logs of all conversations over time, you can see the variety of possible entries that do not lead to a successful conversation. Be it simple unintelligible texts, meaningless questions or utterances, sentences that are not connected to the previous conversation, even insults and the use of offensive, out-of-place language.

In addition, many of the phrases that should be recognised as valid in the early stages of bot configuration may not have been included to achieve the correct intent. In the face of possible errors and divergences in conversations, different measures can be taken:

- **Path correction**: this consists of redirecting the conversation to the optimal path (happy path), answering that the previous question cannot be resolved, but giving options to redirect the conversation with options that are contemplated. Or by indicating that a note is taken, and that it cannot be resolved now, but it can be resolved in the future.
- **Human intervention**: it is a common solution that when the conversation diverges so much from the path to success, a real person is redirected to continue the conversation and resolve it.
- **Restart the conversation**: this is the easiest solution, but it can be very annoying, generating a bad user experience.
- **Redirect to another bot**: not widely used at the moment, but given the modular architecture with modular applications (skills) of the predominant systems on the market, it will be common for bots to specialise and redirect requests from one to another (even raising the dilemma of the conversation between bots).

Other considerations in error handling are the consistency of responses throughout the conversation, showing a certain "character" or "personality" of the bot, which must be maintained in a coherent manner. In the same way that a human being would respond to the appearance of problems in a conversation, and not by generating numerical code or messages that cannot be interpreted by a person.

This process of error management and correction is not immediate, and must occur gradually, learning from mistakes made in the early stages. By reviewing the intentions that have failed, it will be possible to deduce and improve what goes wrong, **adjusting and refining the set of training sentences associated with an intent**. The process of growth and improvement of a bot is continuous, as is the learning process of a person.

5. Voice-based assistants

Advances in speech recognition (Speech to Text or **STT**) and text to speech (Text to Speech or **TTS**) over the last two decades have given a definite boost to the incorporation of speech-based interfaces as an additional element of bots. Figure 5 shows a typical early-generation assistant with integrated microphone and speaker, without a display.

Figure 5. Example of a conversational device for the home [Image: Unsplash licence - https://unsplash.com/)

Commercial examples of large companies supporting voice-based assistants that are common in everyday life are Amazon Alexa, Apple Siri, Google Assistant or Microsoft Cortana. However, we must differentiate between the concept of voice assistants (i.e. software generally integrated in the cloud), such as those mentioned above, and their corresponding "smart speakers" (or even more complex and multimodal devices) such as Amazon Echo, Google Home or Harman Kardon Invoke (for Cortana), which are still the physical means of access to the conversational agent (i.e. hardware).

From a practical point of view, the introduction of this voice-based interaction, both for asking and answering through this combination of software and hardware, adds some additional issues to consider.

Initially there are certain **advantages** in its use over the keyboard-based text input solution:

- Faster question issuance.
- Hands-free", leaving the user free to perform other actions while using the bot (and in a safer way).
- Intuitive: interaction with speech is very natural.
- Empathy: the inclusion of tone, volume, intonation and speed of speech add information that helps to better interpret the answer and avoid misunderstandings.

Additionally, the reduction of screens on wearable devices (e.g. phones, watches, bracelets, rings, etc.) invites the use of these interfaces.

On the other hand, they also offer certain disadvantages to consider in their use:

- Use in public spaces: speaking or raising your voice in public spaces can give a strange feeling to the other people around you. The problem is exacerbated if several people do this at the same time.
- Feeling uncomfortable talking to a computer.
- Ingrained habit of typing to interact with devices.
- Privacy: if you want to discuss sensitive issues (e.g. health) or listen in on private matters (e.g. reading messaging), you don't want anyone else to hear your conversation.

With regard to error handling, these interfaces raise additional issues to be addressed such as:

- No speech (i.e. the user does not ask a question for a certain period of time). The conversation can be terminated or the user can be asked again.
- Recognition problems (i.e. the sentence is not recognised even though it has been heard). Can be asked again.
- Intent handling problems (i.e. the sentence is recognised, but there is no appropriate programmed response or the wrong response is given) already present in text-based bots. Their resolution is more complex.

When designing purely voice-based interfaces, some additional issues have to be taken into account. From a conversation initiation point of view, one does not want the device to be continuously listening, for privacy reasons, and therefore there is the concept of a **wake word** that must be spoken by the user to explicitly initiate a conversation by activating the microphone.

On the other hand, responses should **not be excessively long**, as the cognitive load may exceed the user's capacity. In multimodal systems this is additionally solved by relying on the presentation of information on the screen, but this is not always possible and must be considered when giving certain answers.

6. Technology solutions for personal assistants

The following is a review of current solutions, both from the four major technology leaders, in terms of the use of **conversational bots** as well as other platforms that allow the integration of bots. We address both text and voice solutions (with integrated microphone and speaker), and multimodal solutions combining images, hyperlinks, etc., provided that the associated device also has a smaller or larger screen.

Alexa Amazon

Based on Amazon's online ecosystem, it is one of the benchmarks in recent years, having one of the largest cloud computing infrastructures behind it. It is an agglutinator of functionalities called skills. By adding more or fewer skills to Alexa, the user obtains more or fewer functionalities and types of conversations. With a focus on home automation and control of devices in the home, it is one of the current benchmarks.

Associated physical devices: Amazon Echo, Amazon Dot or Amazon Echo Show, etc.

Apple Siri

First precedent in conversational agents, integrated into iPhones. However, its more closed and high-cost philosophy, common in Apple products, hinders integration with third parties and its wider diffusion.

Associated physical devices: iPhone.

Google Assistant

It is Google's solution for conversational agents, building on all its previous experience in text-based search engines such as Google. The support of Android devices, which are currently very widespread, gives a strong boost to this solution, also associated with lower costs. It follows a similar skills architecture to Amazon Alexa. Also, with a certain orientation towards home automation and control of devices in the home.

Associated physical devices: Google Nest, Nest Mini, Nest Audio, Nest Hub Max, etc.

Microsoft Cortana

Microsoft product to compete directly with Amazon Alexa and Google Asssistant. Its possible abandonment in the next few years suggests that it will not be better supported in the future. Its fundamental (although not exclusive) link to Microsoft platforms (e.g. Windows 10 on computers) and Microsoft's lack of success on mobiles has meant that it is less widely used. Future integration with more successful Microsoft 365 products such as Outlook or Teams is expected.

*Associated physical device*s: Harman Kardon Invoke and Surface Headphones.

Table 2. Conversational agents shows a summary of the four assistants that currently constitute the de facto standard.

Table 2. Conversational agents

Assistant	*Company*	*Starting date*	*Referring device*	*Wake word*
Alexa	Amazon	November 2014	Echo	"Alexa"
Siri	Apple	October 2011	iPhone	"Siri"
Assistant	Google	May 2016	Nest	"Ok Google" "Hey Google"
Cortana	Microsoft	January 2015	PC Windows 10	"Hey Cortana"

Along with the four big dominators, there are other platforms that allow the development and integration of bots, usually referred to in this branch as chatbots, and in some cases also partially linked to these four companies. Table 3 below lists, but is not exhaustive, some of the best-known examples.

Table 3. Chatbots development platforms

Product	Description	Features
Amazon Lex	Amazon product for the development of chatbots.	It uses the same **NLU** engine as Alexa, but incurs costs after the second year of implementation, due to the use of Amazon's platform.
Chatcompose	Chatbots platform for marketing and support.	Offers a live chat option, allowing the inclusion of human agents in the conversion. Limited number of chatbots in the free version.
Chatfuel	Integration of chatbots.	Only Facebook Messenger and Instagram integration is available.
DialogFlow	Google product for the development of chatbots.	Simplicity in its use and free of charge. Unlimited chatbots and with an intuitive graphical interface for creation.
Microsoft Bot Framewework	Also known as Azure Bot Service. Microsoft solution for the creation and integration of chatbots.	Offers integration into the Microsoft ecosystem with Office and Teams. With certain limitations in the free version.
Rasa	Open source framework for machine learning and chatbots creation.	Developed in Python, with a high learning curve, without cloud hosting and in its free version without graphical interface.
Watson Assistant	IBM product for the development of chatbots.	Focus on more complex developments, with more complex conversational models.

7. Practical applications in health

Based on the study by (Car et al., 2020), the objective of its application is **to improve accessibility, personalisation and efficiency in patient care through bots.** Their inclusion as an emerging technology should always be carried out with this objective in mind, to improve treatment, and not simply for the sake of introducing an additional technological element. This paper reviews works on databases such as MEDLINE, EMBASE, PubMed, Scopus and Cochrane Central, focusing on the use of terms such as chatbots, conversational agents, conversational **AI**, etc.

While there is already precedent in the literature for the use of text messages and SMSs as a tool for mental and physical health treatment (Hall et al., 2015; Rathbone & Prescott, 2017), these have been replaced by more modern web-based solutions, integrated into mobile apps or with more advanced voice interfaces. In particular, **mobile phones (smart phones)**, as ubiquitous devices in widespread use, have massively become the object of study for their application in therapeutic intervention.

On the other hand, advances in artificial intelligence are giving a boost to much more advanced bots. Applied to coaching (virtual coaches), personalised personal agents or specific applications for the control of behavioural changes (Car et al., 2020).

In health, the main lines of application in recent years are:

- Treatment and monitoring.
- Support to health services.
- Patient education.

In such contexts, jobs tend to be more oriented towards **topic-oriented conversations** rather than tasks, and work on the patient rather than the professional. Applications with a text interface tend to be more common than the use of voice. Only in the particular context of older people, due to sight and mobility problems, the use of voice is more widespread.

On the other hand, its use on the web favours its use and reduces abandonment, compared to its use with mobile apps, which makes incorporation or onboarding more difficult, with the exception of widespread messaging apps such as Facebook, Messenger, Telegram, Whatsapp, etc.

In (Car et al., 2020), although recognising the wide range of fields in which it is applied in health, some particular fields are highlighted, such as:

- Mental health (Abd-Alrazaq et al., 2020; Bérubé et al., 2021; Piette et al., 2013).
- Neurodegeneration (Li et al., 2020; Rahman et al., 2021).
- Obesity and diabetes (Steinberg et al., 2014).
- Sexual health (Bauermeister et al., 2017).

Although other lines of application are also in their infancy:

- Primary care (Lee et al., 2021; Fan et al., 2021; Schario et al., 2022).
- Cardiology (Nahar & Lopez-Jimenez, 2022).
- Coaching for adolescents (Gabrielli et al., 2020).
- Dermatology.
- Disability (Masina et al., 2020).
- Nursing (education) (Shorey et al., 2019).
- Cardiovascular diseases (Kowalska et al., 2020).
- Kidney diseases (Fink et al., 2016).
- Pulmonary diseases (Gross et al., 2020; Kim et al., 2021).
- Geriatric (Gudala et al., 2022; Bennion et al., 2020).
- Stress management (Mauriello et al., 2021).
- Obstetrics (Chung et al., 2021).
- Oncology (Bibault et al., 2019; Greer at al., 2019; Chaix et al., 2019; Greer et al., 2019; Hong et al., 2021).
- Orthopaedics (Bian et al., 2020).
- Paediatrics (Wong et al., 2021; Espinoza et al., 2020).
- Vaccination (Ferrand et al., 2020; Wijesundara et al., 2020).

From the perspective of early childhood education it has been approached with the use of *PopBots* (Crompton et al., 2018; Williams et al., 2019). But from a point of view closer to industrial robotics with which they interact in a constructivist way, with Lego elements, sensors, motors, tablets and mobile apps, not in a conversational and patient-oriented sense. However, in the more specific area of **early care**, the application of this type of technology is still scarce, more from the point of view of **assisting the therapist**, and therefore there is a whole line of research open in the future on the use of conversational bots in this field.

Summary

The module sets out with the basic elements to understand what botsare (as intelligent personal assistants) and how they work at an abstract level. It also shows their possible use and usefulness in the field of health, and points to their future applications in **early care**.

Glosary

AI: Artificial Intelligence

IPA: Intelligent Personal Assistant

NLP: Natural Language Processing

NLU: Natural Language Understanding

TTS: Text To Speech

STT: Speech To Text

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Comprehension questions

Answer (true answer is in bold)

Question 1. The Turing Test was defined in:

a) The 1980s
b) The 1970s
c) The 1960s
d) **The 1950s**

Question 2. Which of the following is NOT a known bot in Turing Test competitions?

a) PARRY.
b) ALICE.
c) **HAL.**
d) Mitsuku.

Question 3. A bot is...

a) Hardware with a conversational interface.
b) **Software with conversational interface.**
c) Physically interacting robot.
d) All of the above.

Question 4. Which of the following is a common use case for a bot?

a) Inserting product entries in a warehouse.
b) **Closing an appointment in a diary.**
c) Changing a piece of machinery.
d) Performing a surgery operation.

Question 5. The interfaces of a bot are currently NOT:

a) **Haptic.**
b) Textual.
c) Audio.
d) Multimedia.

Question 6. The goal or purpose of a conversation is called:

a) Utterance.
b) Entity.
c) Event.
d) **Intent.**

Question 7. The sentence explicitly given by the user to a bot is called:

a) **Utterance.**
b) Entity.
c) Event.
d) Intent.

Question 8. A concept that will be extracted from the sentence is called:

a) Utterance.
b) **Entity.**
c) Event.
d) Intent.

Question 9. Which of the following content can be included in a bot?

a) Textual phrase.
b) Voice sentence.
c) Informative image with hyperlinks.
d) **All of the above.**

Question 10. Language processing performed in a bot is known by the acronym:

a) **NLP**
b) STT
c) TTS
d) NLU

Question 11. The first contact with a bot is referred to as:

a) Landing.
b) **Onboarding.**
c) Entry.
d) Introduction.

Question 12. In order for a bot to be coherent in a conversation it must be trained to maintain:

a) Sense of humour.
b) Erratic character.
c) **Context.**
d) Critical personality.

Question 13. In a conversational voice agent, the conversation needs to be triggered by:

a) A very loud shout.
b) **A trigger word.**
c) Pressing a button.
d) With recognizable body movements.

Question 14. A skill that books train tickets is considered to be directed to:

a) Theme.
b) Loyalty.
c) Entertainment.
d) **Task.**

Question 15. In a sentence like "I want to buy a red jumper", "jumper" and "red" are referred to as:

a) Concepts.
b) Interests.
c) **Entities.**
d) All of them.

Question 16. Which of the following actions in error management is the least recommended?

a) **Restart the conversation.**
b) Redirect the conversation.
c) Redirect to a person.
d) Redirect to another bot with more knowledge.

Question 18. Speech to Text Conversion corresponds to the acronym:

a) TTS
b) T2T
c) STS
d) **STT**

Question 19. Which of the following is NOT a "smart speaker"?

a) **Amazon Alexa.**
b) Google Home.
c) Alexa Echo.
d) Harman Kardon Invoke.

Question 20. Which of the following is NOT a disadvantage of conversational voice agents?

a) Inconvenience of use in public environments.
b) Loss of privacy.
c) Feeling of embarrassment.
d) **Natural conversation.**

Question 21. Which of the following commercial assistants is least popular or successful?

a) Siri.
b) Amazon Alexa.
c) Google Assistant.
d) **Microsoft Cortana.**

Question 22. In general, bots applied to health are oriented....

a) **The patient.**
b) The therapist.
c) Society in general.
d) None of the above.

Question 23. The use of bots in health is generally oriented to...

a) Task.
b) **Topic.**
c) Entertainment.
d) Generic information.

Question 24. The use of bots in early care seems that they will be more directed to guide the...

a) Patie nt.
b) **Therapist.**
c) Institution.
d) Everyone.

MODULE VII.3 EARLY CARE AND APPLICATION OF SMART RESOURCES: USE OF EYE TRACKING TECHNOLOGY AND THE EEARLYCARE WEB APPLICATION

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I. INTRODUCTION

Module VII.3 refers to the use of intelligent resources for observation, analysis and intervention at early ages. Specifically, this part of Module VII will introduce the use of eye tracking technology applied to the assessment of children at an early age. In addition, it will present a web application, eEarlyCare, which allows observational analysis to be recorded and the results to be interpreted through a Learning Analytics system. This system offers personalised profiles for each user and, based on these profiles, provides proposals for individualised programmes for therapeutic intervention.

II. OBJECTIVES

1. To learn the functionalities of the use of eye tracking technology for the observation of skills in children at an early age.
2. To learn the possibilities offered by using the eEarlyCare web application for assessment and intervention in functional skills for the developmental period 0-6 years.

III. CONTENT SPECIFIC TO THE THEME

1. Eye tracking applied to early intervention

First, we will address the concept of eye-tracking technology and its possible application in the evaluation of information processing during the resolution of a task with children (with and without impairments) at an early age.

1.1. What is eye-tracking technology?

Eye-tracking technology is based on eye tracking and measures eye movements. The explanation is basically the capture of eye tracking—while the user performs a task—through a pattern of infrared light directed towards the eyes. The infrared light is reflected by the eyes and the eye reflections are captured by the eye-tracker cameras. Then, from the application of algorithms, the eye tracker recognises where the user is looking. Figure 1, shows how it works, there is a stimulus on the computer screen, the eye perceives the image in a position of coordinate axes (these can be in 3D, x,y,z, or 2D x,y) in the position of the right eye and left eye. Also, eye movement can be recorded without the need for the subject to look at a screen, they can look at a blackboard, an object, or a surface, etc. (see Figure 2).

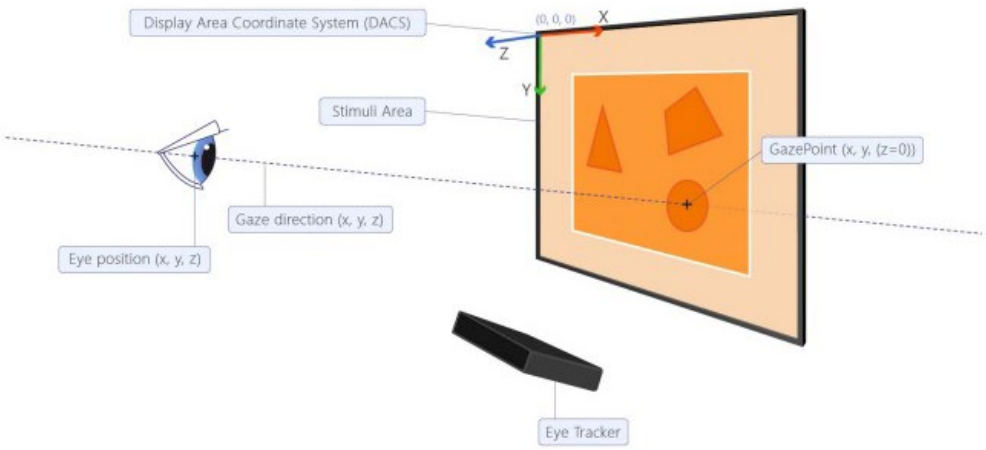


Figure 1. Taken from Tobii Pro Lab Manual v. 1.194 p. 155

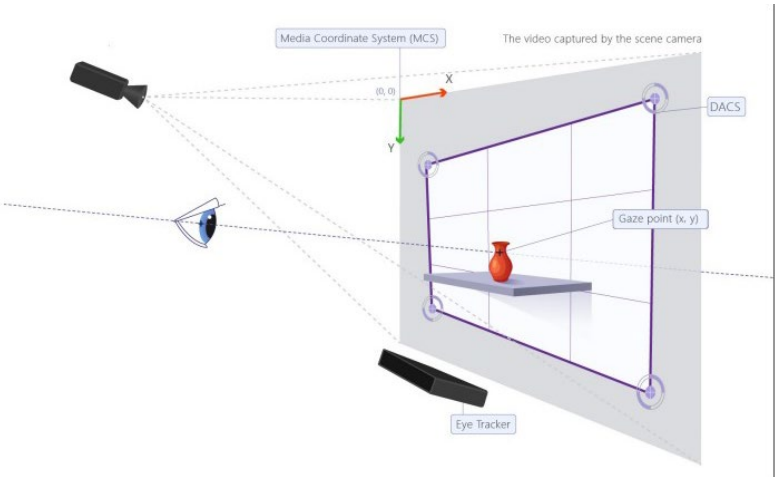


Figure 2. Taken from the Tobii Pro Lab Manual v. 1.194 p. 158

This is a useful option in observation and assessment of young children. An example of such an assessment is shown in Figure 3 and Figure 4 (in this case only the 2D coordinates, x, y coordinates, are analysed). These devices are very powerful and are highly capable of adjusting to head movements. They are therefore recommended for assessment of young children. They can capture eye movement data at speeds ranging from 60 Hz to 1200 Hz.

Figure 3. Image taken from Tobii information on the web, https://www.tobiipro.com/es/products/tobii-pro-spectrum/

Figure 4. Image taken from Tobii information on the web,
https://www.tobiipro.com/es/aplicaciones/investigacion-cientifica/

Another possibility is using glasses that incorporate eye-tracking software (see Figure 5). The glasses can measure using a 3D coordinate system. The eye position and gaze vectors are calculated from images of the eye on a 3D model. The gaze point is calculated as the vergence point between the two gaze vectors.

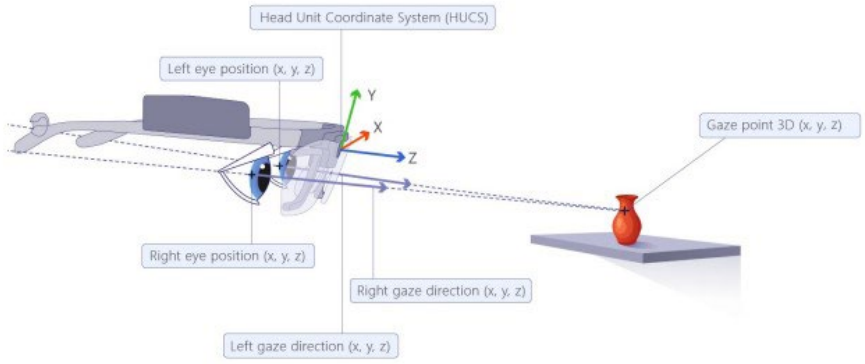


Figure 5. Taken from Tobii Pro Lab Manual v. 1.194 p. 159

In this process it is important to correctly calibrate gaze positioning. An example of a gaze adjustment positioning analysis is shown in Figure 6.

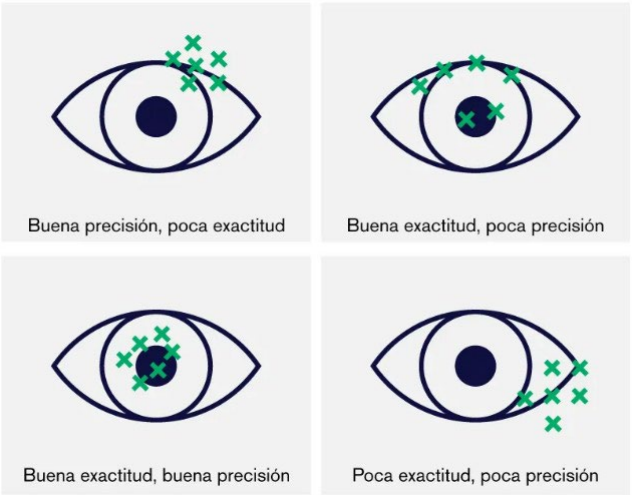


Figure 6. Taken from Tobii dynavox,
https://es.tobiidynavox.com/pages/what-is-eye-tracking

1.2. Registration metrics in eye tracking and their significance in information processing

Eye tracking can record many metrics, which can be classified into static and dynamic metrics (Sáiz-Manzanares et al., 2020). The former are related to fixation, saccade and glance parameters. All have different extensions such as (frequency, speed, average duration, etc.). Dynamic metrics refer to the recording of the positional pattern of eye tracking performed, depending on the type of technology, they maybe called scan path or gaze point.

Table 1 shows the most significant metrics and their correspondence with the cognitive processes that occur during the performance of different tasks.

Table 1. Representative metrics in eye tracking and their correspondence with information processing. Adapted from Sáiz-Manzanares et al. (2019); Sáiz-Manzanares et al. (2020).

Metric	Acronym	Meaning	IP Correspondence
Duration of interval	DI	Duration of all intervals of cas Time of Interest, with means, medians, sums, frequencies, variances and standard deviations.	
Start of interval	YES	The starting time of all time intervals for each Time of Interest, with means, medians, sums, frequencies, variances and standard deviations.	
Number of Events	NE	Customised events and Live logged events, for each event time, with means, medians, sums, frequencies, variances and standard deviations.	
Validity of eye data	VED	Refers to whether the eyes have been correctly identified. That is, whether the calibration is correct.	
Calibration	C	Information on calibration adjustment.	
Fixation Count	FC	Number of fixations of all selected stimuli.	A high FC means a higher number of fixations on a stimulus, indicating that participants may possess less task knowledge or have difficulty discriminating between relevant and non-relevant information.
Fixation Duration	FD		Gives an indication of the user's level of interest and reaction times. Longer durations are usually associated with deeper cognitive processing and greater effort. The duration of the fixation also provides information on the search process.

Metric	Acronym	Meaning	IP Correspondence
Fixation Duration Average	FDA	Average duration of fixation	A longer FDA means that the participant spends more time analysing and interpreting the information content within the different AOIs.
Fixation Duration Maximum	FDMa	Maximum duration of fixation	Refers to reaction times.
Fixation Duration Minimum	FDMi	Minimum duration of fixation	Refers to reaction times.
Fixation Dispersion Total	FDT	Sums all dispersions on the fixation axes (x,y or x,y,z) depending on whether the device measures in 2D or 3D.	Refers to the perception of the information in different components of the task.
Fixation Dispersion Average	FDA	Sum of all fixation dispersions on the axes divided by the number of fixations in the test.	analyses the dispersions in each of the fixations on thedifferent stimuli
Saccade Count	SC	Total number of saccades in each of the stimuli.	More saccades mean more search strategies. The greater the amplitude of the saccade, the lower the cognitive effort. It may also refer to problems in understanding information.
Saccade Frequency Count	SFC	Sum of the frequency of all saccades	Refers to the frequency of use of saccades which are related to search strategies.
Saccade Duration Total	SDT	Sum of the duration of all saccades	Refers to the frequency of use of saccades which are related to search strategies.
Saccade Duration Average	SDA	Average duration of saccades in each AOI	This data allows the discrimination of dependent or independent field users.
Saccade Duration Maximum	SDMa	Maximum duration of the saccade	Novice users in the execution of a task have shorter saccades.
Saccade Duration Minimum	SDMi	Minimum duration of the saccade	Novice users in the execution of a task have shorter saccades.
Saccade Amplitude Total	SAT	Sum of the amplitude of all saccades	Novice users in the execution of a task have shorter saccades.
Saccade Amplitude Maximum	SAMa		Novice users in the execution of a task have shorter saccades.

Metric	Acronym	Meaning	IP Correspondence
Saccade Amplitude Minimum	SAMi		Novice users in the execution of a task have shorter saccades.
Saccade Velocity Total	SVT	Sum of the speed of each saccade	This is directly related to the speed of information processing when moving from one element to another within a stimulus.
Saccade Velocity Maximum	SVMa	Maximum value of the recorded speed of the saccade	This is directly related to the speed of information processing when moving from one element to another within a stimulus.
Saccade Velocity Minimum	SVMi	Minimum value of the recorded speed of the saccade	This is directly related to the speed of information processing when moving from one element to another within a stimulus.
Saccade Latency Average	SLA	Equal to the time between the end of one saccade and the start of the next saccade.	This is directly related to reaction times in information processing. The initial latency of the saccade provides time-related information on the search process.
Blink Count	BC	Number of flashes during activity	Blinking is related to information processing during exposure to a stimulus to generate the next action. Users with faster information processing may have shorter blinks. However, this action can also occur where attention is required. These results must be compared with results from other metrics to fit them within the analysis of a learning pattern.
Blink Frequency Count	BFC	Number of flashes of all selected tests trials per second divided by number of selected trials	
Blink Duration Total	BDT	Sum of the duration of all the flickering of selected trials divided by the number of tests selected	
Blink Duration Average	BDA	The sum of the duration of all the flashing of all selected tests divided by the number of selected tests	
Blink Duration Maximum	BDMa		
Blink Duration Minimum	BDMi		
Pupil diameter	PS	Pupil diameter	Refers to the interest that a stimulus or part of it can attract the user’s attention.

Metric	Acronym	Meaning	IP Correspondence
Total duration of Visit	TDV	Total time each participant has visited the AOI house.	Gives data on attention to a stimulus or part of a stimulus.
Average duration of Visit	ADV	Average duration of each participant for each AOI over the total average.	
Number of Visits	NV	Number of visits within each AOI.	
Scan Path Length	SPL	Provides the learning pattern user's behavioural behaviour during task resolution	The study of behavioural patterns of learning will facilitate guidance on how to learn. The length of the scan path provides information on reaction times in tasks without predetermined duration.
Dwell Time	DWT	Duration of all fixations and saccades within an AOI, including revisits (exits and re-entries) of all participants in the study divided by the number of participants.	DWT refers to a participant's interest in a stimulus within a given AOI.
Glance Duration	GD	Duration of the saccade when entering the AOI plus the sum of all fixation and saccade durations before leaving the AOI.	GD indicates reaction times when processing information within a stimulus and an AOI. It helps to distinguish between field dependent vs. field independent participants.
Fun Duration	DD	The sum of all durations of saccades into and out of the AOI plus the sum of all durations of fixations and saccades within the AOI before exiting.	DD can be used to analyse the input, dwell time and output time of each stimulus inserted into each AOI.
Glance Count	GC	Number of glances at a target (taken from the outside) in a given period with both eyes.	GC helps to analyse reaction times and their duration for different stimuli. This provides information about how information is processed in different participants.

1.3. Synchronisation of eye tracking with other records

a) Psychogalvanic Skin Response Recording (GSR)

Nowadays, eye tracking technology allows synchronisation of information from eye tracking with other recording channels such as the Psychogalvanic Skin Response (GSR). The traditional theory of galvanic skin response analysis is based on the assumption that skin resistance varies with the state of the sweat glands. Sweating in the human body is regulated by the Autonomic Nervous System (ANS). In particular, if the sympathetic branch (SNS) of the ANS is highly aroused, sweat gland activity also increases, which in turn increases skin conductance, and vice versa. Thus, skin conductance can be a measure of human SNS responses. This system is directly involved in the regulation of emotional behaviour. Other studies have highlighted the relationship between the GSR signal and some physical states that can influence mental

states, such as stress, fatigue and activity engagement. The GSR signal is recorded with two electrodes placed on the second and third fingers of one hand. The variation of an applied low voltage current between the two electrodes is used as a measure of the electrodermal activity (EDA).

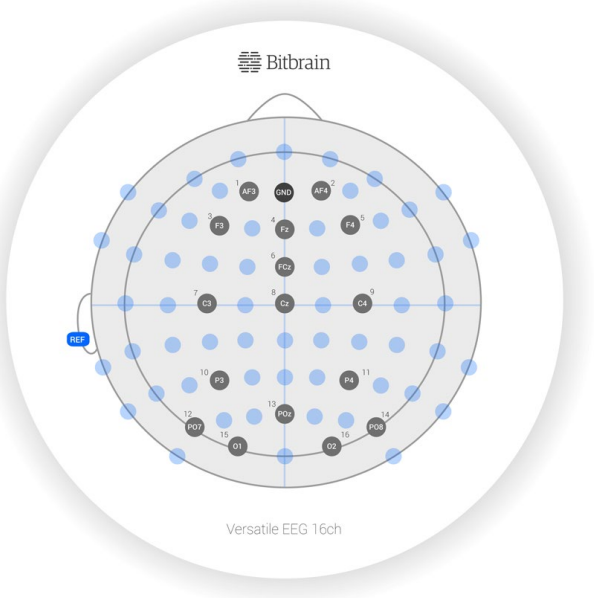
GSR can offer the following measures:

Activation: This refers to the baseline level of physiological arousal produced by a stimulus or situation. Emotional arousal may be due to a positive or negative emotional response. Activation is expressed in percentages from a defined baseline during calibration stimuli. Values below 0 are associated with a relaxed or calm state. Values above 0 are associated with a state of arousal. A value of -100% refers to the maximum relaxation response observed during calibration. A value of 100% refers to the maximum observed response to the calibration media. A value greater than 100% is possible if the calculated response exceeds that measured during calibration.

Impact: Emotional impact measures the number and intensity of one-off changes in emotional state produced by a stimulus, external event or during task performance. In other words, impact identifies something that is striking or produces arousal or stress. Impact is expressed as a percentage. A value of 0% means that there is no impact. A value of 100% equals the value measured in response to the calibration means. A value higher than 100% is possible if the calculated reaction exceeds that measured during calibration.

b) Encephalographic recording (EEG).

Depending on the device, EEG recordings can record information from 8, 16, 32 and 64 channels via dry or semi-dry electrodes. These sensors are designed for versatile monitoring with respect to a wide variety of monitoring environments from a high level of accuracy even in motion. An example of the recording areas can be seen in Figure 7, taken from free Bitbrain data. Specifically, 16 channels in developmental, frontal, prefrontal and occipital areas are analysed in this image.



FFigure 7. 16-channel EEG recording image taken from Bitbrain, https://cdn2.hubspot.net/hubfs/2607603/versatile-eeg-layouts-bitbrain.pdf

The metrics that can be extracted from EEG are:

Valence: measures the degree of attraction experienced in response to stimuli or a situation, ranging from a positive/pleasant reaction to a negative/unpleasant reaction. Valence is expressed as a percentage. A value of 100% positive or negative is equivalent to the value measured in response to the calibration medium. A valence level higher than 100% (positive or negative) is possible if the calculated reaction exceeds that measured during calibration.

Memorisation: refers to workload, measuring the neurological focus or concentration of a participant when presented with stimuli. In other words, it represents the use of cognitive resources to perform a task or visualise a stimulus. Workload is expressed as a percentage. Values close to 0% indicate that the participant is very distracted, while a value close to 100% indicates that the participant is very attentive to the stimulus.

Engagement: refers to the degree of involvement or connection between the participant and the stimulus or task. It is a more complex indicator than attention, as a participant may be attentive to a task even if they do not find the information presented interesting. Involvement is expressed as a percentage. A value close to 0% indicates no connection or link to the stimuli. A value close to 100% indicates high engagement with the stimuli or task.

All metrics can be incorporated and analysed in different logging channels, an example can be found in Figure 8.

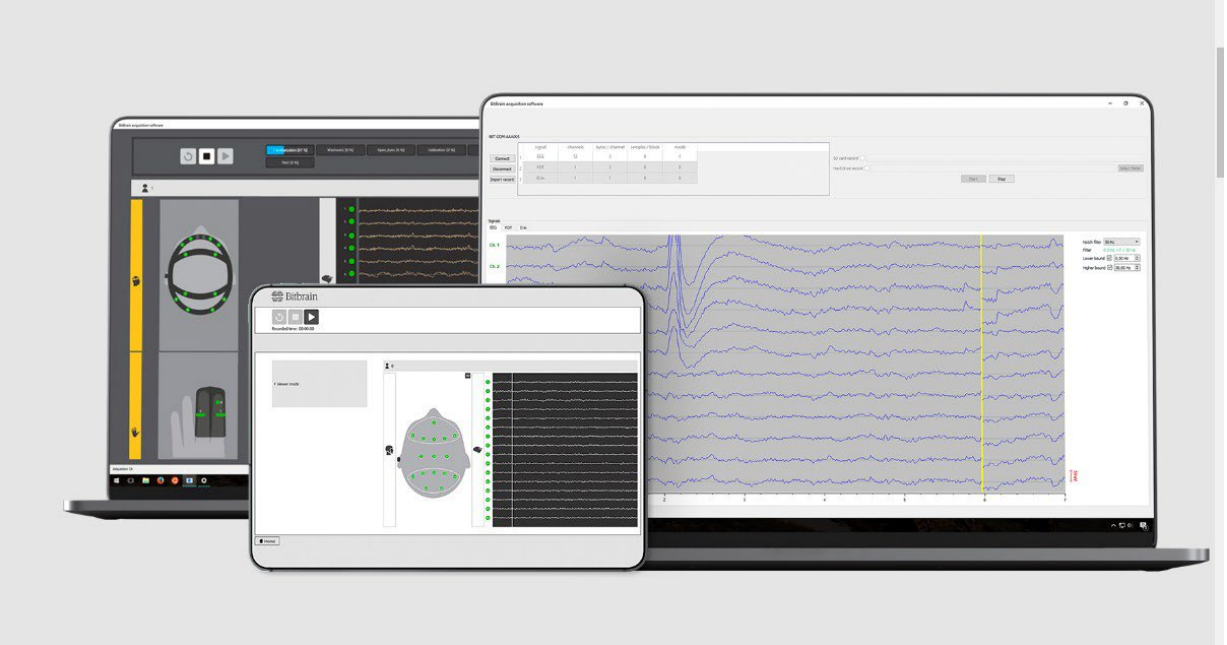


Figure 8. Multi-channel log analysis Taken from Bitbrain,
https://www.bitbrain.com/es/productos-neurotecnologia/software/sennslab

Application of this technology can be found in studies by Dollion et al. (2021); Boxhoorn et al. (2019); Murias et al. (2017) and Leckey et al. (2020).

1.4. Biometric markers applied to assessment and intervention with young children

The results of recent studies on the use of biometric measures applied to the analysis of information processing are promising. Biometric measures allow people's unconscious and involuntary behaviours to be captured (Borgianni and Maccioni, 2020). The use of biometric measures is useful for understanding the ways in which humans process information and emotional responses. Also, different studies are being carried out to test the effectiveness of the application of different Machine Learning techniques with respect to the accuracy in the analysis of the results of different biometric records (Borgianni and Maccioni, 2020). Specifically, regression machine learning techniques have been found to be more effective than using Naive Bayes algorithms and the J48 and Random Forest decision tree algorithms (see Module IV. 1).

The following is a list of recent research in which eye-tracking technology has been applied in studies with infants and children using different single and multi-channel eye tracking equipment, see Table 2.

Table 2. List of recent research using eye-tracking technology to analyse different aspects of information processing in infants and young children with and without impairments.

Study	Summary	Functionality of the application of eye tracking technology	Applied tool
Gastmann, F., and Poarch, G.J. (2022). Cross-language activation during word recognition in child second-language learners and the role of executive function. *Journal of Experimental Child Psychology*, *221,* 105443. https://doi.org/10.1016/j.jecp.2022.105443	This study investigated lexical retrieval processes in bilingual children aged 4-6 years, exploring cross-linguistic activation during second language (L2) word recognition in semantically related and unrelated contexts in English. Both button press (reaction times and accuracies) and eye tracking data (percentage of glances to the target) and eye tracking (percentage of glances to the target) showed a significant facilitation effect of cognates, indicating that children's performance was enhanced by cognate words. However, the degree of phonological overlap of cognates did not modulate their performance. In addition, a semantic interference effect was observed in the children's eye movement data. However, in these young L2 learners, cognate status exerted a comparatively stronger impact on L2 word recognition than semantic relatedness. Finally, correlation analyses between the children's non-cognitive performance and executive function yielded a significant positive correlation between non-cognitive performance and their inhibitory control, suggesting that non-cognitive processing was more dependent on inhibitory control than cognitive processing.	Analysis of information retrieval processes in bilingual children aged 4 to 6 years. Analysis of inhibitory control.	SMI Experiment Center and run on a laptop (HP ZBook 15 G2) with a 15.6-inch display

Study	Summary	Functionality of the application of eye tracking technology	Applied tool
Gepner, B., Charrier, A., Arciszewski, T., & Tardif, C. (2022). Slowness Therapy for Children with Autism Spectrum Disorder: A Blind Longitudinal Randomized Controlled Study. *Journal of Autism and Developmental Disorders. 52*, 3102-3115. https://doi.org/10.1007/s10803-021-05183-6	The world often moves too fast for children with autism spectrum disorder (ASD) to process. This study tested the therapeutic efficacy of slowing down input in children with ASD. Over 12 months, 12 children with ASD had weekly speech therapy sessions in which stimuli were played slowly on a PC, while 11 children with ASD of the same age and level received speech therapy using real-time stimuli. At the beginning and end of the study, all participants were assessed on communication, imitation, facial emotion recognition, behaviour and face exploration. While communication and facial emotion recognition improved in both groups, imitation increased, inappropriate behaviours decreased and mouth and eye fixation time increased only in the group using slowness. Slow therapy seems very promising for children with ASD.	Children diagnosed with ASD according to DSM-5 criteria between the ages of 3 and 8 years.	Tobii T120 Eye Tracker® (eye tracker) (Tobii, Stockholm, Sweden). This system made it possible to capture time-resolved data (120 Hz sampling rate) spatial resolution (accuracy of .,4°) at a distance of approximately 50cm from the screen, which corresponds to a visual angle of 30°. Since this eye-tracking system is non-invasive, tolerates some head movement and looks like a TV or PC screen, it is very suitable for children aged 3 to 8 years. Video streams with a resolution of 1024 × 764 pixels were presented with Tobii Pro Studio™ version 3.4.0 software on a 17-inch LCD screen on a 17-inch LCD screen (Tobii T120 screen, 8-bit colour, 1280 × 1024 resolution, 75 Hz refresh rate). Two speakers. Two loudspeakers were also connected to the PC to amplify the sound from the video sequences (HP 2.0 multimedia loudspeaker, 1 W mean square, signal-to-noise ratio = 70 dB). Studio 2.2®, a gaze analysis software, was used on the PC to process the data and identify fixations using the ClearView fixation filter..

Study	Summary	Functionality of the application of eye tracking technology	Applied tool
King, J., and Markant, J.(2022). Selective attention to lesson-relevant contextual information promotes 3- to 5-year-old children's learning. *Developmental Science, 2022,* 25, e13237. https://doi.org/10.1111/desc.13237	Attention to distracting or competing information is often considered detrimental to learning, but the presence of competing information can also facilitate learning when it is relevant to the goals of the task at hand. Educational environments often contain contextual elements, such as classroom décor or visual aids, to enhance students' learning. Despite this, most research examining the effects of contextual information on children's learning has only used lesson-irrelevant stimuli. Although this research has shown that increased attention to task-irrelevant information hinders learning, the extent to which looking at lesson-relevant information may benefit children's learning is unknown. We addressed this question by examining 3- to 5-year-olds' attention to and learning of lesson-relevant contextual information. Children's eye movements were recorded as they watched science video lessons, while lesson-relevant and lesson-irrelevant images appeared in the periphery. Learning was assessed as a function of improvements in the video lessons and selective attention skills were measured separately using the Track-It task. Overall, children spent more time looking at the lesson versus irrelevant images, and those with greater initial knowledge of the lesson topics or with more advanced selective attention skills showed a greater preference for relevant images. This was related to more effective learning during trials in which both relevant and irrelevant images were present. These results suggest that the effects of contextual information on early learning depend on the relationship between information content and task goals, as well as on children's ability to actively select task-relevant information from their environment.	Selective attention to relevant vs. non-relevant information. Work was carried out with children aged 3 to 5 years.	Eyelink 1000 remote eye tracker (SR Research Ltd., Toronto, ON, Canada).

Study	Summary	Functionality of the application of eye tracking technology	Applied tool
Kong, X-J., Wei, Z., Sun, B., Tu, Y., Huang, Y., Cheng, M., Yu, S., Wilson, G., Park, J., Feng, Z., Vangel, M., Kong, J and Wan, G (2022) Different Eye Tracking Patterns in Autism Spectrum Disorder in Toddler and Preschool Children. *Front. Psychiatry 13,* 899521. https://doi.org/10.1111/desc.13237	Children with autism spectrum disorder (ASD) have been observed to have gaze fixation difficulties, although the dynamics of fixation patterns with age are unclear. In this study, fixation patterns among toddlers and preschoolers with and without ASD were investigated while viewing video clips and still images (i.e., face with mouth movement, biological movement, face with movement vs. moving object, still face image vs. objects, and moving toys). Significant differences were found in the percentage of fixation time of children with ASD vs. children without ASD in almost all areas of interest (AOI), except for the moving toy (helicopter). A diagnostic group (ASD vs. TD) and chronological age (toddlers vs. preschoolers) were also observed for the AOI of the eyes during the mouth movement video clip. Support vector machine analysis showed that the classifier could discriminate ASD from TD in toddlers with 80% accuracy and could discriminate ASD from TD in preschoolers with 71% accuracy. The results suggest that toddlers and preschoolers may be associated with common and distinct fixation patterns. A combination of eye-tracking and eye-tracking and machine learning has the potential to shed light on the development of new methods for early detection/diagnosis of ASD.	Children with (diagnosed according to DSM-5 criteria) and without autism spectrum disorder, age ranges 1.5-3 years and 3-5 years. Analysis of fixation patterns on static and moving stimuli.	The SMI RED250 portable eye-tracking system was used in data collection. Screen resolution was set to 1,024 768 pixels with a sampling frequency of 250 Hz and spatial resolution of 0.03 degrees.

Study	Summary	Functionality of the application of eye tracking technology	Applied tool
Mulder, H., Oudgenoeg-Paz, O., Verhagen, J., van der Ham, I.J.M., and Van der Stigcheld, S. (2022). Infant walking experience is related to the development of selective attention. *Journal of Experimental Child Psychology, 220*, 105425. https://doi.org/10.1016/j.jecp.2022.105425	Previous studies have shown that the way babies perceive and explore the world changes when they move from crawling to walking. The onset of walking in infants often precedes advances in cognitive development, such as accelerated language growth. However, the underlying mechanism that explains this association between the experience of walking and cognition is largely unknown. Selective attention is a key driver of learning in multiple domains. We propose that the alteration of visual information obtained by children in the transition to walking is related to the development of selective attention. and that gains in selective attention may explain previously reported gains in other cognitive domains. As a first step in testing this hypothesis, we investigated how the experience of walking relates to selective attention. In Study 1, 14-month-old crawlers, novice walkers and experts performed on a visual search eye-tracking task (N = 47), including feature and conjunction (effort) items. Walkers outperformed crawlers on the task overall, and effortful search in expert walkers compared to novice walkers, after controlling for crawling onset and general developmental differences occurring prior to gait onset. In Study 2, earlier onset of walking was associated with better visual search performance in 2-year-olds (N = 913). The association appeared to be due to the difference between the 10% of later walkers and early/mid walkers.	Analysis of selective attention.	Tobii T60 binocular eye tracker with a 17-inch LCD monitor (accuracy = 0.5º, sampling rate = 60 Hz).

Study	Summary	Functionality of the application of eye tracking technology	Applied tool
Ståhlberg-Forsén, E., Latvab, R., Leppänen, J., Lehtonen, L., & Stolta, S. (2022). Eye tracking based assessment of lexical processing and early lexical development in very preterm children. *Early Human Development 170,* 10. https://doi.org/10.1016/j.earlhumdev.2022.105603	The associations between lexical processing and lexical development during the second year of life have been little studied in preterm children. The aims of this study were to assess the associations between lexical processing at 18 months and lexical development between 12 and 18 months in very preterm children. A correlational study was applied. We worked with 25 Finnish children born at less than 32 weeks gestation. The measures found were lexical processing (reaction time RT; correct gaze time CLT) was measured with an eye-tracking technology-based task at 18 months corrected age. Lexical development was measured longitudinally at 12, 15 and 18 months corrected age using the following assessment instruments: the short version of the MacArthur Communicative Development Inventories and the Communication and Symbolic Behavior Scale: Infant and Toddler Checklist. Results: The higher the child's TR, the weaker the child's expressive skills at 12 and 15 months (correlation coefficients from 0.45 to 0.51). The more the child looked at the target image compared to the distractor (CLT), the stronger the child's expressive skills were at 18 months (r = 0.45-0.52). A linear regression model with RT and gender as independent variables explained 33% of the variance in lexical skills at 18 months. A model with CLT explained 40% of expressive skills at 18 months. The conclusions were that lexical processing at 18 months was associated with expressive lexical development in very preterm children. The results suggest that methods based on eye-tracking technology may be useful for the assessment of early lexical growth in preterm children, although further research is needed to evaluate the psychometric properties and predictive value of the method.	Reaction times and correct eye gaze time in lexical processing tasks.	The Tobii X2-60 Infrared Eye Tracker which uses image sensors and processing algorithms to track the point of the participant's gaze on a screen.

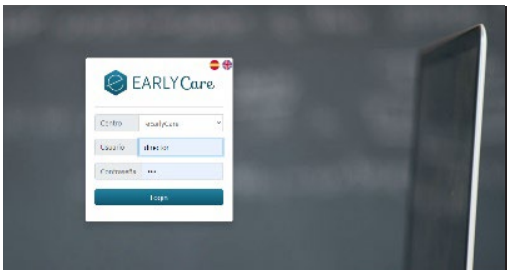
Study	Summary	Functionality of the application of eye tracking technology	Applied tool
Tan, S.H.J., Kalashnikova, M., Di Liberto, M., Crosse, M.J., and Burnham, D.(2022). Seeing a talking face matters: The relationship between cortical tracking of continuous auditory-visual speech and gaze behaviour in infants, children and adults. *NeuroImage, 256,* 119217. https://doi.org/10.1016/j.neuroimage.2022.119217	The auditory-visual speech benefit, i.e. the benefit that visual speech signals bring to auditory speech perception, is experienced from infancy and continues to be experienced to a greater degree with age. Although both behavioural and neurophysiological evidence exists for children and adults, only behavioural evidence exists for infants, as no neurophysiological study has provided a comprehensive examination of the benefit of auditory-visual speech in infants. It is also surprising that most studies on the benefit of auditory-visual speech do not simultaneously report on gaze behaviour, especially since the benefit of auditory-visual speech is based on the assumption that listeners attend to the speaker's face and that there are significant individual differences in gaze behaviour. To address these gaps, we simultaneously recorded electroencephalographic (EEG) and eye-tracking data from 5-month-olds, 4-year-olds and adults while they were presented with a speaker in auditory-only (AO), visual-only (VO) and auditory-visual (AV) modes. Cortical tracking analyses involving direct encoding models of the speech envelope revealed that there was a benefit of auditory-visual speech [i.e., AV > (A + V)], evident in 5-month-olds and adults, but not in 4-year-olds. Examination of cortical tracking accuracy in relation to gaze behaviour showed that infants' relative attention to the speaker's mouth (in front of the eyes) was positively correlated with cortical tracking accuracy of VO speech, whereas adults' attention to the screen in general was negatively correlated with cortical tracking accuracy of VO speech. This study provides the first neurophysiological evidence for the benefit of auditory-visual speech in infants and our results suggest ways in which current models of speech processing can be adjusted.	Auditory-visual speech analysis. Multi-channel study of visual tracking and EEG recordings on attentional analysis of these bimodal (visual and auditory) stimuli in five-month-old monolingual Australian children. Monolingual Australian children aged four years. Monolingual adults aged 18-56 years.	EEG over 92 channels ELAN software (version 5.9)

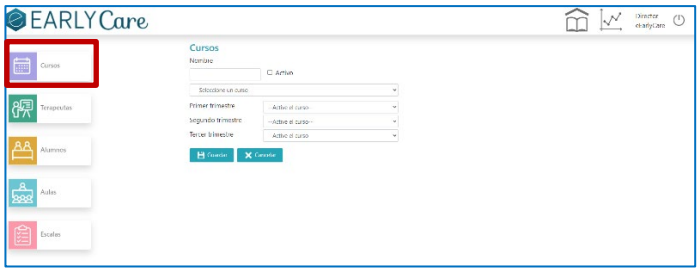
2. eEarlyCare web application

eEarlyCare is a web application that has been developed over several proof-of-concept phases financed with FEDER funds through the Junta de Castilla y León and the University of Burgos (Spain) (Sáiz-Manzanares, Marticorena-Sánchez and Arnaiz-González, and Díez-Pastor, 2020a; Sáiz-Manzanares, Marticorena-Sánchez and Arnaiz-González, 2020b). e-EarlyCare, incorporates an assessment scale of functional skills for ages 0-6 years in 11 functional areas (Autonomy in feeding, Personal care and hygiene, Dressing and undressing autonomy, Sphincter control, Functional mobility, Communication and language, Task resolution in social contexts, Interactive and symbolic play, Daily life routines, Adaptive behaviour, and Attention). The application allows assessments to be recorded and the data to be interpreted through an integrated Learning Analytics system. This system analyses the results from a comparison with the chronological ages assigned to each assessed behaviour (using a scale of developmental ages accepted by the scientific community, based on developmental scales and inventories such as the Brunet Lézine Scale, the Batelle Development Inventory, the Portage Guide, the PDI scale, etc.). In other words, it offers a comparison profile between the expected score at the chronological age and the actual score. The professional can also choose the number of standard deviations to apply with respect to the mean assigned to each assessed behaviour. Then, depending on the results from the assessment phase, the web application offers a possible therapeutic intervention programme. The programme detects the area or areas of functional development and the most affected behaviours (i.e., where there are the largest gaps compared to the chronological reference age). In addition, for each area, functional sub-area and behaviour, activities are proposed to initiate the therapeutic intervention programme. The application allows three evaluations per year (initial evaluation or baseline, intermediate evaluation or follow-up 1 and final evaluation or follow-up 2). The application also offers developmental analysis profiles that can be individual and/or grouped for each assessment. Similarly, the tool allows for longitudinal analysis of the three evaluations.

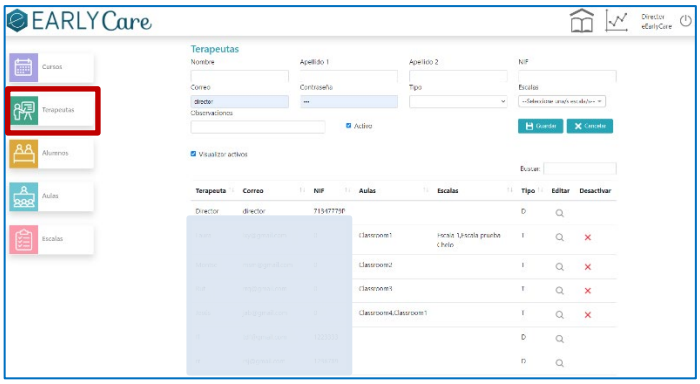
The eEarlyCare web application can be used in two roles, (educational or therapeutic) centre director or manager, and educator or therapist.

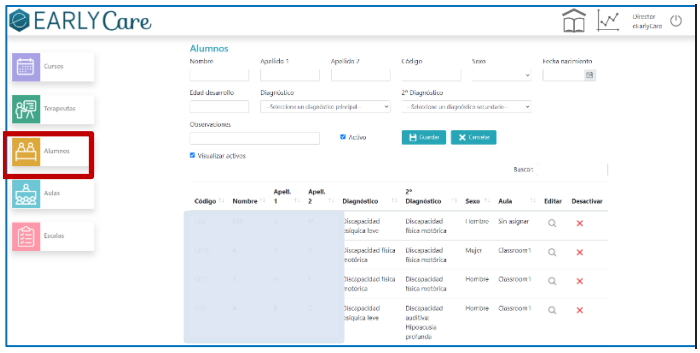
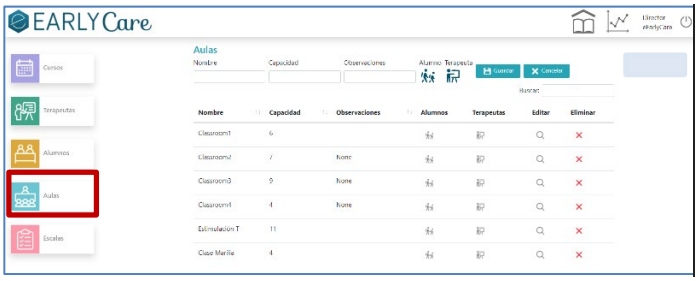
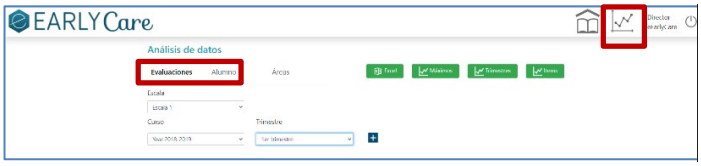
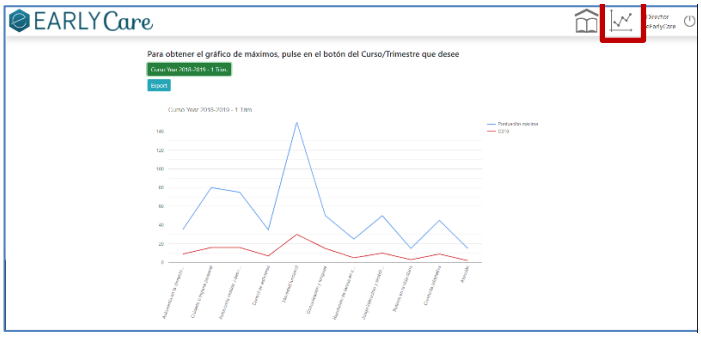
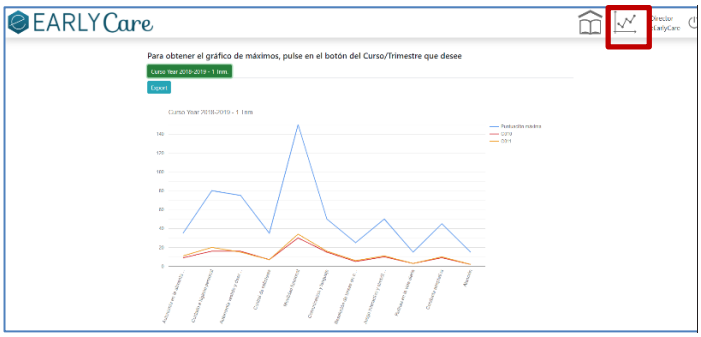
An example of how the tool works for a centre director or manager is given in Figure 9 and an example of how it works for a therapist is shown in Figure 10.





Assignment of therapists



Assignment of users	
Classroom allocation	
Using the Learning Analytics module	
Obtaining an individual development profile. * The application allows the graph to be exported. ** The blue line indicates the expected development and the line graph indicates the development of the selected user.	
Obtaining a group development profile. * The application allows the graph to be exported. ** The blue line indicates expected development and the other lines indicate the development of each user assigned to an intervention classroom.	

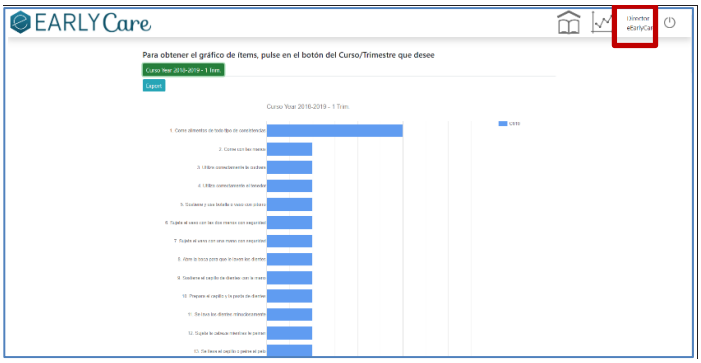
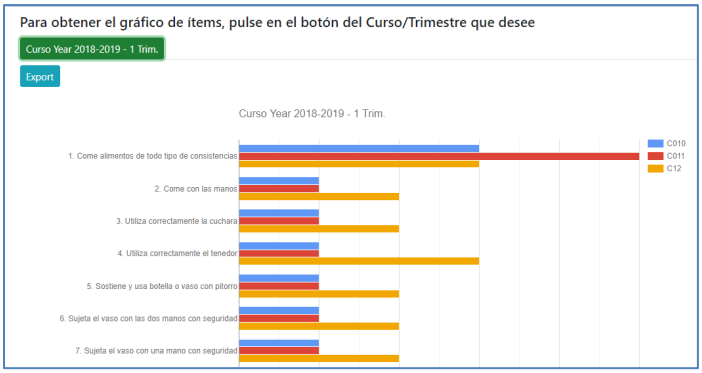
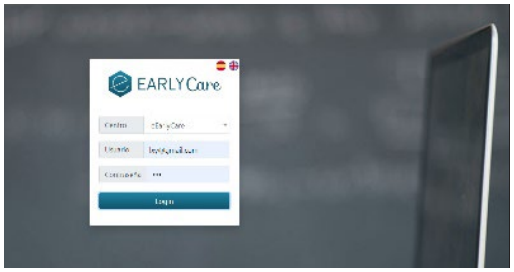
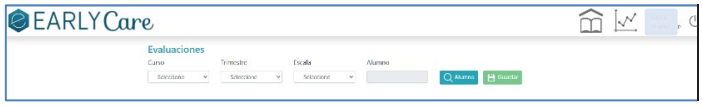
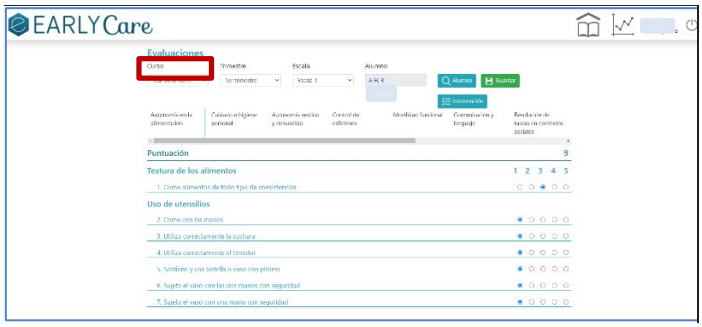
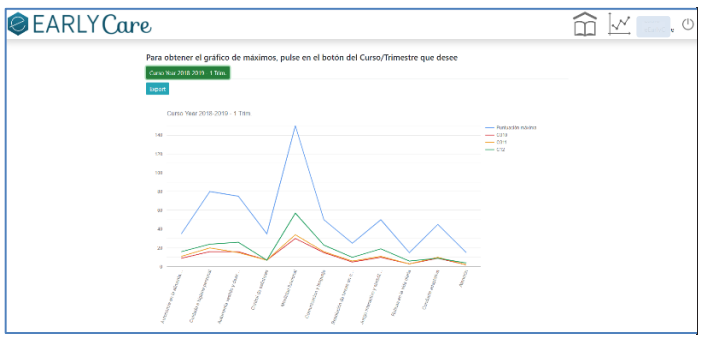
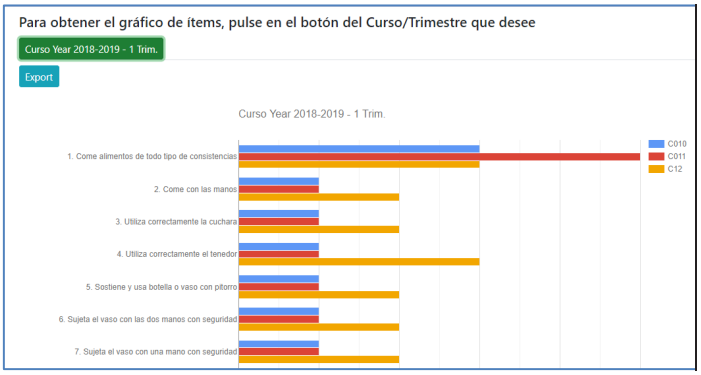
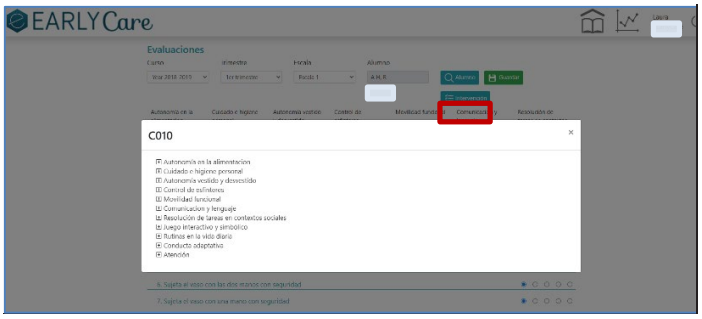
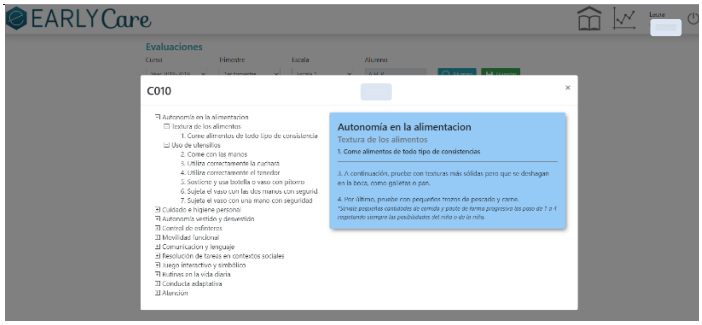
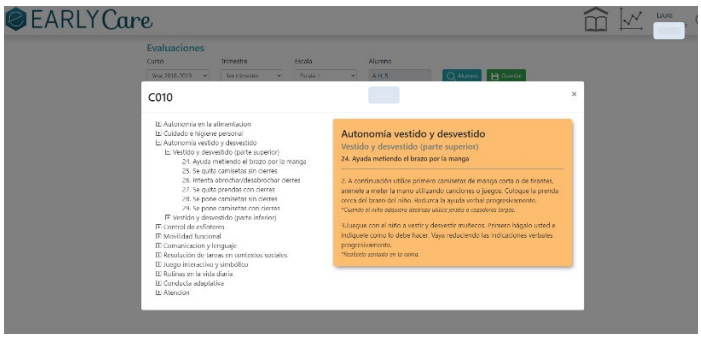
Individual developmental outcome for each behaviour. * The application allows the graph to be exported.	
Obtaining comparative group development in each behaviour.	

Figure 9. Functioning of the eEarlyCare web application for a centre manager.

	
Conducting assessments on assigned users.	
Obtaining a development profile by individual or group functional areas or sub-areas. * The application allows the graph to be exported. ** The blue line indicates expected development and the other lines indicate the development of each user assigned to that intervention classroom.	

Obtaining an individual or group developmental profile for the behaviours assessed in each functional area or sub-area. * The application allows the graph to be exported.	
Depending on the developmental profile, a personalised intervention programme can be produced for the areas, sub-areas and behaviours in with the largest gaps between expected and actual development.	
Each functional area is assigned a colour. *The guidelines for intervention are graded in order of difficulty according to the results of the assessment.	
	
	

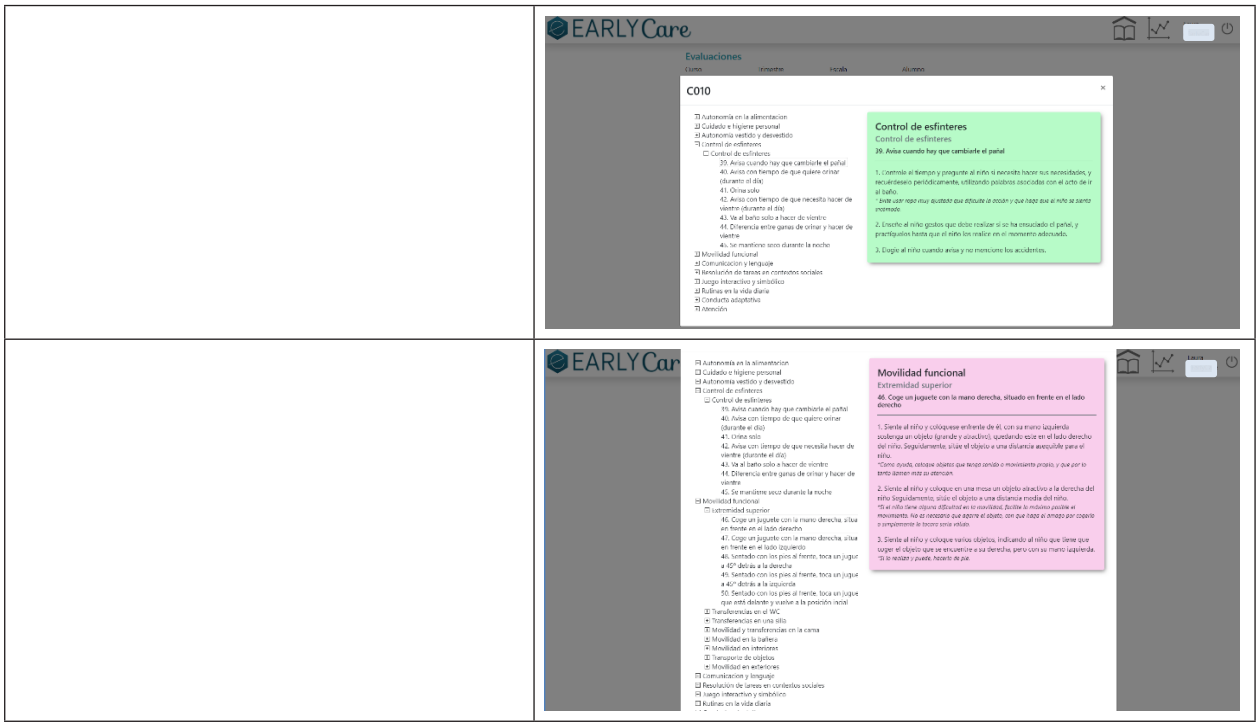


Figure 10. Operation of the eEarlyCare web application for a therapist.

The application also allows the results of the evaluations to be exported as an Excel spreadsheet so that supervised and unsupervised automatic learning techniques can later be implemented (an example of how this works is shown in Figure 11). The former techniques will provide information on prediction and the latter on clustering. Both are highly functional for working with people with developmental disabilities. For example, predicting the priority behaviour(s) for therapeutic intervention is key in producing an accurate therapeutic intervention. Likewise, grouping users with similar impairments in some of the areas of development can give those responsible for the intervention centre key data for programming therapeutic intervention sessions with different professionals (occupational therapist, physiotherapist, speech therapist, etc.). This will help to better distribute the centre's resources and improve the quality of the service. Therefore, implementing this technology will foreseeably reduce intervention costs, since on the one hand it will offer an analysis of the patient's or user's development through the application of data interpretation and visualisation techniques, and on the other it will guide the professionals' intervention towards the development of precision treatment. The eEarlyCare web application is available in Spanish and English.

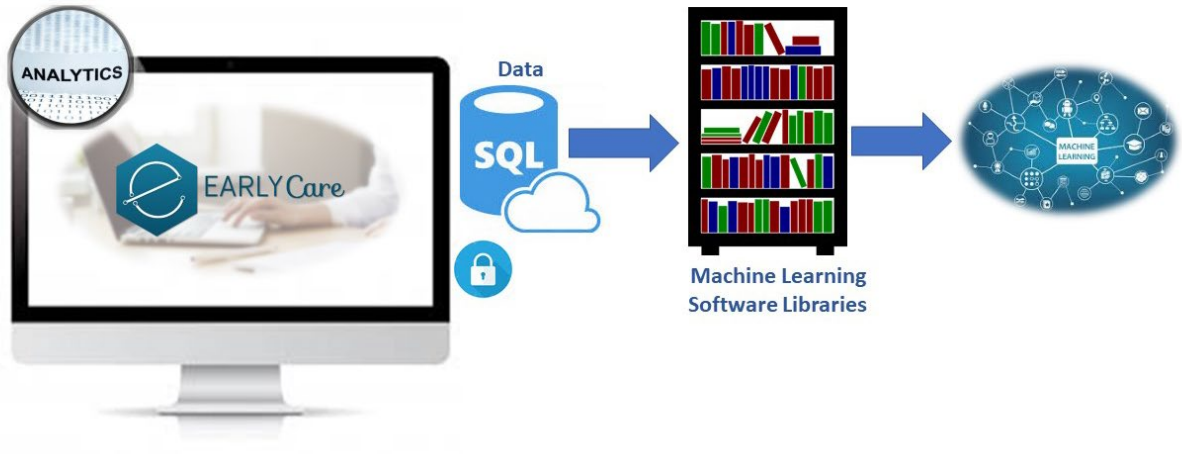


Figure 11. Operation of the e-EarlyCare web application system using Machine Learning techniques.

2.1. eEarlyCare web application functionality: representative studies

The eEarlyCare application has been used with children who have a variety of developmental disabilities, the most representative studies can be found in Sáiz-Manzanares et al. (2020a; 2020b; 2022).

Summary

In this part of Module VII, Module VII. 3, we have looked at using eye-tracking technology for the evaluation of different cognitive strategies during information processing in children at an early age. We also examined the use of different Machine Learning techniques to interpret the records provided by eye tracking. In addition, the eEarycare web application was presented, which allows results related to evaluating functional skills in 11 areas of development to be recorded and interpreted through a Learning Analytics system. This web application provides a development profile and also proposes personalised intervention in the development areas where the greatest impairment has been detected.

Glossary

ANS: Autonomous Nervous System

SNS: Sympathetic Nervous System

EDA: Electrodermal activity

EEG: Electroencephalogram

All other acronyms and meanings can be found in Table 1.

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Resources

Web

Assessment with young children with eye tracking	https://www.tobiipro.com/es/aplicaciones/investigacion-cientifica/neonatal-infanti/
Use of eye tracking for people with special educational needs	https://www.mytobiidynavox.com/#/
Tobii dynavox english	https://es.tobiidynavox.com/pages/what-is-eye-tracking
Tobii dynavox English	https://us.tobiidynavox.com/
Tobii neonatal and infant research	https://www.tobiipro.com/es/aplicaciones/investigacion-cientifica/neonatal-infanti/
Research in Developmental Psychology	https://www.tobiipro.com/es/aplicaciones/investigacion-cientifica/neonatal-infanti/developmental-psychology/
Autism Spectrum Research	https://www.tobiipro.com/es/aplicaciones/investigacion-cientifica/neonatal-infanti/autism-spectrum-disorder/

Comprehension questions

Answer (true answer is in bold)

Question 1. The metrics recorded by eye tracking technology may be

a) oscillating
b) static
c) Dynamic.
d) **Both b and c.**

Question 2. The dynamic metrics in eye tracking are

a) **Gaze Point.**
b) Saccades.
c) Attachments.
d) Glance.

Question 3. The static metrics in eye tracking are:

a) Fixations.
b) Saccades.
c) **Both a. and b.**
d) Scan Path.

Question 4. The Psychogalvanic Skin Response (GSR) can measure

a) **Activation.**
b) Valence.
c) Commitment.

Question 5. Biometric measures applied to the analysis of task-solving behaviour in humans can measure

a) Conscious and voluntary behaviours.
b) **Unconscious and involuntary behaviours.**
c) Conscious and involuntary behaviours.
d) Unconscious and voluntary behaviours.

Question 6. The eEarlycare web application can record behaviours about

a) **11 functional areas in ages 0-6 years.**
b) 11 functional areas at ages 7-8 years.
c) 11 non-functional areas at ages 7-8 years.
d) 11 functional areas in ages 8-10 years.

Question 7. The eEarlycare web application

a) Integrates a Learning Analytics system.
b) Enables a personalised development profile.
c) Facilitates a proposal for a personalised therapeutic intervention programme.
d) **All of the above.**

MODULE VIII. EARLY INTERVENTION PROGRAMMES (0-6 YEARS)

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I. INTRODUCTION

Module VIII is about the development of early intervention programmes for 0–6-year-olds. Firstly, the structure of programme development will be discussed in two parts: the structure of programme development for 0-3 years and the structure of programme development for 3-6 years. Practical examples of the development of early intervention programmes for different disorders can be found in Laboratory 2: Resolution of 3 case studies on cognitive, social and language pathologies and in Laboratory 2: Resolution of 3 case studies on cognitive, social and language pathologies. Likewise, the use of intelligent resources applied to diagnosis and assessment at early ages can be found in Laboratory 4: Application of intelligent resources to diagnosis and assessment at early ages and the development of an intervention programme with the use of the eEarlyCare application can be found in Laboratory 5: How to develop an intervention programme with the e-EarlyCare-T web application.

II. OBJECTIVES

1. Understand the structure of programme development for ages 0-3.
2. Understand the structure of programme development for ages 3-6.
3. Examples of early intervention programmes for different impairments.

III. CONTENT SPECIFIC TO THE THEME

1. Concepts of development 0-3: implications for programme development

The development of representation refers to the capacity of the human mind to extract, store and manipulate information from the environment, as well as to handle it symbolically by constructing another reality or other possibilities within existing reality. Humans seem to have the ability to develop cognitive functions such as thinking, reasoning, awareness, imitation, understanding causes, and solving certain types of problems (Gómez, 1990, Gómez, 1992, Gómez, 1998, Gómez, 2007). However, these skills do not appear spontaneously at a given developmental moment; they are shaped throughout human development and have precursors in the developmental period prior to their functional acquisition.

1.1. Precursors of cognitive abilities

Below, a series of important precursors are indicated to be considered in observation processes and the development of early intervention programmes for 0-3 year-olds.

a. *The discovery of objects*

As already indicated in Module V, infants seem to have more perceptual capabilities than was assumed from early developmental studies. Infants quickly analyse the world and develop representations that divide objects into figure and background (Rochat, 2001). Attention is progressively directed towards three-dimensional objects and there is a tendency to pay more and more attention to more complex stimuli. This suggests that babies know which objects are familiar and which are new to them. The exploration of objects is also related to interactive safety in the environment. That is, there is a cognitive

and motivational basis for why subjects in safe environments will interact more than in unfamiliar environments. Thus, observation and experimentation play an important role in knowledge and representation of objects. Infants acquire the notion of objects first as units of perception and then of action (Fantz, 1964). The infant develops the ability to conjugate schemas in a progressive way that will allow them to create more and more elaborate sequences. This happens when the baby is able to stop something they are doing in order to do a different action that will lead to a better situation and achieve what they want. This is when the development of using **means-ends strategies** begins. Subsequently, using materials or instruments that allow them to achieve something will be one of the most significant achievements of **practical intelligence**. In this, task resolution is fundamental to achieving cognitive development of reasoning. **In this process of problem solving, the development of object permanence is fundamental and is directly linked to the development of representation and resolution on the plane of virtuality**. However, according to the most recent research, the beginning of this capacity occurs earlier than Piagetian theory indicates. The explanation is that Piaget may have confused "action" with "knowledge". Nowadays, technology makes it possible to apply observation indicators more precisely (e.g., habituation-dishabituation processes, gaze tracking, heart rate...) and these seem to indicate that object permanence is acquired at an earlier age. The development of working memory is also involved in this recognition process. Seven-month-old babies may not be able to keep in mind all the variables of a problem in order to solve it correctly. Therefore, **executive and planning capacity seems to develop around the age of one year** (Diamond, 1990). According to this theory, adequate representations are present in babies from an early age, although they would not yet have developed the executive functions to properly coordinate these representations, which is why they would not be able to solve certain problems correctly. This is why development of executive capacities facilitates development of the ability to control behaviour with increasingly complex representations. Babies from **four to five months** are interested in the effects that actions have on objects and repeat them over and over again, which is what Piaget (1952) called **secondary circular reactions**. These observations and actions also facilitate the development of representations. Circular reactions may be a mechanism for learning about what is already represented and discovering new types of actions, initiating new representations (Parker, 1993). Here, **trial-and-error strategies** are used that will lead infants to increasingly successful resolutions. The subject's **intrinsic motivation** plays an essential role in this whole process. Next comes the development of **tertiary circular reactions**, from **eight to twelve months**. These reactions are a complex combination of objects (pushing one object against another). Babies' ability to repeat their schemes over and over again means that they analyse and study the procedure itself. In other words, they develop **causality and multi-schema complexity** (Karmiloff-Smith, 1992).

b. *Symbolisation in childhood*

The key to the beginning of symbolisation is that babies start to contemplate—and not only perceive—objects and act on them. Already after the two-month revolution, babies are less strict in their cognitive processing of things happening in and around them. **The contemplative attitude allows them to begin reflecting on events and asking questions about what they mean. This transition is the necessary precursor to the symbolic functioning that is an essential condition for the emergence of language**. The first signs become apparent at least around the age of two months, when the baby begins to adopt a contemplative attitude, although the obvious symbolic manifestation will appear at the end of the second year. **All the activities of symbolic functioning appear and manifest themselves together between twelve and eighteen months and mark the line between early childhood and infancy proper.** Symbolic skills depend on the same general capacity, but may be asynchronous in their development, e.g., pretend play may appear before or after graphic symbolism and this may be due to the emotional, motor and expressive limitations of the individual child. From the moment referential activities appear: pointing, joint participation, triadic behaviours, the ability to function symbolically is acquired. The hallmark of childhood is symbolic and make-believe play. **Symbolic play begins in early infancy, from eighteen to thirty-six months.** By eighteen months, children will be able to understand significantly better what is being asked for with a symbolic gesture than with the use of a miniature object referent. However, they will show **confusion between the symbol and the referent**. They will understand the gesture better because it is physically distant from the object. Children will have to over-

come the barrier of dual representation (DeLouche, 1995); this representation occurs when one thing (object, image or gesture) can be simultaneously that thing and the symbol of another (a comb, a car, a baby...). The development of symbolic functioning is progressive and depends on circumstances and the demands of the situation. By 36 months, the transgression of conversational use is a minor obstacle to children's symbolic understanding (Tomasello, Striano, and Rochat, 1999). In the development of symbolic play and language, comprehension precedes production. It is only from the age of 36 months that children clearly begin to invent pretend play using objects that represent something else: symbol comprehension develops at 18 months and symbol production at 36 months. The same is true for the reproduction of graphic symbols (Callaghan, 1999). However, this aspect is discussed in more detail in the following section.

c. *Manifestations of the semiotic function at the end of the sensorimotor period.*

As noted above, the **main manifestations of the semiotic function are: deferred imitation, symbolic play, drawing and language** (Delval, 1996). **Deferred imitation** enables the child to imitate in the absence of a model, which implies the development of internal patterns of representation of previously experienced situations. **Symbolic play** allows the child to represent situations they have been involved in. Later, as complexity increases, they will be able to represent other situations that they will not necessarily have to have acted out directly. **Drawing** implies an internalisation of real situations and objects and the possibility of graphically representing them. Although the degree of similarity will depend on the motor skills of reproduction. **Language** is considered to be the most elaborate symbolic skill in terms of complexity and the one that allows the greatest interpersonal and cognitive development. Vygotsky (1977) understood language as a privileged vehicle of cognition. However, this Module for 0-3 years of age focuses on analysing symbolic play, understood as the basic pillar of representation and which implicitly includes other skills, such as the development of language. By analysing that, it will be possible to deduce data that will help both assessment and intervention. Table 1 analyses the dimensions of symbolic play and the strategies to develop its acquisition from the classification by Marchesi (1987) p.38-42.

Table 1. Relationship between dimensions of symbolic play and possible cognitive strategies to facilitate its development (taken from Sáiz, 2000 p. 120-121).

Dimensions	Content	Cognitive intervention strategies
Decentralisation	*First stage*: Everyday actions referring to one's own body and devoid of any real purpose (e.g.: "drinking from an empty glass"). *Second stage*: Games directed towards other participants: *people* or *dolls*; these are taken as passive agents, receivers of the child's action (12-18 months). *Third stage*: The child gives greater participation to people or dolls. This is an advance in the process of decentration (24-30 months), e.g. the child puts the fork in the doll's hand instead of feeding it directly and also accompanies its actions with its own verbal expressions or by attributing intentions, feelings or emotions to the agents.	- Facilitate the child's interaction with toys (with the adult acting, if necessary, as a *model of the* actions to be carried out). - Enable the child to interact with toys (dolls and toys that help the child to reproduce everyday contextual situations), *modelling* and *shaping of* play situations by the adult. - Let the child initiate interactions; if necessary *model* situational patterns of descentration through overt verbal language as a behaviour regulating agent's actions.

Dimensions	Content	Cognitive intervention strategies
Substitution of objects	*First stage*: The child uses mainly real objects (brush, fork...) or small-scale reproductions for his play. *Second stage*: The child substitutes a real object for an undefined one (makes a stick into a fork...) as long as they have some quality that allows them to perform the same function to a certain extent. *Third stage*: The child replaces an object with a very precise function (fork) with an object with a very different function (comb).	- Facilitate the child's interaction with toys in order to imitate functional actions; if necessary *model* the action by the adult. - Facilitate the child's interaction with toys in order to initiate possible functional substitutions; *model* the action using substitution of objects, which may have some relation to those they substitute. - Enable the child to make non-functional substitutions; *model* the action by using objects in the substitution that are not similar to the objects they are substituting.
Integration	*First stage*: Games are simple, isolated actions. *Second stage*: Elementary production takes place, consisting of applying simple schemas to two or more objects or agents. *Third stage*: Multi-schema combinations involving two or more symbolic actions. There will be an evolution in these: first the actions will be disordered and more or less juxtaposed; then they will be organised in a truly integrated sequence.	- Provide the child with appropriate contexts and situations to initiate the development of play. - Enable more elaborate game situations through *modelling* and *shaping* by progressively increasing the difficulty in organisation and sequencing.
Planning	*First stage*: The child seems to be provoked by the presence of certain toys or objects; they are not directed by a concrete plan or action. *Second stage*: The child looks for the materials needed for a certain game and makes preparations before starting the game, and/or verbally announces that they are going to carry it out (indicating that they have a plan to execute).	- Provide the child with toys and situational frameworks for the action to take place. - *Modelling* and *shaping* situations that facilitate the elicitation of intentionality towards play; using language as a regulator of the actions that are performed.

d. *The forerunners of theory of mind in the sensorimotor period.*

At the end of the sensorimotor period, children begin the development of representation. However, its genesis is many months earlier. From eight to twelve months the **triangular relationships** that are established between **the child, adults and objects** present a series of characteristics:

1. the baby's actions cannot be effective in the world, they need the interventions of the adults in their immediate environment to be executed (Gómez, 1990; Gómez, 1992; Rivière and Coll, 1985).
2. communicative actions include **patterns of joint attention**, before, during or after the execution of a gesture, the child seeks eye contact with the adult (Rivière, 1997).
3. **Gestural communication**. Gestures can be used either to make requests of objects to others (**proto-imperative**) or to show situations (**proto-declarative**). The difference between

the two types of gestures lies in the fact that the latter consider the person as the object of interaction and not only as a means of achievement. That is why prelinguistic intentional communication seems to indicate that there is some kind of understanding of the mental processes of others, these early communicative behaviours would be the initial manifestations of theory of mind (Wellman, 1993). Protodeclarative gestures are understood as more complex communicative behaviours than protoimperative gestures, as they require **metarepresentational capacities**. The behaviours of mentally sharing a situation with another involve being aware that the other has a mind that can share that situation with one's own mind, which involves second-order representations or representations of the mental experiences of others and therefore more complex cognitive understanding (Gómez, Sarriá, & Tamarit, 1993).

Another significant concept for understanding how the development of the precursors of theory of mind begins is **intersubjectivity**. Trevarthen (1982; 1989) differentiated between **primary intersubjectivity**, face-to-face reactions with nurturing figures in which infants would manifest different expressions and would develop from two to four or five months, and **secondary intersubjectivity**, the child's deliberate motivation to share interests and experiences with other people and would manifest itself around the first year of life.

Symbolic play is also considered a precursor to theory of mind, and acquisition begins at the end of the second year, at the same time as the development of other representational skills begins.

Thus, **the link between the development of prodeclaratives, symbolic play and theory of mind is most likely the ability to have meta-representations** (Leslie, 1987; Leslie and Happé, 1989; Gómez, Sarriá and Tamarit, 1993).

1.2. Therapeutic Implications in Early Childhood

So far, the most important acquisitions in the sensorimotor period have been analysed, although an overall developmental picture that would facilitate the creation of intervention programmes is lacking. First of all, it should be **pointed out that there is no single way of intervening, as this will depend on the initial developmental level of the child in question. Therefore, before any action is taken, it is necessary to evaluate the real situation of the subject we want to work with, in order to define a baseline for intervention and subsequently analyse both the acquisition processes and the acquisitions themselves.**

Table 2 (Sáiz, 2003), presents an analysis of the developmental stages and possible sensorimotor acquisitions that occur at these ages, as well as the cognitive intervention strategies that will help the acquisition process (Rivière and Coll, 1985 and Delval, 1996).

Table 2. Cognitive strategies to support child development during the sensorimotor period (taken from Sáiz, 2000 p. 122-123).

Developmental ages and their relationship to the stages of the sensorimotor period.	Sensorimotor intelligence	Cognitive intervention strategies
Stage I (0-1 months)	- Development of reflexes. - Signs of accommodation of perceptual selection schemes (attunement to attachment figures). - Beginning of *non-specific linkage*.	- Develop visual tracking of objects. - Facilitate sucking-pausing relationships between mother and baby. - Enable breast-shaking or feeding-pause container relationships. - Implement rocking-pause relationships.

Developmental ages and their relationship to the stages of the sensorimotor period.	Sensorimotor intelligence	Cognitive intervention strategies
Stage II (1-4 months)	- Primary circular reactions. - First adaptations acquired. - First scheme co-ordinations. - Beginning of the social smile. - Emergence of primary intersubjectivity. - Start of proto-conversations.	- Develop sucking and grasping coordination. - To facilitate vision-hearing coordination. - To develop phonation-audition coordination. - Enabling the elicitation of social smiles. - Facilitating the development of primary intersubjective behaviours. - Implement the development of contingency awareness. - Develop circular games. - Facilitate the development of proto-conversational patterns between infant and nurturing figures.
Stage III (4-8 months)	- Secondary circular reactions. - Full coordination of vision and grasping. - Beginning of the means-ends differentiation. - Anticipatory behaviours.	- Facilitating the development of vision-impairment coordination. - Enable the development of the beginning of means-ends differentiation. - Facilitate the development of the search for partially hidden objects. - Enable the development of anticipatory behaviours.
Stage IV (8-12 months)	- Coordination of secondary schemes. - Pursuit of ends using others as means. - Reciprocal assimilation of means-ends. - Progressive differentiation of means-ends. - First acts of practical intelligence. - Occurrence of intentional behaviours. - Beginning development of proto-imperative behaviours.	- Facilitating pursuit of ends by using other schemes as a means. - Search for completely hidden objects that have just been hidden. - Enable situations in which the child has to communicate and reinforce intentional communication behaviours. - Facilitate the development of proto-imperative behaviours.
Stage V (12-15 months)	- Tertiary circular reactions. - New media are discovered by experimentation and known patterns are differentiated.	- Facilitate the search for an object in different places where it can be hidden.
Stage VI (15-18 months)	- Use of new media by mental combination. - Occurrence of proto-declarative behaviours. - Object permanence. - Start of performance.	- Present problem situations in which the child has to develop mental combination. - Facilitate situations in which the child has to develop protodeclarative behaviours. - Facilitate the search for objects in all locations. - Facilitate the development of representative behaviour.

In the *first stage, attunement-harmonisation patterns* develop. Infants appear oriented to respond to *social stimuli* that facilitate the development of *patterns of interaction* with others. They synchronise muscular responses to the prosodic characteristics of the human voice, as well as orienting their perceptual system towards members of their own species. They also shows emotional expressions imitating others'. All these behavioural responses facilitate *caring* and *protective* behaviours in the adult, both *physiologically* and *emotionally* and *affectively*. This is followed by the *first shared experiences* between adult and baby. From two to 4-5 months, the *primary circular reactions* develop, and the differentiation between *assimilation* and *accommodation* begins, evolving towards the progressive coordination of elementary sensorimotor schemes (vision, hearing, grasping, sucking, vocalisation and the first relational behaviours), although *intentional communication* as such does not exist yet. From two to three months of age, the recognition of the *expressive significance* of others' gestures begin to appear, initiating the progressive development of the *social smile*. Trevarthen (1982) speaks of a *primary intersubjectivity* or *interpersonal motivation* system, which is a kind of *primary regulator* of *mental development*. From that, the baby initiates the recognition of familiar and unfamiliar people. From six to eight weeks there are exchanges of complex expressions of interaction between the baby and the mother or attachment figure. Although there is still no *communicative intention* as such, the adult will attribute it to the baby and this is an essential step in the baby's *cognitive*, *social and communication development.* Another aspect to consider is the emergence of *contingency perception* (Watson and Ramey, 1972). The development of *circular play* facilitates the emergence of expressive behaviour on the part of the child and the perception of contingency relationships. Repeated and contingent situations help lay the foundations for *predictability* and *anticipation*, which are the building blocks for the development of later *intentional behaviour* (Atance and Meltzoff, 2005). From four to eight or nine months, *recognition*, *anticipation* and *attachment* develop. The infant becomes increasingly active in interactive exchanges. There is the beginning of *differentiation* between the baby's own *expressive behaviours*, understood as a *means of* obtaining *social stimulation* contingent on these behaviours. There is an improvement in the development of *anticipatory* and *memory behaviours*. An indicator of this is the *ability to recognise*; the first *recognition schemes* are established in the *here and now*, in the immediacy of the present, so it is not yet recognition that lasts over time. At around five months of age, *visual recognition* of the mother or the parent figure begins, which is the beginning of attachment, establishing the development of the *specific attachment*. This progressive differentiation of the attachment figure means in turn the differentiation of the "self", of the "I", from the environment and therefore the beginning of *categorical differentiation* in the social world (Olson, 1981).

The *anticipation of contingencies* from *shared interaction patterns* is part of the basis for the development of communication (Rivière and Coll, 1985 and Rivière, 1997). By the end of Stage III, *anticipatory signals* are increasingly restricted and the mere presence of the attachment figure is sufficient to initiate patterns of interaction and anticipation. It is therefore important to facilitate *relational* situations for *cognitive development* as well as for *affective and social development*. The child not only learns immediate contingencies in *interaction situations*, but also learns the *scripts* of interaction and communication. By the fifth *month, the* child's relationships with others are increasingly realised through objects (Schaffer, 1984; Deval, 1996). All this occurs at the same time as a progressive increase in hand-eye coordination skills and fine manipulative coordination. As noted above, the development of *triangulation relationships* between adult, child and objects begins. However, the relationship patterns in the interaction of the baby towards objects and towards adults are different and consequently *means-ends differentiation* appears (Rivière and Coll, 1985).

The schemes of interaction and intentional communication begin at around eight months, and the first *communicative behaviours* proper appear (Bates, 1976; Bates, Benigni, Bretherton, Camaloni, and Volterra, 1979) along with manifestation of *coordination of schemes of action* directed at objects. This co-ordination involves intentional co-ordinations to achieve an end, so that there is a progressive differentiation of means-ends, indicating *intentionality*, the first manifestation of *intelligent behaviour*.

The development of *intentional communication* is important not only from the point of view of communication initiation but also from the perspective of *protomental* development. It begins, as already noted, with the emergence of *proto-imperative* gestures towards the end of the first year and continues with *proto-declarative* gestures which emerge approximately towards the end of the second year (Rivière and Coll,

1985). The highest point of the process is marked by the development of *secondary intersubjectivity*, which is nothing other than the expressed motivation to share interests and situations with others (Trevarthen, 1982).

Thus, in the *sensorimotor period,* basic aspects of cognitive, social and communication development are developed, which could be summarised as follows (Delval, 1996):

> 1. *"Object recognition*: This occurs when the child can use *schemas* that they have already applied previously and obtain the same results. The *reciprocal coordination* of these *schemas* allows them to see that the same object can *be explored* from different spheres and therefore *be known* from different dimensions and yet it is still the same object. Object recognition appears when they can use the same *schema* in *new situations* and obtain the same results as in a previous event, and also when different events take place in the same order and they can therefore *anticipate* what is going to happen next. The application of the same *schemas* is what enables them to *identify objects* and establish *categorical relations* between them.
>
> 2. *Object permanence*: Its acquisition is fundamental in the development process; it allows the child to discover that an object exists beyond the *here and now*. At the end of the *sensorimotor period*, the acquisition of object permanence begins, a representation which enables the child to play mentally with objects and situations.
>
> 3. *Problem solving*: Cognitive growth generates the *acquisition of problem-solving skills* and *strategies*, a fundamental aspect for the development of *cognition*. *Stage III* is when the acquisition of *means-ends differentiation* and the development of *secondary circular reactions* begins. In the *fourth stage,* the child begins to set a priori goals, the child carries out actions different from the end in itself, while in the *fifth stage they begin* to use *new means* to achieve their ends, thus using strategies that allow them to reach the goals they desire. Throughout the sixth *stage, the* development of *representation* begins and therefore the possibility of solving problems on the symbolic plane and not only in present situations. This achievement takes place around the age of two and is one of the fundamental acquisitions in cognitive and language development.
>
> 4. *Intentional communication patterns*: The onset of intentional communication develops with the acquisition of *proto-imperatives* (at the end of the first year) and *proto-declaratives* (at the end of the second year).
>
> 5. Development of the precursors of the *Theory of Mind*.
>
> 6. Beginning of the *development of self-awareness*, the progressive evolution of language and *symbolisation capacities* allow the subject to develop a *reflective conscience*" (Sáiz, 2003 p. 124-125).

Table 3 shows a summary of the acquisitions seen, as well as possible strategies to facilitate their development (Sáiz, 2003).

Table 3. Relationships between interaction subjects, representational acquisitions and cognitive strategies that can encourage development (adapted from Sáiz, 2003 p. 125-126).

OBJECTS OF KNOWLEDGE AND INTERACTION	REPRESENTATIONAL ACQUISITIONS	COGNITIVE INTERVENTION STRATEGIES
OBJECTS	- Knowledge of the properties of objects. - Object permanence. - Problem solving with objects.	- Facilitate the development of strategies for approaching and observing objects. - To know the same object according to its characteristics. - Facilitate the development of hide-and-seek games (e.g. peek-a-boo). - Enable the development of the resolution of simple tasks to involve the use of means-ends strategies.

OBJECTS OF KNOWLEDGE AND INTERACTION	REPRESENTATIONAL ACQUISITIONS	COGNITIVE INTERVENTION STRATEGIES
PERSONS	- Attachments to attachment figures. - Petitioning behaviour. - Interactions with others: establishing gestures of greeting, farewell, etc.	- To increase the development of interaction situations with the parenting figures and their close environment. - Develop "give and take" games. - Enable the use of gestures in social situations.

By way of summary, during the **sensorimotor period** (approximately 0-18 months), the child gradually establishes regularities in everyday interaction situations, which facilitates the ability to develop **anticipatory behaviour.** At the end of this period, the possibility of using **symbolic means** to solve everyday problems appears. Capacity for **representation** increases in complexity with regard to the use of signifiers. First, indexes or signs are used, then symbols and finally language signifiers.

2. Structure for creating programmes for 0-3 years of age.

We suggest using the script of a stimulation programme developed by Sáiz, M.C. and Román, J.M. (2011). *Mentalistic Stimulation in Early Childhood*. Madrid: CEPE, as it presents a practical adaptation of all the aforementioned current trends in development to the world of stimulation. The programme includes the following intervention units that refer to the stimulation of all the mental precursors corresponding to the evolutionary milestones of the sensorimotor period.

Unit 1: Ability to develop object tracking skills.

Unit 2: Ability to perform pause-suction actions I.

Unit 3: Ability to perform pause-suction actions II.

Unit 4: Ability to perform rocking-pause actions.

Unit 5: Suction pressure coordination skills.

Unit 6: Vision-hearing coordination skills.

Unit 7: Speech-listening coordination skills.

Unit 8: Ability to develop social smile.

Unit 9: Ability to develop primary intersubjective behaviours.

Unit 10: Ability to develop contingency awareness.

Unit 11: Ability to develop conversational patterns.

Unit 12: Ability to develop vision-awareness coordination.

Unit 13: Ability to develop means-ends differentiation.

Unit 14: Ability to develop object finding skills.

Unit 15: Ability to develop anticipatory behaviours.

Unit 16: Ability to develop means-ends schemes.

Unit 17: Intentional communication skills.

Unit 18: Ability to develop proto-imperative behaviours.

Unit 19: Ability to develop proto-declarative behaviours.

Unit 20: Ability to develop secondary intersubjectivity skills.

Unit 21: Representational Skills I.

Unit 22: Representational Skills II.

These units are based on a common structure, which includes the following sections:

1. Specification of the intervention unit.
2. Structure of the Intervention Unit:
   - Objective of the intervention.
   - Indicators for the evaluation of the intervention unit.
   - Task (activities).
   - Materials needed for the intervention.
   - Generalisation activities (i.e., activities that are similar to those in the task but involve a different context or are more challenging).

2.1. Examples of 0-3 year programmes

The following is an example of an intervention unit taken from the Sáiz-Manzanares and Román (2011) programme.

Unit: Ability to develop pause-suction actions II.

Objectives

1. To develop visual tracking of objects.

Evaluation indicators

- The baby follows objects presented in its field of vision.
- The baby follows objects presented in its field of vision from right to left.
- The baby follows objects presented in its field of vision from left to right.
- The baby follows objects that are presented in its up-down field of vision.
- The baby follows objects presented in its field of vision from bottom to top.

Task

Present objects that are attractive (brightly coloured, and that produce no loud noises) to the baby. Place them in the baby's field of vision from left to right or right to left. From top to bottom and from bottom to top.

Materials

Brightly coloured rattles.

Brightly coloured objects (roundels that can be grasped).

Generalisation activities

Present the baby with various different-sized objects. Place shiny objects that are not too large in the baby's field of vision (about 15-20 cm from the baby's eyes) and draw the baby's attention to them. When the baby is looking at the object, move it from one side of the baby's face to the other, passing through the centre. Move the object up and down from chest height to forehead. Repeat the exercise in a field 30 cm in diameter.

Sáiz-Manzanares and Román (2011) p. 47-48.

3. Concepts of development in ages 3-6: implications for programme development

During the preoperational period the child consolidates many of the acquisitions they began in the sensorimotor period while acquiring new ones. By the end of the sensorimotor period, the child has acquired the ability to represent, although with incomplete development, since consolidating it needs the development of other systems of representation, such as language. Piaget (1952) called this period pre-operational, from his perspective the child has not yet developed operations—sets of actions organised in systems that are dependent on each other. One of the achievements during this pre-operational period is the construction of invariants. Invariants means that the child learns that an object remains the same, even if it undergoes various transformations, and therefore it maintains its identity (acquisition of the identity of objects) (Delval, 1996). There is also important language development during this period, particularly inserting it into the subject's own actions

and those of others. From the Vygotskian perspective, language is a privileged vehicle of cognition that allows the subject to use words to represent concepts, inter-conceptual relations and interactive sequences with both objects and people. This acquisition facilitates the child's transition from the world of experimentation to the world of deduction. This is a key milestone in the development of problem-solving processes. Another important acquisition in this period is theory of mind, which is the ability to think about what others think, to put oneself in their place and to act accordingly in order to achieve things or induce situations.

4. Programme development structure for ages 3-6

4.1. Lines for cognitive intervention in the preoperative period

The following programs offer lines for interventions to facilignitive and social development:

Sáiz-Manzanares, M.C., and Román, J.M. (1996). Programa de intervención cognitiva para niños pequeños. Madrid: CEPE.

Sáiz-Manzanares, M.C., and Román, J.M. (2010). Programme for the development of mental skills in young children. Madrid: CEPE.

The first programme works on the basic prerequisites for learning, the skills to develop: planning thinking (means-ends strategies); self-evaluative thinking; consequential thinking; alternative thinking and identifying emotions. The second works on the skills to: solve interpersonal problems; identify causes and effects of actions; identify the mental states of others; generate consequences; and to evaluate. It also works on the acquisition of using mental verbs: knowing, teaching, wondering, solving, supposing, understanding, explaining, learning, remembering, believing and the resolution of first-order and second-order false belief tasks. Table 4 summarises the most representative acquisitions in the pre-operational period, as well as some of their limitations (Delval, 1996) and possible intervention strategies (Sáiz and Román, 1996).

Table 4. Acquisitions and limitations of pre-operational thinking (reference Delval, 1996) and the cognitive strategies that can favour its development (reference Sáiz and Román, 1996) (adapted from Sáiz, 2003, p. 128-129).

PREOPERATIVE ACQUISITIONS	COGNITIVE INTERVENTION STRATEGIES
- Ability to represent by means of differentiated signifiers. The child develops the ability to represent that began in the sensorimotor period. - Ability to communicate through language: * informative function: transmitting/receiving information through language. * self-regulation of one's own behaviour through language. * function of regulating the behaviour of others through language. - Ability to use language to explain the events of everyday life. - Understanding of entities and functions (acquisition of invariants and regularities of a qualitative nature). * Identities. An object remains the same even if it undergoes some transformations (as long as the transformations are qualitative). * Functions: Functional dependence is developed (a change in one situation produces a change in the second and so on, deals with qualitative transformations). - Differentiation between appearance and reality. - Elaboration of the theory of mind.	- Facilitate the development of representational skills (through the use of language, drawing, deferred imitation, improvement of symbolic play, in general of all representational skills. The adult will act by modelling (acting as a model) and shaping (guiding the child's actions verbally and/or manually). The adult will also reinforce the child's attempts (however small they may be). - To promote the child's use of language both to ask for and to transmit information. - The adult will model their own actions by regulating their own behaviour through their own language (Meichenbaum and Goodman's (1969) strategies of self-instructional training). - The adult will first shape the child's actions through their own language and then seek to make the child regulate their own actions with their own language (see Cognitive Training Programme, Sáiz and Román, 1996). - Work from the tangible, providing the child with multiple experiences that help them better understand: * The variations that occur in objects and fundamentally the process of transformation both in the formation of identities and in the development of functional dependence. - Work on the development of resolution processes. - Facilitating the development of theory of mind, enabling fictional and dramatized situations that help the child to break out of centring processes, to put them self in the place of the other and to take different perspectives or points of view into consideration.

BEGINNING OF ACQUISITIONS AND LEARNING THAT MUST BE PERFECTED IN THE PRE-OPERATIVE PERIOD	COGNITIVE INTERVENTION STRATEGIES
- Begins to develop problem-solving strategies, but has difficulty in considering several aspects of the same situation simultaneously. - Still has difficulties in understanding that an object can belong simultaneously to two classes. - Has difficulty understanding processes and tends to see elements in isolation. - Has difficulty in developing generalisation processes.	- To facilitate the development of problem-solving processes* by enabling the child to tangibly deal with several aspects of the same situation simultaneously. - Using problem-solving strategies* the adult will play games in which the child can see that an object can belong to two or more categories at the same time (categorisation processes). - Place special emphasis on the child observing and understanding the process and not just the outcome of a problem or situation. - Facilitate the development of generalisation processes* of learning. * See Cognitive training programme for young children (Sáiz and Román, 1996).

Work on current lines of metarepresentational development in the pre-operational period has been explained above. However, they can be expanded with the bibliography below.

Sáiz-Manzanares, M.C. (2003). Cognitive intervention in young children. In A. Gómez, P. Viguer and M.J Cantero (Eds.), *Intervención Temprana: Desarrollo óptimo de 0 a 6* años (pp.117-133). Madrid: Pirámide.

Sáiz-Manzanares, M.C. and Román, J.M. (2010). *Mentalistic skills development programme*. Madrid: CEPE.

Sáiz-Manzanares, M.C., & Payo, R.J. (2012). *Psychology of Early Childhood Development: A Teaching Project adapted to the European Higher Education Area*. Burgos: Servicio de Publicaciones de la Universidad de Burgos.

Sáiz-Manzanares, M.C. (2018). *E-project based learning in Occupational Therapy: an application in the subject "Early Stimulation"*. Burgos: Servicio de Publicaciones de la Universidad de Burgos.

4.2. Lines of language intervention in the pre-operative period

Following the Vygostkian perspective, language development—although it cannot be reduced to cognitive development—is directly involved with the development of pragmatic function. Recent research highlights the relationship between the development of metarepresentational skills, mental skills and the development of comprehension and expressive language in terms of phonological, morphosyntactic, semantic and especially pragmatic development. The following is a summary of the most significant current theoretical contributions. Although they are more exhaustively described in:

Sáiz-Manzanares, M.C. (2003). Cognitive intervention in young children. In A. Gómez, P. Viguer and M.J Cantero (Eds.), *Intervención Temprana: Desarrollo óptimo de 0 a 6* años (pp.117-133). Madrid: Pirámide.

Sáiz-Manzanares, M.C. and Román, J.M. (2010). *Mentalistic skills development programme*. Madrid: CEPE.

Sáiz-Manzanares, M.C., & Payo, R.J. (2012). *Psychology of Early Childhood Development: A Teaching Project adapted to the European Higher Education Area*. Burgos: Servicio de Publicaciones de la Universidad de Burgos.

Sáiz-Manzanares, M.C. (2018). *E-project based learning in Occupational Therapy: an application in the subject "Early Stimulation"*. Burgos: Servicio de Publicaciones de la Universidad de Burgos.

The most representative milestones in this context are discussed below.

Development of "mental verbs".

Mental verbs have been considered metarepresentational expressions. Human beings can make their own mental states—and inferences about the mental states of others—explicit through language. Antonietti, Liverta-Sempio, Marchetti, and Astington (2006) analysed the most representative studies on the acquisition of theory of mind and its possible relationship with the "linguistic skills" associated with the acquisition and use of mental verbs. It appears that there are relationships between children's semantic and syntactic competences and their competences in solving mental tasks. However, the acquisition of syntactic skills alone cannot explain mental development (Astington, 2000; Charman & Shmueli-Goetz, 1998; Ruffman, Slade, Rowlandson, Rumsey, & Garnham, 2003; Perner, Sprung, Zauner, & Haider, 2003). Looking at the relationship between the development of mental skills and semantic development, Antonietti et al. (2006) found strong correlations between the acquisition of mental verbs and the acquisition of first-order tasks and low correlations between these and the development of second-order tasks. In *first-order* tasks the questions represent *mental states* produced by *mental acts*; in *second-order* tasks the questions represent *mental activities*. The verbs that these authors include in the "metacognitive vocabulary test" (Antonietti et al., 2006) coincide more with mental states than with mental acts. According to these authors, second-order tasks include a high level of recursive thinking "I think he thinks he thinks she thinks", in which linguistic and metalinguistic components play a minor role. Another important factor in understanding mental development is the age variable. Papafragou, Cassidy, and Gleitman (2007) studied the development of mental verbs such as *think* or *know* and their relationship with age. These verbs do not appear until children are three years old and are not differentiated from each other until they are at least four years old. For these authors, the difficulties in acquiring mental verbs can be explained by the difficulty children have in observing and experiencing them. Such verbs require contextual situational frameworks that favour experimentation and testing the causality of propositions of semantic and syntactic relations. Comprehension of mental states increases significantly with age (Gopnik & Astington, 1988; Perner & Wimmer, 1985; Wellman, 1995; Wimmer & Perner, 1983). Comprehension of the second-order theory of mind task is difficult to a high degree at all ages. This complexity has been explained by several hypotheses: the syntactic complexity of the task, the age of the subjects and the development of representational levels (Astington, 2001; Olson and Astignton, 1993). It seems that metacognitive skills in mental verbs and in the development of meta-representation are important for the proper creation of belief specifically in first-order tasks but not in second-order tasks due to the problematic recursion involved. It should be understood that in the former the child can represent situations, but in the latter they have to represent mental states, i.e., the mental content of a mental act (Antonietti et al., 2006). Mental verbs express mental states, involving propositions that mark a relationship between the subject, the context (propositions), the attitude (mental state), and the part of the real world being evaluated (Doherty, 2009). If the propositional content of the subject's belief corresponds to the state of situations in the real world, the subject's belief is true and if not it is false (Astington, 1998 p. 91-92). In this framework it is important to relate the *thoughts* (the mental states: beliefs, desires, intentions and emotions) that a subject has to the *words* (the verbal expression of the mental states) that they use and to the *facts* (the behaviours). We can only observe actions and behaviours and listen to the words that others use. Mental states are inferred from language and behaviours (Astington, 1998 p.97).

According to Scholnick (1987, quoted by Sotillo and Rivière, 2000a p. 207) the following aspects should be considered in children's understanding of mental language:

1. *Definition of the semantic space of the language of mental reference*. This refers to the understanding of representational and meta-representational aspects.
2. *Definition of the processes by which the child acquires understanding*. This refers to the metacognitive capacity in the processes of semantic comprehension.
3. *Definition of the context in which the language is used*. This refers to the contextual situation in relation to the language.

Another important variable for the understanding of belief states (especially of the second order) is introduced here, namely *metacognitive capacity* in the development of the understanding process. In mental verbs such as "to know" [referring to *metacognitive mental processes*, the difference between what a subject knows and the process of knowing will be marked. That is, the difference between "knowing something" and "knowing how to arrive at that knowledge" (procedure)]. It is important to keep in mind that behind every mental verb there is a cognitive and sometimes a metacognitive process that goes beyond

the semantic content. Mental verbs have three important properties: *factivity*, *intentionality* and *recursivity*. *Factivity* refers to the property of a verb by which the truth of its predicate is assumed (Kiparsky and Kiparsky, 1970 cited by Rivière and Sotillo, 2000 p.171; Sotillo and Rivière, 2000a p. 208). Sotillo and Rivière (2000), in their review of research on mental verbs, point out that the acquisition of factivity in children begins around the age of 4 years and continues until adolescence. It is important to differentiate between factive verbs (knowing, forgetting, remembering) and non-factive verbs (thinking, believing and dreaming), since with age the acquisition of one improves over the other. Factuality is in some cases related to *intentionality*. The intentionality of a mental verb implies an absence of commitment to the truth of the predicate of that verb (Searle, 1983 cited by Rivière and Sotillo, 1998 p.173). *Intentional mental verbs* refer to mental or cognitive functions that the subject cannot see directly and *non-intentional mental verbs* refer to mental functions or processes that the subject, although not able to see, can objectify from the execution itself. Intentional verbs: 1.- Do not ensure the veracity of an utterance; 2.- Do not ensure the existence of the predicate element and 3.- It is not possible to substitute that utterance with another that has the same reference, this is what has been called *referential opacity* (Rivière, Sotillo, Sarriá, and Nuñez, 2000 p.129). Riviére et al. (2000) studied the relationships of the verbs: *remember*, *believe* and *know* in children aged 4.5 to 5.5 years. They found that the relationships between prediction and non-intentional verbs such as *remember* and *know* are fulfilled but this is not the case for the intentional verb *believe*. The difficulty in the acquisition of verbs ranges from the simplest, to *remember*, then to *know* and the most complex to *believe*. The truth is that there are a series of linguistic statements that are difficult to measure and quantify, as they have a subjective reference. Thus, Theory of Mind relates to the development of *mental states*, the development of language, especially in its pragmatic components, cognitive and metacognitive processes (Rivière and Nuñez, 1996).

4.3. Lines of intervention in entities and functions of transformations in the pre-operative period

In recent decades, research on Piagetian theory has led to changes in the understanding of developmental acquisitions related to the world of interactions with objects and the reasoning used in understanding them. The most significant contributions to the knowledge of the world of transformations and to the understanding of physical phenomena are presented below. The following summary is based on the book by Goswami, U. (2008). Cognitive Development: The Learning Brain. Hove and New Cork: Psychology Press.

a. Causal reasoning and the world of transformations.

Causal reasoning is a general domain of skills and a core of cognitive development. Children around the age of three begin to analyse different physical causes and their effects on objects (cutting, melting, breaking etc.). Causal reasoning requires children to think in a spatio-temporal causal sequence. Gelman, Bullock, and Meck (1980) suggest that children at age three understand some of the cause-effect relationships of relationships that occur over reversible events. However, Gupta and Bryant (1989) criticised the methodology used in Piagetian studies. For them it is possible to solve sequences of causal reversibility before developing causal reasoning correctly. Sometimes children at this age may choose the most salient answer which does not necessarily have to be the correct one from the point of view of a causal reasoning sequence, but in their answer they have not taken into account all the possibilities given from sequentially reasoned thinking. For these authors, true causal thinking implies the representation of the transformation sequence from its initial state to its final state. Three-year-olds are likely to be distracted by the most salient or important of the possible options, this type of response is non-canonical in the beginning of the development of early causal thinking. Understanding sequences requires causal inference based on the difference between the initial state of an object and its final state. Thus, representational causal reasoning begins around the age of three years and is acquired, depending on the type of problem, around the age of four years, although the understanding of causal reasoning in real and non-representational situations begins as early as the age of two years. However, it will not be fully acquired until the subject has a causal understanding of the physical world.

b. Reasoning and causal principles

Causal reasoning has been studied from the causal parameters proposed by Hume (1748).

1. Principle of priority

   Causes precede effects. Particular mechanisms of causal transmission may develop before those of spatial or temporal transmission and may determine causal attributions. This is why the context in which they develop is important. Shultz (1978) demonstrated the importance of children's development of "conscious self", i.e., meta-knowledge about causal agents in developing their own causal reasoning.

2. Covariation principle

   Causes and their effects should covary systematically. Shultz and Mendelson (1975) showed that children between the ages of three and four can use this type of inference about covariation to determine causality, mostly choosing the correct answers. Siegler and Liebert (1974) concluded that the ability to make inferences about causal covariation simply depends on the physical phenomena.

3. Principle of temporal contiguity

   Causes and their effects must be contiguous in space and time. This principle is closely related to the principle of covariation, as it implies temporal covariation and also temporal contiguity. The latter is related to the principle of priority whereby causes precede their effects. Thus, if physical rationality is delayed in time between cause and effect, the principle of temporal contiguity may take time to occur. Shultz and Mendelson (1975) concluded that the absence of time-contingent cause-effect indicates its importance for the development of the principle of covariation and in the comprehensive development of causal reasoning.

4. Principle of similarity of causes and effects

   Shultz and Ravinsky (1977) noted the importance of cause-effect similarity. Recent studies explain similarity reasoning from the use of Bayes' Theorem A→B→C or A←B→C or A←B←C (Gopnik, Gymour, Sobel, Shultz, Kushnir, and Danks, 2004). Gopnik, Sobel, Schulz, and Glamour (2001) examined whether two- to four-year-olds could discriminate which objects have causal power over others. They concluded that children's causal inferences are consistent with the relationships between causality and probability of occurrence proposed by Bayes' theory. In addition, these authors indicated that children have the capacity for causal representation through the use of relationship maps between events.

c. Understanding causal changes

Understanding causal structure is crucial in making causal inferences (Shultz, Pardo, and Altmann, 1982). If the causes of A on B produce C (A→B→C), it implies that there is no direct relation between A and C.

d. Therapeutic implications

In summary, it seems that the beginnings of causal thinking about physical objects are present in children from the age of two, and this coincides with the onset of their representational capacity. However, the development of rational causal thinking is directly related to the ability to develop meta-representation, i.e., to mentally imagine trajectories of objects and representations of them from a mental continuum, even if that is not a visible time-based sequence. Of particular importance in this process is the way in which transformation tasks are presented. If the tasks are presented in a real and experimental way, children will be able to tangibly verify the possible transformations of an object. This will later enable the ability to make meta-representations of them and mentally produce a transformation sequence, even if it is not spatially contingent in the here and now. Causal reasoning is fundamental to cognitive development, it is particularly important in learning about empirical relations in the world, and in learning what the world is like.

Current lines of development and their relation to cognition in the pre-operational period have been summarised above. However, they can be expanded with the following bibliography, which can be taken as explanatory manuals:

Goswami, U. (2008). *Cognitive Development: The Learning Brain: The Learning Brain.*

Sáiz, M.C. (2003). Cognitive intervention in young children. In A. Gómez, P. Viguer and M.J Cantero (Eds.), *Intervención Temprana: Desarrollo óptimo de 0 a 6* años (pp.117-133). Madrid: Pirámide.

Sáiz, M.C., & Payo, R.J. (2012). *Psychology of Early Childhood Development: A Teaching Project adapted to the European Higher Education Area*. Burgos: Servicio de Publicaciones de la Universidad de Burgos.

4.4. Examples of programs for children aged 3-6

The developmental increase in problem-solving ability is one of the enigmas of human developmental psychology. This increase seems to be related to the cognitive increase that in humans is linked to their ability to use increasingly sophisticated strategies in problem-solving processes. The difficulties lie in evaluating the type and use of these strategies, as they cannot be observed directly and have to be inferred from the analysis of the problem-solving process. A number of general skills incorporated in the solving process can be identified in any problem-solving task:

1. Recognise that there is a problem.
2. Identify a goal.
3. Plan a strategy to solve the problem.
4. Observe whether the strategy is effective.

Research in problem solving has shown that children can succeed in solving Piagetian problems where they have not traditionally done so. Success depends on how the problem is formulated and how familiar the subject is with the type of problems posed (Gelman, 1978). Another variable that seems to be involved in problem solving is language development (Donaldson, 1993). The process of problem solving can be supported by applying the following tools:

1. Stimulation and guidance through language.
2. Help in the choice of material.
3. Help in the preparation of the assembly.
4. Modelling and shaping actions.

It should also be borne in mind that not all problems can be taught in the same way; those that are more familiar are easier and those that involve different levels of abstraction are more complex. The work on current lines of problem solving in the pre-operational period was summarised above. More information is available in the bibliography listed below.

Sáiz, M.C. (2003). Cognitive intervention in young children. In A. Gómez, P. Viguer and M.J Cantero, *Intervención Temprana: Desarrollo óptimo de 0 a 6* años (pp.117-133). Madrid: Pirámide.

Sáiz, M.C. and Román, J.M. (1996). *Cognitive training programme for young children.* Madrid: CEPE.

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Sáiz, M.C., & Payo, R.J. (2012). *Psychology of Early Childhood Development: A Teaching Project adapted to the European Higher Education Area*. Burgos: Servicio de Publicaciones de la Universidad de Burgos.

Below, an outline is proposed for creating intervention programmes based on the book by Sáiz-Manzanares, M.C. and Román, J.M. (1996). *Programa de entrenamiento cognitivo para niños pequeños.* Madrid: CEPE. Sáiz, M.C. & Román, J. M. (2010). This programme is structured in intervention units using the following scheme:

1. Objectives.
2. Assessment indicators per unit.
3. Tasks.
4. Materials.

5. Generalisation activities.

The Cognitive Training Programme for young children is aimed at children aged four to seven years or older with developmental difficulties. Both the programme and the assessment instruments allow for an individual analysis of each child. The programme addresses the following units of therapeutic intervention:

Unit 1: Attentional skills. Works on the development of the basic prerequisites for learning: attention, imitation, following instructions.

Unit 2: Relaxation skills. Work on relaxation practice by segmentation.

Unit 3: Discrimination skills of the different weather conditions. This is a regular activity in the Infant Education curriculum and is the starting point for the modelling technique.

Unit 4: Thinking aloud skills (I). This is the key unit in the whole programme. Through the figure of a pet, children are helped in the acquisition of general strategies in problem solving processes:

1. Focusing attention. Through the question "What is my problem?
2. Planning: Through the question: "How am I going to do it?
3. Continuous evaluation of the process: "How am I doing?
4. General self-evaluation of the whole process: "How did I do it?

Unit 5: Thinking aloud skills (II). Using the solving process from unit 4, we work on the task of discriminating geometric figures.

Unit 6: Skills to develop alternative plans. Using the solving process from unit 4 applied to a puzzle solving task.

Unit 7: Verbal labelling skills I. Using the solving process from Unit 4 applied to a solving task of finding items equal to.

Unit 8: Verbal labelling skills II. Using the solving process from unit 4 applied to a solving task of looking for distinct items that.

Unit 9: Phonetic and semantic discrimination skills. Using the resolution process from unit 4, we work on phonetic and verbal discrimination tasks, which are common in the second cycle of the infant education curriculum.

Unit 10: Auditory inhibition skills. Using the resolution process from unit 4, listening tasks are worked on in which children must develop inhibition processes when they hear the key word.

Unit 11: Interpersonal problem solving skills (I). Using the resolution process from unit 4, the development of interpersonal problem solving begins. We work on situations of happiness, anger, sadness, reinforcing positive feelings as opposed to negative ones.

Unit 12: Categorisation skills. Using the solving process from unit 4, the children are introduced to the importance of categorisation in decision making before solving a problem.

Unit 13: Ability to identify causes. Using the resolution process from unit 4, consequential thinking is worked on.

Unit 14: Thinking aloud skills (III). Using the resolution process from unit 4. Role-talking is worked on in the solving process. Also, the maze solving task.

Unit 15: Interpersonal problem solving skills (II). Using the solving process from unit 4, the child is encouraged to start thinking of more than one solution to a problem.

Unit 16: Ability to identify meaningful sentences. Using the resolution process from unit 4, we work on the analysis of meaningful sentences using consequential thinking.

Unit 18: Ability to generate consequences (I). Using the resolution process from unit 4, we work on consequential thinking.

Unit 19: Ability to generate consequences (II). Using the resolution process from unit 4, we work on consequential thinking.

Unit 20: Auditory inhibition skill (II). using the resolution process from unit 4, we work from consequential thinking.

Unit 21: Ability to generate consequences (III). Using the solving process from unit 4, subjects are asked to find more than one consequence to the solutions given.

Unit 22: Ability to evaluate (I). Using the resolution process from unit 4, we work from the categorisation of: security-insecurity.

Unit 23: Inductive thinking skills. Using the solving process from unit 4, inductive thinking is worked on.

Unit 24: Ability to evaluate (II). Using the resolution process from unit 4, we work from the categorisation of: "fair-unfair".

Unit 25: Ability to evaluate (III). Using the resolution process from unit 4, we work from the categorisation of: "good-bad feelings".

Unit 26: Ability to evaluate (IV). Using the resolution process from unit 4, we work from the categorisation of: "effectiveness-non-effectiveness".

Unit 27: Ability to evaluate (V). Using the resolution process from unit 4, we work on the resolution of an interpersonal problem using all of the previously seen categorisation criteria.

Unit 28: Ability to evaluate (VI). Using the resolution process from unit 4, the resolution of an interpersonal problem is worked on using all the previously seen categorisation criteria.

Unit 29: Ability to evaluate (VII). Using the resolution process from unit 4, we work on the resolution of an interpersonal problem using all the previously seen categorisation criteria.

The programme from Sáiz-Manzanares, M.C. , and Román, J.M. (2010) is also provided as an example. *Mentalistic skills development programme*. Madrid: CEPE. This programme is structured in intervention units that follow the same scheme as the previous programme:

1. Objectives.
2. Assessment indicators per unit.
3. Tasks.
4. Materials.
5. Generalisation activities.

The Mental Skills Development Programme for young children is aimed primarily at children between 4 and 7 years of age, although it can be applied at other ages to establish or reinforce the development of the mental skills described, as well as in the framework of special education with respect to pathologies associated with deficits in the acquisition or development of task resolution and/or in the acquisition or development of mental skills. This programme provides a series of assessment instruments that allow the teacher to study individual children through the analysis of tasks during problem-solving processes, facilitating the assessment of competences related to cognitive and metacognitive content in mental tasks. The units covered by the programme are described below.

Unit 1: Interpersonal problem-solving skills (I). This unit begins the work on interpersonal problem solving. Problem-solving strategies applied from the four steps of metacognitive resolution are proposed (Meichenbaum and Goodman, 1969; Camp and Bash, 1985): "What is my problem?", "How can I solve it properly?", "Am I following the strategies I thought of?", "How did I do?". The self-instructional training is based on the identification of feelings of joy, sadness and anger, reinforcing positive feelings as opposed to negative ones. The intervention structure is as follows:

1.- Focusing attention, through the first image and the question: "What is my problem?" or "What is my task?", we will try to make the child aware of what they have to do, what they have to solve.

2.- Planning: in order to satisfactorily solve a task or problem of any kind, it is necessary to think about the strategies to be used. There needs to be a process of analysis between the possible answers and their consequences. This is a complex step in the processing and analysis of information that will require the subject to make a precise study of both the task and the appropriate strategies to solve it. The teacher or therapist models the process through the second figure by asking "How can I do it" or "What do I have to do to solve it? Here the development of planning thinking is worked on.

3.- Continuous evaluation of the process: The solver has to reflect on whether the solving process they are following agrees with what they planned. Systematic feedback of the process is essential in order to be able to modify it if necessary. We work with the third image by asking: "How am I doing?", thus developing self-evaluative thinking.

4.- General self-evaluation of the whole process. It is very important that the solver develops self-evaluative thinking, so that they learn to self-reinforce when they have resolved a task or situation well and to manage tolerance to frustration when they have not done so and can in this case begin to resolve the task again. To do this, the therapist uses the fourth slide with the question: "How did I do?"

Unit 2: Ability to identify causes and effects of actions (I).

Work begins on the development of causal and consequential thinking. It is important to initiate children in analysis before making decisions. All behaviour has causes (antecedents) and also consequences (consequents). In other words, a series of consequences will follow from the answers they give to a problem. Children are taught to analyse the factors for and against, so that the consequences do not come as a surprise later on.

Unit 3: Ability to identify causes and effects of actions (II).

This unit continues the work started in unit 2 on the development of causal and consequential thinking.

Unit 4: Ability to identify the mental states of others (I).

Role-taking (putting oneself in the other person's place) is worked on to solve a task or a problem. It starts by considering the mental states of the other person and giving a solution to a problem by thinking from the mental state of another person and not from one's own.

Unit 5: Ability to identify the mental states of others (II).

The work described in unit 4 is followed up in a variety of situations.

Unit 6: Ability to identify the mental states of others (III).

The work described in unit 4 is followed up in a variety of situations.

Unit 7: Ability to generate consequences (I).

In this unit we try to increase the difficulty and ask the children to indicate more than one consequence to a problem, and in turn to analyse the possible situational effectiveness of these consequences.

Unit 8: Evaluation skills (I).

This unit aims to increase the difficulty of analysing the processes of solving an interpersonal task, from the evaluation of the mental states of others and the hypothesis of possible answers to a situation taking into account the mental states of the characters and not one's own.

Unit 9: Evaluation skills (II).

Reinforces the objectives seen in Unit 8.

Unit 10: Evaluation skills (III).

Reinforces the objectives seen in Unit 8.

Unit 11: Ability to use the verb to forget.

This unit aims to introduce children to the conceptualisation of mental verbs such as forgetting. The aim is for the child to analyse the given stories taking into account the mental states of the characters and to use the verb to forget in common, everyday situations.

Unit 12: Ability to use the verb understand.

This unit aims to introduce children to the conceptualisation of mental verbs such as understand. The aim is for the child to analyse the given stories taking into account the mental states of the characters and to use the verb understand in common, everyday situations.

Unit 13: Ability to use the verb to teach.

This unit aims to introduce children to the conceptualisation of mental verbs such as teach. The aim is for the child to analyse the given stories taking into account the mental states of the characters and to use the verb teach in common, everyday situations.

Unit 14: Ability to use the verb wonder.

This unit aims to introduce children to the conceptualisation of mental verbs such as wonder. The aim is for the child to analyse the given stories taking into account the mental states of the characters and to use the verb wonder in common, everyday situations.

Unit 15: Ability to use the verb decide.

This unit aims to introduce children to the conceptualisation of mental verbs such as decide. The aim is for the child to analyse the given stories taking into account the mental states of the characters and to use the verb decide in common, everyday situations.

Unit 16: Ability to use the verb suppose.

This unit aims to introduce children to the conceptualisation of mental verbs such as suppose. The aim is for the child to analyse the given stories taking into account the mental states of the characters and to use the verb suppose in common, everyday situations.

Unit 17: Ability to use the verb comprehend.

This unit aims to introduce children to the conceptualisation of mental verbs such as comprehend. The aim is for the child to analyse the given stories taking into account the mental states of the characters and to use the verb comprehend in common, everyday situations.

Unit 18: Ability to use the verb explain.

This unit tries to introduce children to the conceptualisation of mental verbs such as explain. The aim is for the child to understand the given stories taking into account the mental states of the characters and to use the verb explain in common, everyday situations.

Unit 19: Ability to use the verb learn.

This unit aims to introduce children to the conceptualisation of mental verbs such as learn. The aim is for the child to analyse the given stories taking into account the mental states of the characters and to use the verb learn in common, everyday situations.

Unit 20: Ability to use the verb remember.

This unit aims to introduce children to the conceptualisation of mental verbs such as remember. The aim is for the child to analyse the given stories taking into account the mental states of the characters and to use the verb remember in common, everyday situations.

Unit 21: Ability to use the verb believe.

This unit aims to introduce children to the conceptualisation of mental verbs such as believe. The aim is for the child to analyse the given stories taking into account the mental states of the characters and to use the verb believe in common, everyday situations.

Unit 22: Ability to solve first-order false belief tasks (I).

This unit works on the resolution of first-order false belief tasks. It tries to implement the work done in other units, from the analysis of the mental states of the characters who in this case have a false belief.

Unit 23: Ability to solve first-order false belief tasks (II).

This unit works on the resolution of first-order false belief tasks. It tries to implement the work done in other units, from the analysis of the mental states of the characters who in this case have a false belief. This unit aims to reinforce the work in the previous unit (22).

Unit 24: Ability to solve first-order false belief tasks (III).

This unit works on the resolution of first-order false belief tasks. It tries to implement the work done in other units, from the analysis of the mental states of the characters who in this case have a false belief. It aims to reinforce the work of units 22 and 23.

5. STEPS TO INITIATE THE DEVELOPMENT OF AN EARLY INTERVENTION PROGRAMME

The steps to start the development of a therapeutic intervention programme for 0-6 year-olds are outlined below.

1. Study the user's medical history.
2. Assess their current age of development in the different areas (psychomotor, cognitive, communication and language, socialisation and personal autonomy).
3. Establish the difference between the developmental age and the chronological age of the user.
4. Establish priorities of the most affected development area(s).
5. Depending on the professional profile of the therapist, choose the corresponding area and start drawing up the intervention programme, always based on collaborative and interdisciplinary work.
6. The programme should include objectives, evaluation indicators, activities, materials, spaces, start date, follow-up date and results. A record template is recommended, such as the example attached.

Objectives	Evaluation indicators	Activities	Materials	Spaces	Start date	Follow-up date	Results

Summary

This module dealt with the development of early care programmes aimed at children aged 0-6 years, split into two periods, 0-3 and 3-6. We reviewed the evolutionary milestones of the two developmental periods, sensorimotor and pre-operational. We looked at examples of pre-existing programmes for both periods, as well as a general outline for creating therapeutic intervention programmes.

Glossary

This topic does not have a specific glossary as the concepts have been explained throughout the module.

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Comprehension questions

Answer (true answer is in bold)

Question 1. The following are understood to be precursors of mentalistic abilities

a) The discovery of objects.
b) Symbolisation.
c) Symbolic play.
d) **All of them.**

Question 2. The main manifestations of the symbolic function are:

a) Imitation.
b) Deferred imitation.
c) Language.
d) **Both b and b.**

Question 3. Representation is initiated by

a) **With triangular relationships between the child, the adult and the objects.**
b) With dyadic relationships between the child and the objects.
c) With dyadic relationships between child and adults.
d) None of the above.

Question 4. Representation is initiated by

a) **With triangular relationships between the child, the adult and the objects.**
b) With dyadic relationships between the child and the objects.
c) With dyadic relationships between child and adults.
d) None of the above.

Question 5. The forerunners of Theory of Mind relate to

a) Proto-imperative gestures.
b) **Protodeclarative gestures.**
c) Both a and b.
d) None of them.

Question 6. An early intervention programme should include

a) Objectives.
b) Evaluation indicators.
c) **Both a and b.**
d) Neither a nor b.

Question 7. Which of the following verbs is not a mentalistic verb?

a) To know.
b) To believe.
c) To assume.
d) **To do.**

Question 8. What techniques should an early intervention programme include

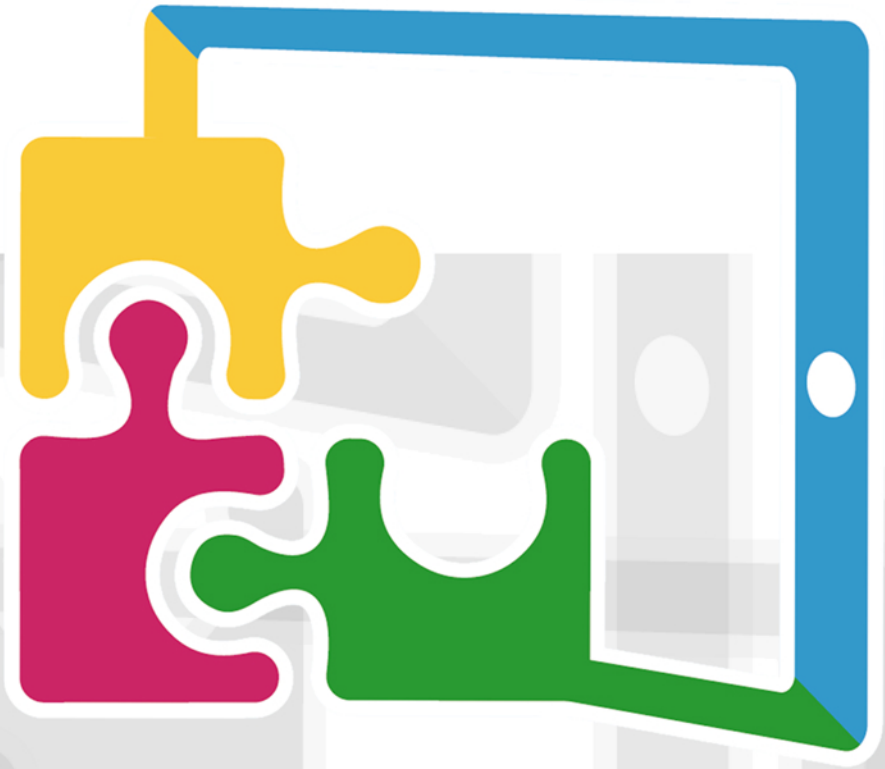
a) Modelling.
b) Moulding.
c) Social reinforcement.
d) **All of them.**

Question 9. An early intervention programme in the preoperative period should work on

a) **Planning thinking.**
b) Manipulative imitation.
c) Verbal imitation.
d) None of the above.

Question 10. Causal reasoning should be worked on in

a) The sensorimotor period.
b) **The pre-operational period.**
c) The gravitational period.
d) In the intersubjective period.



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