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# TERAPIA OCUPACIONAL EN DISCAPACIDAD INTELECTUAL: FUNCIONALIDAD, PROCESAMIENTO COGNITIVO Y COMPONENTES MOTORES.

# OCCUPATIONAL THERAPY IN INTELLECTUAL DISABILITY: FUNCTIONALITY, COGNITIVE PROCESING AND MOTOR FUNCTIONS.

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A mi familia y amigos

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"La verdadera discapacidad es la persona que se niega a reconocer sus propias habilidades" Mandy Harvey.

## ABREVIATURAS

| | |
|---|---|
| ID | Intellectual Disability |
| WHO | World Health Organization |
| ADL | Activities of daily life |
| BADL | Basic activities of daily life |
| IADL | Instrumental activities of daily life |
| IFS | INECO Frontal Screening |
| WAIS-IV | Wechsler Adult Intelligence Scale |
| BADS | Behavioural Assessment of the Dysexecutive Syndrome |
| ANOVA | Analysis of variance for one factor |
| NHPT | Nine Hole Peg Test |
| MPG | Mechanical Pinch Gauge |

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# 1. RESUMEN

La discapacidad intelectual se caracteriza por la manifestación de alteraciones en el funcionamiento intelectual y el comportamiento adaptativo de las personas, presente antes de los 18 años. El término de funcionalidad representa la capacidad para mantener en equilibrio el desempeño de tareas, de actividades y el mantenimiento de habilidades y funciones a lo largo de la vida del individuo. La limitación en alguna habilidad, destreza, función o capacidad de procesamiento puede conllevar a una pérdida de la funcionalidad, viéndose afectada la participación en las actividades de vida diaria. El procesamiento cognitivo implica la gestión de estímulos, almacenaje de información en nuestra memoria y su posterior utilización en nuestra vida diaria. Las funciones ejecutivas son el conjunto de procesos cognitivos superiores que permiten el control, la organización y la coordinación de las acciones y del comportamiento. Las funciones ejecutivas incluyen habilidades de planificación, organización, flexibilidad cognitiva, memoria de trabajo, monitorización y autorregulación. Por otra parte, los recursos atencionales hacen alusión a los procesos cognitivos que mantienen un estado de regulación adecuado para poder tomar decisiones, planificar y desarrollar de forma adecuada las actividades de vida diaria. La discapacidad intelectual, por definición, implica una limitación en las habilidades intelectuales y de funcionalidad; sin embargo, no conocemos qué procesos cognitivos específicos son los que pueden estar afectando el desempeño de las actividades de vida diaria. Desde el ámbito motor, las actividades de vida diaria implican habitualmente destrezas manuales específicas para cada movimiento realizado. Las destrezas manuales se definen como la habilidad para orientar los miembros superiores en el espacio, de manipular objetos y agarres con la mano. Según la literatura revisada, no existe evidencia suficiente que indique que la destreza manual está alterada en estas personas; sin embargo, desde una perspectiva

clínica puede observarse como personas con discapacidad intelectual muestran ciertas limitaciones motoras a la hora de realizar movimientos cotidianos. Por lo tanto, podría ser importante conocer si estas personas presentan limitaciones reales en las destrezas manuales en el desempeño de las actividades diarias. Conocer cuáles son los factores que implican una alteración en el desempeño de las actividades de vida diaria puede condicionar un abordaje más específico desde la terapia ocupacional.

Los objetivos principales de esta tesis doctoral son: evaluar los niveles de funcionalidad y de función cognitiva y motora en personas con discapacidad intelectual, e investigar la posible relación entre la funcionalidad y estas funciones en una muestra de personas con discapacidad intelectual.

La presente tesis incluye tres estudios descriptivos de tipo observacional-transversal. En el primer estudio se incluyeron 90 personas adultas mayores de 18 años con diagnóstico de discapacidad intelectual. Este estudio tuvo como objetivo la evaluación de la funcionalidad en las actividades de vida diaria y las funciones ejecutivas, además del análisis de su posible relación. En el segundo estudio se incluyeron 88 personas adultas mayores de 18 años con diagnóstico de discapacidad intelectual, divididas en dos grupos. Un primer grupo contaba con 39 personas con discapacidad intelectual moderada y, un segundo grupo, con 49 personas con discapacidad intelectual leve. En este estudio, el objetivo fue evaluar la funcionalidad en las actividades de vida diaria y los procesos atencionales en ambos grupos, además de su posible relación. En el tercer estudio se incluyeron 65 personas adultas mayores de 18 años con diagnóstico de discapacidad intelectual y se evalúo las destrezas manuales de coordinación y fuerza muscular de los miembros superiores. En relación a las herramientas de evaluación utilizadas en la tesis, en el primer estudio se usaron

instrumentos de evaluación del desempeño en las actividades de vida diaria y de las funciones ejecutivas globales, tales como la capacidad de abstracción, la flexibilidad cognitiva, la atención alternante, la producción verbal fluida y la planificación. Las herramientas utilizadas para el segundo estudio fueron instrumentos de evaluación de actividades de vida diaria e instrumentos que evaluaron los recursos atencionales: span de atención, atención sostenida, atención dividida, atención alternante y la atención ejecutiva. En el tercer estudio se evaluó la destreza manual mediante instrumentos de evaluación de la coordinación y la fuerza muscular de la prensión y pinzas digitales. Los procedimientos de evaluación fueron similares en todos los estudios.

Los resultados del primer estudio de la tesis sugieren diferencias entre personas con y sin discapacidad intelectual para el desempeño de las actividades instrumentales de la vida diaria y el rendimiento para las funciones ejecutivas tales como la capacidad de abstracción, atención sostenida, inhibición de conducta verbal-motora, perseveraciones, memoria de trabajo, programación motora, span de atención, fluencia verbal, flexibilidad cognitiva, atención alternante y planificación. Por otra parte, el grado de dependencia-independencia para las actividades instrumentales de la vida diaria apareció relacionado con el rendimiento global de las funciones ejecutivas en el grupo de personas con discapacidad intelectual, donde un aumento de la dependencia para estas actividades estaba directamente asociado a un rendimiento inferior en las funciones ejecutivas. El control ejecutivo global y las habilidades de planificación mostraron en conjunto una predicción del 81% de la varianza explicada de la dependencia para las actividades instrumentales de la vida diaria en la muestra de personas con discapacidad intelectual leve-moderada. En el segundo estudio de la tesis, las personas con discapacidad intelectual también mostraron un rendimiento inferior en los recursos atencionales respecto al grupo de personas sin discapacidad. En el segundo

estudio de la tesis, la comparativa entre personas con discapacidad intelectual leve y moderada reveló diferencias entre los grupos para la atención selectiva, sostenida y ejecutiva, con una magnitud de diferencia que varió de pequeña a grande, pero no hubo diferencias para la atención dividida y alternante. Respecto al desempeño de las actividades básicas de la vida diaria, este apareció asociado a la edad de los participantes, el grado de discapacidad y el rendimiento en la atención sostenida, explicando un 40% de su varianza. Respecto al desempeño de las actividades instrumentales de vida diaria, la atención sostenida, dividida y ejecutiva explicaron un 68% de su varianza en las personas con discapacidad intelectuales leve-moderada. En relación al tercer estudio de la tesis, los resultados observaron diferencias en las funciones de destreza manual entre las personas con y sin discapacidad intelectual, ya que las personas con discapacidad requerían más tiempo para ejecutar las tareas que implicaban la ejecución de movimientos precisos y coordinados, además de mostrar niveles inferiores de fuerza. Sin embargo, no se observaron diferencias en las destrezas manuales entre las personas con un grado de discapacidad leve y moderada.

Las principales conclusiones de las tesis son que las personas con discapacidad intelectual muestran alteraciones en el desempeño de los aspectos cognitivos y motores, afectando a su funcionalidad para el desempeño las actividades de vida diaria. Estas personas parecen mostrar un rendimiento inferior que las personas sin discapacidad en los componentes cognitivos de abstracción, la memoria de trabajo, la programación motora, el control inhibitorio, el procesamiento mental, la flexibilidad cognitiva, la planificación, la atención sostenida, la atención dividida, la atención alternante y la atención ejecutiva. En esta línea, se puede destacar que el procesamiento de los recursos atencionales también parece ser diferente entre personas con discapacidad intelectual moderada y leve, encontrándose diferencias en la atención selectiva, sostenida y

ejecutiva. Las personas con discapacidad intelectual también parecen experimentar limitaciones en el rendimiento de la destreza manual, tanto en las funciones de coordinación como de la fuerza muscular, en comparación con personas sin discapacidad intelectual, no siendo determinante el grado de discapacidad que la persona presenta. La funcionalidad para las actividades de vida diaria básicas parece ser influenciada por la edad, el grado de discapacidad y la atención sostenida. Por otra parte, la funcionalidad para las actividades instrumentales de la vida diaria parece igualmente ser influenciada por el rendimiento en las funciones ejecutivas, tales como la capacidad de planificación, la atención sostenida, la atención dividida y la atención ejecutiva. Estos resultados podrían contribuir al diseño y desarrollo de programas de intervención basados en la evidencia en esta población que involucren estrategias de apoyo específicas enfocadas a la ocupación para satisfacer las necesidades individuales de estas personas. Además, los resultados de las tesis pueden facilitar el diseño de estrategias encaminadas a la adaptación de las actividades terapéuticas usadas en el ámbito social-laboral-clínico. Estas estrategias deberían focalizarse en el desarrollo de herramientas terapéuticas que potencien las funciones ejecutivas, los recursos atencionales y las destrezas manuales.

## 2 ABSTRACT

Intellectual disability is defined as the manifestation of alterations in adaptive behaviour and intellectual functionality in individuals, occurring before the age of 18. Functionality is the ability to balance the performance of tasks, activities and the maintenance of skills and functions throughout an individual's life. Limitations in any of these areas could result in a loss of functionality, impacting participation in daily activities. Cognitive processing involves stimulus perception, storage in our memory, and subsequent utilization in our daily lives. Executive functions are the set of higher cognitive processes that enable the control, organisation and coordination of actions and behaviour. These skills include planning, organization, cognitive flexibility, working memory, monitoring, and self-regulation. On the other hand, attentional resources refer to the cognitive processes that maintain an adequate state of regulation in order to be able to make decisions, plan and develop daily life activities appropriately. Intellectual disability, by definition, implies a limitation in intellectual ability and functionality. However, we do not know which specific cognitive processes may affect the performance of activities of daily living. In the motor domain, activities of daily living usually involve specific manual dexterity for each movement performed. Manual dexterity is defined as the ability to orient the upper limbs in space, manipulate objects, and perform various hand grips. Intellectual disability usually implies a limitation of intellectual and functional abilities, but we do not know which specific cognitive processes may affect the performance of activities of daily living. As far as we know, there is not enough evidence to suggest that manual dexterity is impaired in these people; however, from a clinical perspective, it can be observed that people with intellectual disabilities show certain motor limitations when performing everyday movements. Therefore, it seems important to know whether these people have real

limitations in manual dexterity when performing everyday activities. Knowing the factors that imply a change in the performance of activities of daily living can condition a more specific approach from occupational therapy.

The objectives of this doctoral thesis were as follows: to evaluate levels of functionality, cognitive and motor skills in people with intellectual disabilities, and to investigate whether there is a relationship between these skills in people with intellectual disabilities.

This thesis includes three observational-cross-sectional descriptive studies were conducted to achieve these objectives. The first study included 90 adults over 18 years of age diagnosed with intellectual disabilities, evaluating functionality in activities of daily living and executive functions, and analysed their possible relationship. The second study included 88 adults over 18 years of age with a diagnosis of intellectual disability, divided into two groups. The group with mild intellectual disabilities comprised 49 individuals and the group with moderate intellectual disabilities consisted of 39 individuals. Functionality in daily activities and attentional processes were assessed between these two groups of individuals with disabilities, and analysed their possible relationship. In the third study 65 adults over 18 years of age diagnosed with intellectual disabilities were included, and manual skill of coordination and muscular strength of the upper limbs in individuals with this diagnosis was evaluated. The tools used in the first study included assessment instruments for daily activities and global executive functions, abstract reasoning ability, cognitive flexibility, alternating attention, verbal fluency, and planning. Instruments used for the second study included evaluation tools for daily activities and instruments assessing attentional resources: attention span, sustained attention, divided and alternating attention, and executive

attention. Tools used for the third study assessed manual dexterity through instruments evaluating hand coordination and strength. The evaluation procedure was consistent across all studies.

The results of the first study of the thesis suggest differences among individuals with intellectual disabilities in the performance of instrumental activities of daily living and lower performance in executive functions, such as abstraction ability, sustained attention, inhibition of verbal and motor behaviour, perseveration, working memory, motor programming, attention span, verbal fluency, cognitive flexibility, alternating attention, and planning, compared to the group without disabilities. On the other hand, the degree of dependence-independence for instrumental activities of daily living in the group of the people with intellectual disabilities appeared to be related to overall performance in executive functions, where an increase in dependence for these activities was directly associated with lower performance in executive functions. The overall index for the assessment of executive dysfunction and planning predicted 81% of the explained variance in dependence for these activities in the sample of individuals with mild to moderate intellectual disability. Attentional resources also demonstrate lower performance in individuals with intellectual disabilities compared to the group without disabilities. However, in this second study, the comparison between individuals with mild and moderate intellectual disabilities revealed differences between the groups for selective, sustained, and executive attention on a small to large scale, but there were no differences for divided and alternating attention. The relationship between attentional resources and the performance of basic daily activities may be associated with the age of participants, the degree of disability, and sustained attention, explaining 40% of the explained variance. Sustained, divided, and executive attention explains 68% of the explained variance in the performance of instrumental activities of daily living in

individuals with mild and moderate intellectual disabilities. Differences were also found in this study between individuals with disabilities and those without disabilities regarding manual dexterity. In manual coordination, individuals with disabilities require more time to execute a task compared to those without disabilities. Similarly, manual strength is altered in the group of individuals with disabilities. However, there are no differences based on whether individuals have a moderate or mild disability.

The main conclusions of the thesis indicate that individuals with intellectual disabilities exhibit impairments in both cognitive and motor skills, affecting their functionality in daily activities. They show lower performance than individuals without disabilities in cognitive components such as abstraction, working memory, motor programming, inhibitory control, mental processing, cognitive flexibility, planning, sustained attention, divided attention, alternating attention, and executive attention. However, it is noteworthy that attentional resource processing is not equal between individuals with moderate and mild intellectual disabilities, with differences observed in selective, sustained, and executive attention but no differences in divided attention and alternating attention. Individuals with intellectual disabilities also experience limitations in manual dexterity performance, including coordination and strength, compared to individuals without intellectual disabilities, with the degree of disability not determining the level of dysfunction in motor components. Functionality for daily activities is altered by age, degree of disability, and sustained attention when it comes to basic activities. While functionality is related to executive function, planning ability, sustained attention, divided attention, and executive attention in instrumental activities. This information could contribute to the design and development of evidence-based intervention programs for this population, involving specific support strategies focused on occupation to meet individual needs. Additionally, the results of the study could

facilitate the design of strategies aimed at gauging the actual support needed by these people and can be used to adapt therapeutic activities in order to develop a therapeutic tool to enhance executive functions, attentional resources and manual dexterity.

# 3 INTRODUCTION

## 3.1 Intellectual Disability

According to the World Health Organization, intellectual disability (ID) is a condition characterized by delayed or limited mental development. It is primarily identified by the deterioration of specific functions at various developmental stages, impacting overall intellectual abilities. These limitations may include alterations in cognitive, language, motor, and socialization abilities. For this reason, individuals with ID may face challenges in adapting to their environment. The assessment of intellectual development levels in cases of ID involves a comprehensive approach, considering diverse strategies such as the use of clinical indicators and evaluation of the practical adaptive skill in daily life (World Health Organization, 2001). The American Association on Intellectual and Developmental Disabilities states that, in addition to significantly below-average intellectual performance, simultaneous limitations are observed in two or more areas of adaptive skills. These areas include communication, personal care, daily living, social skills, community living, self-care, home management, community participation and engagement, self-direction, health and safety, functional academic skills, leisure, and work. It is important highlighting that this condition usually occurs before the age of 18 years (Navas et al., 2008; Schalock et al., 2012; Verdugo Alonso, 2012). The previous description also aligns with the International Association for the Scientific Study of Intellectual and Developmental Disabilities and the International Classification of Functioning Disability and Health (Navas et al., 2008).

There have been changes in recent decades in how disability is perceived or understood. Currently, a new model focused on the development of individual functioning within a social context has emerged. These updates to the concept of ID

stem from improved research on the social construct of illness, a differentiation between the biological or social causes of disability, and the recognition of the multidimensionality of human functioning (Katz & Lazcano-Ponce, 2008; Schalock, 2013). A multidimensional approach to disability entails classification systems proposing dimensions where individuals may exhibit limitations but emphasize the need to include a support plan necessary to address these limitations (Gutiérrez et al., 2018; Schalock et al., 2012). The classification according to "The Diagnostic and Statistical Manual of Mental Disorders -DSM-5", categorizes ID as mild, moderate, and severe (Katz & Lazcano-Ponce, 2008; Lense et al., 2011). The classification systems propose dimensions that emphasize the generation of a support plan that improves the quality of life of people with disabilities. This support plan should use a methodology focused on the design and application of multiple and diverse type of supports. These supports must provide facilitators for daily participation of these individuals (Jiménez et al., 2017).

Support plans contribute to the learning and performance of activities that are significant for every individual with ID. Supports are defined as resources and strategies that promote the development, learning, interests and well-being of people with specific needs. A support plan involves evaluating the needs of these individuals, determining the level of intensity at which the supports should be provided, and generating guidance for professionals and the community on how to implement each support. The design of this intervention plan makes it possible to improve the functioning of people with ID in all dimensions of quality of life (Buntinx & Schalock, 2010; Schalock et al., 2012). The construction of these support plans should be established using the available scientific evidence regarding the factors that limit individuals with ID from performing well in daily tasks.

In Spain, the prevalence of individuals with ID among all represented disabilities was 12.6% in the year 2022, according to data obtained from the National Institute of Statistics. In Andalusia, the prevalence of individuals with ID was 16.4%. In the labour market, active people with disabilities were 35.3% in 2022. This employment activity rate was 42.7 points lower than that of the population without disabilities (INE, 2022). These data could indicate that various societal factors may have a significant impact on the personal, family, social, and health spheres of this population. Hence, research on ID is essential for building inclusive and equitable societies where all people have the opportunity to fully participate in all aspects of life (Gutiérrez et al., 2018).

## 3.2 Occupational Therapy as a discipline approaching intellectual disabilities

Occupational therapy supports people's health, using occupation to develop active participation, physical well-being, emotional well-being and independent living. Health is understood as a state of physical, mental and social well-being, not just the absence of disease. This factor is important because of its influence on people's ability to function (Canelo et al., 2008). Participation is defined as a living environment where people naturally engage in meaningful occupations or activities based on their own interests. Performance in occupations is based on an interrelationship between the activity, individual abilities, the individual's motivation and the meaning attributed to the occupation in a given context (Law, 2002; Taylor et al., 2024). A European study on the health of people with ID conducted in Spain indicates a higher use of health care and higher rates of mental illness, neurological diseases, eating disorders, and sensory and mobility impairments in people with ID than in the general population (Martínez-Leal et al., 2011).

The framework for Occupational Therapy practice is an approach that aims to provide a holistic understanding of health maintenance processes (O'Brien & Kielhofner, 2017). The conceptual aspects that comprise this framework includes the "domain" and the "process", which will be further developed below:

- The "domain" of occupational therapy comprises the following factors: occupation, context, performance, performance skills and client factors. The interaction of the factors allows the construction of occupational identity enhances the health and well-being of individuals and promotes the active participation of people in their daily lives. Thus, the domain directly influences human functioning (Taylor et al., 2024).

- The "process" refers to the services provided to the client. In the context of ID, the process involves developing a person centred support plan that enables individuals to achieve their personal goals based on their interests (Taylor et al., 2024). Therefore, the main aim of the process is to promote people's health, identity and sense of competence. However, for the 'process' to be applied accurately, evidence is needed regarding the physical and mental factors that are related to the 'domain' in this population.

The domain conceptually defines the characteristics of the individuals, considering all factors that may interrelate in maintaining human functioning. Participation in human occupations involves an engagement in activities that take place throughout an individual's life. Activities are in turn composed of different tasks. All activities performed by humans can be categorized under the construct of the activities of daily living (ADL). ADLs hold significance for the individual performing them, as they provide meaning and purpose to their life. Although individuals engage in ADLs

on a personal level, there are also activities that people participate in as part of society (O'Brien & Kielhofner, 2017).

ADLs are context-related and influenced by performance skills or "client factors". The environment and personal factors that influence the generation of opportunities to develop occupations constitute the context. Performance skills are defined as the necessary abilities that allow a person to perform an activity successfully. They are classified into motor, cognitive or social interaction skills according to the occupational therapy framework. Individual factors are the capacities, characteristics or beliefs that reside within individuals, groups or populations. These factors influence occupational performance. Client factors are conditioned by performance abilities, the presence or absence of illness, disabling conditions and life experiences. The client's motivations and beliefs influence their engagement in occupations aligned with the values, that is, the things that are truly important to people. Body structures and functions are made up of body systems (sensory, cardiovascular, musculoskeletal, respiratory, endocrine and mental functions) and anatomical structures (Law, 2002; Taylor et al., 2024). This entire conceptual framework helps to understand the relationship between a person's skills, abilities, and capacities, and their performance in the activity.

Patterns of performance form a construct that includes an individual's habits, routines, roles and rituals as the occupation develops. These factors are what establish lifestyle and help to achieve a balance between the areas of occupation present in people's lives, commonly known as "occupational balance". The classifications of ADLs are diverse; for example, one classification divides ADLs into: education, work, play, free time, and social participation. Specifically, habits refer to adaptive behaviours that develop throughout a person's life. Routines are a sequence of activities that give

structure to daily life. Roles are made up of participation in a set of activities or in a specific activity, but which are expected by society, based on culture and context (Taylor et al., 2024).

Occupational therapy assesses and analyses individuals' domains to address their specific needs, enabling tailored intervention processes and support plans that enhance participation in daily life. It is important to consider the contexts in which the person has developed, as these contexts shape life experiences and values. In Spain, policies on care for people with disabilities have been evolving over the last 60 years (Escoriaza, 2018). In the infant stage, individuals can develop and learn in special education centres or in ordinary educational centres. Special education centres provide comprehensive attention to the diversity of each student, while ordinary education centres offer specialised attention and curricular adaptations for each student (Martinez-Pujalte et al.,n.d.). The choice of one centre or another is usually conditioned by the support needs of the person. In the juvenile stage, there are programmes that accompany the transition of young people to adult life, with the main objective being participation in compulsory education training activities, participation in the community and the generation of satisfactory social relations (Pallisera et al., 2014). In the adult stage, historically, the models were aimed at providing care services, offering care programmes, and providing training in personal and social skills. However, to promote inclusion and respond to the increased visibility of the rights of people with, laws have been passed to prioritize labour inclusion as a fundamental aspect of current approaches to addressing this population. Consequently, social inclusion for these individuals has been promoted (Verdugo Alonso, 2018).

The basic areas of attention for this group of people in our country at present are (Escoriaza, 2018):

- Care centres: day centres, occupational centres, respite services, psychosocial rehabilitation centres, residential homes and assisted living facilities.

- Workplaces and special employment centres.

Analysing the services available in Spain, people with ID continue to be segregated from the environments where the general population undergoes typical training and professional development. The development of care models for people with ID is evolving towards person-centred plans, active support, personalised employment or employment with support, where these models. These models, together with the framework of occupational therapy, allow the development of independence in ADL, promoting their autonomy and human functioning (Becerra Traver et al., 2012). Person-centred work models promote contexts that can offer opportunities for participation in occupations based on the motivation of people with ID (Egido-Gálvez et al., 2009). The environment is important for generating habits, routines and roles related to the occupations that individuals engage in throughout their lives, as these occupational aspects enhance performance skills. New insights into performance skills could improve the current training programs aimed at improving the performance of the ADLs. The objectives of occupational therapy in this specific area, as part of its clinical reasoning, are firstly to identify the skills, capacities, or abilities required to carry out various ADLs. Secondly, to conduct assessments that provide insights into the individual's personal characteristics related to these skills. Finally, occupational therapy aims to promote autonomy in the performance of ADL since the development of occupation is

part of human functioning. Therefore, it is important to observe what factors may be modulating the performance of ADL in order to establish assessments and support plans aimed at maintaining or enhancing the functioning of people with ID.

### 3.3 Functionality in people with intellectual disability

Functionality is defined as the ability to perform ADLs taking into account performance skills, client factors, participation, and context, according to the Model of Human Occupation (Taylor et al., 2024). However, according to the Model of Human Functioning, that supports the occupational therapy perspective, individuals are observed from a multidimensional viewpoint that includes intellectual abilities, adaptive behaviour, health, participation, and context (Schalock et al., 2010). Under this model, functional state is formed by the interaction of biological, psychological and social aspects, representing the integrity of the person throughout their life. ADL performance usually allows an individual to develop in different spheres of their life and interact with the external environment (other humans, physical, virtual, and other contexts).

ADL can be classified into two groups, basic activities of daily living (BADL) and instrumental activities of daily living (IADL) (Danielsson et al., 2010). BADLs refer to lower complexity activities related to survival, requiring less cognitive processing and manipulative skills. BADLs include activities such as eating, showering, and dressing. IADLs refer to activities that require more complex cognitive processing because they require the interrelation of multiple processes, social interaction, and community participation, which usually involve caring for others, the use of new technologies, or the use of public transport (García-Molina et al., 2010). According to the International Classification of Functioning Disability and Health, the correct performance of ADL requires the coordination of function, body structure, activity, and

participation (Danielsson et al., 2010). Therefore, impairment or poor development of cognitive processing may negatively impact ADL performance (Danielsson et al., 2010).

The functional abilities—or functionality—of individuals with ID are currently understood from a multidimensional perspective. Based on the International Classification of Functioning Disability and Health, functionality involves the activities, daily tasks, and abilities present throughout the individual's life (Schalock et al., 2010; World Health Organization, 2001). A functional limitation in daily tasks usually involves a disability stemming from problems related to body functions or structures (King et al., 2016). New paradigms of ID emphasize the need to provide the necessary support to improve the level of human functioning in these individuals (World Health Organization, 2001). Based on this, a series of parameters are established, and resources are assigned based on person-centred planning (King et al., 2017). Human functioning is closely related to performance in ADL (Hallgren & Kottorp, 2005). Individuals with ID often exhibit limitations in both intellectual functioning and adaptive behaviour, which can affect their ADL performance (Fortin et al., 2003). People with ID do not always have the skills required to adequately perform the more complex ADL. This fact may be related to the number of opportunities for people with ID to participate in ADL may be limited in diverse contexts such as family or institutional life (Hallgren & Kottorp, 2005).

Performance is used as a metric to compare individuals with moderate or severe ID, those with mild ID, and those without ID in studies assessing the functional abilities of individuals with ID. The results indicate that people with moderate or severe disability have lower performance in ADLs, while people with mild ID have

comparable performance to people without ID (Kottorp et al., 2003). However, to the best of our knowledge, there is no recent literature investigating the level of performance of individuals with ID. A study conducted with older adults with disabilities found that people who live independently or with a family perform better on ADLs, while people who live in institutionalized environments require significant higher levels of support to complete ADLs. Highlighting the importance of context, they observe that in residential centres people have fewer opportunities to engage in IADL. The ability to perform an activity may depend on the opportunity we have throughout life to develop it. Based on their results, ADL could be influenced by age, gender, and cultural context, with younger individuals and women demonstrating higher levels of performance. This finding could be explained because older women throughout their lives may have had more opportunities to perform ADLs related to the home tasks, likely influenced by cultural norms and expectations (Lechowska et al., 2022).

Given the potentially limited abilities in the population with intellectual disabilities, it is important to emphasize that the performance of ADLs requires the maintenance of cognitive skills (Lechowska et al., 2022). Therefore, the functional capacity of people with ID could be improved by providing them with support in carrying out these activities, enabling and maximizing their own abilities (Danielsson et al., 2010). To achieve this goal, further studies are necessary to identify the specific cognitive skills or abilities that are limited, along with other factors associated with functionality in ADLs among people with ID.

## 3.4 Cognitive processing in people with intellectual disabilities

A person's autonomy is closely linked to the activities that people perform throughout their day and their lives. The skills typically required to successfully perform an activity include cognitive, motor and social interaction skills. These activities involve cognitive processing to control the actions necessary to perform them. The processes that control actions involve a variety of cognitive skills, ranging from the most basic to higher-level cognitive functions such as executive functions. Being functional implies adaptive behaviour in a constantly changing environment. Additionally, in our daily lives, we need to select relevant information from the environment and adapt our performance to environmental demands by flexibly switching among multiple processing strategies (Macoun et al., 2021; Zink et al., 2021).

Over the past 50 years, considerable theoretical and experimental progress has been made in describing how humans control their actions by selecting, processing, and prioritising task relevant stimuli, and flexibly adapt to environmental changes and demands. However, there is currently no conclusive theoretical and empirical model supported by evidence that fully defines cognitive processing during activity performance (Zink et al., 2021).

### *3.4.1 Executive function in people with intellectual disabilities*

Executive control, representing higher cognitive functions, is defined as the self-regulatory processes that facilitate the supervision, organization, and coordination of other cognitive functions, as well as emotional and behavioural responses (García et al., 2019). Although there are different classifications of executive functions (Fidler & Lanfranchi, 2022), the most widely used constructs in research are action planning

ability, working memory, inhibitory control, verbal fluency, or abstraction capacity (García et al., 2019). Action planning ability refers to the skills to anticipate future events (Gligorović & Đurović, 2012). Working memory is the ability to organize, synthesize, relate, and use information in order to perform other more complex cognitive activities (Renteria et al., 2008). Inhibitory control is considered one of the basic mechanisms of adaptive behaviour. This construct is involved in new or complex situations and scenarios in which integration of experience and knowledge is important (Verdugo Alonso, 2012). Verbal fluency is recognized as the ability to produce language using inhibitory control and certain memory processes. For this reason, the verbal fluency may be an index of mental processing. This function is associated with cognitive processing and thought processes (Gligorović & Đurović, 2012). Abstraction consists of identifying the common elements in things that are apparently unconnected (Bell-McGinty et al., 2002).

In the research conducted by the authors Spaniol & Danielsson (2022), in a meta-analysis of the executive function components in ID, individuals with this disability are compared to a control group with the same mental age for the performance in executive functions. The results obtained showed lower levels of cognitive functions in the samples with ID. The review of the studies also concluded that the etiology of the disability was a significant factor explaining the lower performance in these cognitive functions; that is, the findings suggest that executive function interferes with task execution differently among syndromes involving ID (Spaniol & Danielsson, 2022). For example, people with Willis syndrome show better performance in verbal inhibition and poorer performance in planning compared to a sample of people with Down syndrome (Costanzo et al., 2013). This work measures the difference between intellectual quotient, mental age, and chronological age, but underscores the importance of

categorizing studies based on whether individuals exhibit mild, moderate, or severe disabilities. In another study that evaluates factors related to executive functions in individuals with ID, using assessment scales similar to ours, correlations were found between intelligence level and performance in working memory tasks. The study found significant alterations in the working memory of people with ID (Fidler & Lanfranchi, 2022). The opportunities to influence the development of executive functions are extensive. Executive functions usually develop in childhood and allow children to develop behaviours and skills. The development of skills related to executive function are affected by environmental influences, social and cultural support and the opportunity to develop activities continuously over time (Zelazo, 2020). The literature highlights the importance of evaluating the magnitude of the association between these constructs in people with ID and points out participation in ADL as a central aspect of human functioning (Carretti et al., 2010; Fortin et al., 2003; Gligorović & Đurović, 2012; Memisevic & Sinanovic, 2013; Wise et al., 2019). A review indicated that further research is necessary to formulate a participation definition that harmonizes established descriptions from rehabilitation literature with aspects derived from ID studies (Dean et al., 2016). Researchers such as Carretti et al. (2010) have reported that understanding executive function is crucial to advancing patient-focused health models (Carretti et al., 2010; Wise et al., 2019). A study of patients with acquired frontal lobe injury has shown that individuals need executive functions, such as planning ability, self-correction, decision-making, and judgment, to correctly perform their daily activities (Pride et al., 2017). In older adults, the common clinical measures of executive function are useful in predicting functional status (Perna et al., 2012; Tomaszewski et al., 2018). A study of young adults with Down syndrome has suggested that executive function and adaptive behaviour are associated with their employment status (Memisevic & Sinanovic, 2013).

Therefore, it could be hypothesized that the successful performance of ADLs in other populations with impaired executive functions may also depend on the control of higher cognitive functions (Fortin et al., 2003). New studies should contribute to determining the factors that are associated with the performance of the ADLs in individuals with ID and the magnitude of this contribution.

### *3.4.2 Attentional resources in people with intellectual disabilities*

Attentional cognitive processing refers to the capability of processing, storing, and retrieving information during activities performance or in a resting state (García-Madruga et al., 2016; Zagaria et al., 2021). According to the Multidimensional Model of Attention (González de la Torre-Benitez, 2002; Mirsky et al., 1991), attentional resources involve selecting relevant information while suppressing irrelevant information from inner or external contexts (Kim et al., 2021). These attentional resources can be divided into five categories. First, attentional span, or selective attention, which is defined as the ability to select relevant information while inhibiting attention to certain distracting stimuli. Second, sustained attention, which is defined as the ability to maintain responses over a longer period of time. Third, divided attention, which is defined as the ability to attend to two stimuli or perform two tasks simultaneously. Fourth, alternating attention, which is defined as the ability to change tasks based on the contextual requirements. Alternating attention is closely related to flexibility and is present in IADL when there is a need to continuously change the focus of attention between tasks. Fifth, executive attention, which functions as an interrelation between other cognitive processes such as working memory, behavioural inhibition, and self-regulation (García-Madruga et al., 2016).

Individuals with ID often exhibit high rates of comorbidity with other developmental disorders such as autism spectrum disorder and attentional deficits. Therefore, it is crucial to differentiate whether alterations in attentional processing stem from attention deficits or attentional resource limitations (Deutsch et al., 2008). In both attention deficits and attentional resource limitations, individuals may find it challenging to maintain the regulatory status necessary to perform daily tasks, compared to those without ID (Schefke & Gronek, 2010). Attentional resources are interrelated with other cognitive processes, such as memory, inhibition, and planning (García-Madruga et al., 2016; Van Loon, 2015). Previous studies indicated that attentional resources such as planning, self-correction, decision-making, and judgment are necessary for the correct performance of ADL (Burgess et al., 2000; Fortin et al., 2003). However, these studies were conducted on patients with brain damage and degenerative diseases. To the best of our knowledge, the relationship between attentional resources and functionality in both BADL and IADL in individuals with ID has not yet been examined. These hypotheses should be scientifically evaluated to obtain evidence regarding the reality of these individuals. In the case that these hypotheses are verified, this information would be valuable when developing cognitive training programs that can enhance the participation of individuals with ID in their ADL. Training programs can be more effective when the characteristics of the population, cognitive abilities, and limitations of information processing are thoroughly understood.

## 3.5 Potential relationship between cognitive functions and ADL in intellectual disability

Cognitive functions can play an important role in the development of activities and roles that allow people to be functional in their daily lives (Taylor et al., 2024).

Cognitive functions allow people to plan and execute complex tasks, manage their time effectively, and adapt to changes in their environment (Spaniol & Danielsson, 2022). The potential reasons for the potential link between cognitive functions and the capacity of individuals with ID to effectively perform ADL, that is BADLs and IADLs, can be based on: (i) in the executive processes that sustain the ability to plan, organize, prioritize, and adapt in response to the demands of daily life; (ii) deficits in executive functions could significantly impact an individual's ability to perform ADLs, leading to challenging everyday functioning; (iii) the functions such as planning, cognitive flexibility, inhibitory control, and working memory, are essential for successful completion of complex tasks and problem-solving. For instance, when an individual engages in activities such as cooking, managing finances, or organizing their timetable, they rely on their executive functions to plan and sequence the steps required to complete the task efficiently; (vi) these functions are vital for time management and decision-making, which are fundamental aspects of many ADLs. For instance, cognitive processes are necessary for multiple daily tasks such as planning a daily routine, prioritizing among several tasks, and setting goals; and, (v) the ability to switch between different tasks and manage multiple activities simultaneously is dependent on cognitive flexibility. In the context of ADLs, this is particularly relevant as individuals frequently need to manage various responsibilities throughout the day (Hallgren & Kottorp, 2005; Pride et al., 2017; Wise et al., 2019). Thus far, the ability to perform ADLs has been shown to be related to individual factors such as age, cognitive functions, motor skills and degree of disability (Hilgenkamp et al., 2011; Kottorp et al., 2003; Lechowska et al., 2022).

People with ID may show a high level of ability to perform self-care activities, although they may exhibit problems with activities that require greater cognitive

abilities (Lechowska et al., 2022). Tasks performance involves the ability to execute the task over time and familiarity with the context. For this reason, it is important to identify whether poorer performance is due to learning difficulties or whether the context in which they live (Delgado-Lobete et al., 2021; Kottorp et al., 2003). Recently, some authors suggested that a higher intellectual performance could be correlated with a higher degree of independence for BADL (Lechowska et al., 2022). A study carried out with elderly people with disabilities in a residential environment observed that 60% had a maximum score in BADL performance, while 37% showed a need for support to be able to perform these activities. They found that lower scores on cognitive tests had a significant impact on reducing abilities to perform BADL. People showed a high level of ability to execute self-care activities; however, they exhibited problems for activities that required greater cognitive capacity. These authors also concluded that age seems to be a factor that affects cognitive abilities, impacting human functioning (Lechowska et al., 2022). The study by Kottorp et al. (Kottorp et al., 2003), finds that the degree of disability does not determine the performance of ADLs. BADLs are easier to perform for individuals with mild and moderate ID, although there are differences in the skills required by the activity. Although people with moderate ID may have more limited cognitive functioning than people with mild ID, they showed equivalent abilities to use tools and respond appropriately to task demands. Better task performance is related to the ability to perform the task over time and familiarity with the context (Kottorp et al., 2003). Other authors highlight that BADL and IADL performance seems to be related to cognitive and motor components rather than age or gender. Mobility affected BADL performance while the degree of disability was more related to IADL. Cognitive abilities could affect multiple activities such as grooming, eating, using the telephone, shopping, or finances (Hilgenkamp et al., 2011).

Individuals with ID are anticipated to encounter greater challenges in performing IADL, as these tasks require more complex cognitive abilities and higher levels of cognitive functioning. Research has shown that there are more complex tasks such as managing money, doing laundry or preparing a complete meal (Delgado-Lobete et al., 2021). A study of older people found limitations in all participants in performing IADL, finding difficulty with complex tasks such as money management, washing clothes or preparing a complete meal but not with making bed or simple household tasks. However, these findings may have limited applicability to individuals who are institutionalized, given their restricted opportunities to participate in such activities (Delgado-Lobete et al., 2021). People with mild and moderate ID show difficulties in using information and communication technology. These difficulties restrict some aspects of daily life such as social interaction or performance of household activities. The participants describe using technology to watch TV, listen to music or watch videos (Ramsten et al., 2020). However, there are no studies in the field of occupational therapy that offer a comprehensive assessment of ADL performance among people with ID.

### 3.6 Motor functions in people with intellectual disabilities

According to the definition and the diagnostic criteria of ID, a person with this disability does not show changes in other bodily functions such as motor functions. However, in the clinical setting, it is possible to observe a poorer ability to handle objects when comparing this population with people without disabilities (De Giorgio, 2017). Motor skills affect the performance of ADL and the potential for lifelong occupational development (Taylor et al., 2024). At early stages of life, cognitive development is linked to motor skills, which allow knowledge and exploration of the

environment (Jeoung, 2018; Piek et al., 2008). For this reason, some authors suggest that cognitive development is associated to motor function, and vice versa (Jeoung, 2018). Furthermore, throughout life, motor development provides the opportunities to interact with the environment, which in turn facilitates the development of cognitive, social and emotional functions. Motor skills can make a positive contribution to the performance of ADL (Vuijk et al., 2010; Jeoung, 2018), movement requires skills of inhibition, motor planning and attention. In children, the cognitive skills of attention, working memory, planning, flexibility and inhibition are strongly related to hand motor skills such as grasping, lifting, manipulation and bimanual coordination (Vuijk et al., 2010).

Manual dexterity is defined as the ability to use hand muscles to grasp and manipulate objects. Manual dexterity usually includes functions such as the coordination and strength to produce small and precise movements (Makofske, 2011). Hand coordination is regarded as the ability to integrate the action of different muscles to perform fine movements such as typing, cutting, writing, drawing (Alonso, 2018). Hand strength the measures reflect the maximum force generated by the musculature of the upper limb, and more specifically the hand musculature. The upper limb strength includes both hand strength and the ability to pinch with the fingers. There are three types of fingers' pinch: three point, lateral (key) and palmar pinch (El-samad et al., 2021; Cabeza-Ruiz & Castro-Lemus, 2017). Hence, the assessment of the coordination and strength of the upper limb could provide valuable information about the level of manual dexterity of people with ID. This knowledge could help in research conducted in relation to manual dexterity and the performance of daily living tasks and participation in the community of this population (Jeoung, 2018; Logan et al., 2017).

Manual dexterity alterations are usually observed in populations with central nervous system impairment, due to neurodegenerative causes or acquired brain damage, and peripheral nervous system damage (Feys et al., 2017; Kamm et al., 2012; Kimura, 1977; Shah et al., 2019). Nevertheless, other populations without these impairments in body structures, such as schizophrenia, also seem to show an alteration in manual dexterity (Hidese et al., 2018; Wang et al., 2020). In individuals diagnosed with this mental disorder was documented diminished manual dexterity scores in comparison to their healthy counterparts (Hidese et al., 2018). The rationale behind these alterations in manual dexterity within this population remains unclear. The explanation of these findings could be due to medication intake or the reduction of activity participation (Kern et al., 1998; Térémetz et al., 2017). Previous studies demonstrate that children with ID show deficits in manual dexterity, specifically in bimanual coordination; however, studies assessing manual dexterity in adults with ID are lacking (Vuijk et al., 2010). Fine motor dexterity has been related to greater maturation and integrity of the cortical nervous system (Wuang et al., 2008). The development of manual dexterity may be conditional on the child's development, which could take these deficits into adulthood (Vuijk et al., 2010).

## 3.7 Potential relationship between motor functions and ADL in intellectual disability

People with ID find it difficult to be autonomous in society, even though they have no physical impairment of the locomotor system (Delgado-Lobete et al., 2021). The development of activities, exploration and play early in life allows for the development of motor competence and social interaction, which could benefit the client's skill development and lead to greater opportunities for meaningful occupations

earlier in life. Development in childhood and youth may influence human functionality (Chiviacowsky et al., 2013). Physical skills is an important factor influencing the performance of BADL and IADL (Delgado-Lobete et al., 2021). Daily functioning in people with ID is affected by physical abilities such as balance, walking speed, lower limb strength and manual dexterity. People with ID have the ability to resist during the task, regulate strength and grasp objects effectively even though they show less ability to sustain the activity over time, showing more physical effort when performing motor actions while performing ADLs (Fisher, 2006; Kottorp et al., 2003). Age could be a factor influencing muscle strength and sense of balance, affecting motor development and human functioning (Lechowska et al., 2022). Physical and cognitive degeneration in older people may affect functioning in ADLs (Hilgenkamp et al., 2011). In the study of adults with ID, they find that manual dexterity is more closely linked to the development of IADL (Hilgenkamp et al., 2011). The motor components related to IADL are shopping, washing clothes, using means of transport and taking responsibility for medication, activities that require greater manual dexterity (Hilgenkamp et al., 2011). Whereas, BADL performance is related to motor components involved in the activities of ambulation or stair climbing, activities where manual dexterity is less involved (Gama et al., 2000; Hilgenkamp et al., 2011). Support plans aimed at improving balance, strength and manual dexterity may influence people's opportunities to perform ADLs, interact with the environment and develop daily functioning. Motor skills training improves the ADL performance of people with ID (Delgado-Lobete et al., 2021).

# 4 JUSTIFICACIÓN DE LA TESIS

La terapia ocupacional tiene como objetivo que las personas puedan desarrollar ocupaciones significativas a lo largo de su vida para conseguir un estado óptimo de salud y bienestar. Éste objetivo se consigue mediante el acompañamiento en el desarrollo de planes de intervención que permiten a las personas establecer sus propias metas, desarrollar de actividades significativas y participar en la comunidad donde viven.

El desarrollo de las ocupaciones en el colectivo de personas con discapacidad intelectual puede verse afectado debido a dificultades en el funcionamiento asociadas a la condición de discapacidad y a las pocas oportunidades que le ofrece el contexto para poder desarrollar sus habilidades. Las evaluaciones sobre los componentes cognitivos y motores son importantes a lo largo de la vida de las personas para poder establecer planes de entrenamiento que faciliten el aprendizaje de habilidades y la adquisición de competencias. El entrenamiento en habilidades permite ofrecer diferentes retos a la persona que va a incrementar su habilidad cognitiva y física, permitiéndole una mayor autonomía en su vida diaria.

La funcionalidad de las personas con discapacidad intelectual también puede verse comprometida por una falta de oportunidades para desempeñar las actividad cotidianas. Desde la terapia ocupacional, la participación en las actividades implica diversos componentes volitivos. En ocasiones, el contexto de las personas con discapacidad impide o facilita la presentación de oportunidades para que se desarrollen esos aspectos motivacionales. Los ambientes institucionalizados ofrecen oportunidades diferentes a la vida en la comunidad o en una familia. Estas oportunidades van a favorecer o limitar el funcionamiento de la persona a lo largo de su vida. Por lo tanto,

las habilidades cognitivas y motoras pueden estar condicionadas por la oportunidad de aprender o desarrollar las actividades a lo largo de la vida. En un ambiente institucionalizado, bajo metodologías asistenciales, la oportunidad de desarrollar las actividades cotidianas se reduce debido a planes de intervención que tratan de facilitar la vida de la persona, a cambio de reducir el número de oportunidades de desarrollar actividades que fomenten la autonomía. Estas metodologías garantizan que las personas pueden disfrutar de niveles aceptables de calidad de vida, pero provocan una disminución de la participación de estas en una vida con oportunidades normativas. Gracias a la evidencia, las metodologías asistenciales actuales, están centrando su atención en establecer planes de apoyos necesarios para que la persona pueda participar activamente en su vida, fomentando su autonomía y participando en la sociedad.

El estudio de los componentes cognitivos y motores asociados al desempeño de actividades diarias permite tener información valiosa de las limitaciones y potencialidades de esta población, lo que probablemente permita un mejor diseño de las estrategias de entrenamiento de habilidades y adquisición de competencias. El fin último siempre será que las personas con discapacidad desarrollen una participación satisfactoria en sus roles, que permitan desarrollar oportunidades de participación en un contexto y en la sociedad. Bajo esta perspectiva las personas pueden acceder al empleo y a la vida independiente, convirtiéndose en un recurso para la sociedad y generando una sociedad más justa e inclusiva. El avance de la investigación en esta área y el cambio de visión actual respecto a la discapacidad se han visto reflejados en el lenguaje usado por parte de diferentes agentes de la sociedad, pasando del uso de conceptos como el retraso mental a otros como diversidad funcional. Este cambio permite a la sociedad ver a las personas desde un punto de vista más positivo, resaltando la diversidad y no las limitaciones clásicamente asociadas a esta población. En personas

jóvenes, los colegios necesitan soporte científico que permita establecer programaciones y contenidos adaptados al nivel de todos los niños, independientemente de sus características. Actualmente las personas con discapacidad encuentran dificultades para acceder a una formación oficial que les permita desarrollarse como trabajadores, debido a que hay pocas formaciones con sus contenidos adaptados a las necesidades individualizadas de aprendizaje de cada persona. La situación que se observa en la formación se complica si la persona con discapacidad quiere acceder a un empleo. Aunque las políticas sociales favorecen la contratación de las personas con discapacidad, es necesario establecer protocolos de funcionamiento en las empresas que permitan el desarrollo y el entrenamiento en competencias para el desarrollo de la ocupación. Aunque la adaptación de los puestos en muchos casos es necesaria, invertir en este entrenamiento nos va a permitir tener trabajadores más especializados y formados.

En materia de investigación, actualmente existe la necesidad de nueva información sobre los niveles de funcionalidad de las personas con discapacidad intelectual, además de los niveles de función cognitiva y motora. Sería importante que una vez establecido el conocimiento sobre esta población y su funcionamiento en la vida diaria, se promocionen los planes de apoyo que permitan la recogida de datos sobre cómo influyen estos sobre su calidad de vida. De este modo, podríamos establecer modelos de funcionamiento de las personas con discapacidad intelectual a lo largo de las diferentes etapas de sus vidas. Cuando las personas con esta discapacidad llegan a edades avanzadas, se observa una pérdida de la funcionalidad, afectando al desarrollo cognitivo y motor. Por lo tanto, la investigación en éste área es importante con el objetivo de frenar la pérdida de funcionalidad en adultos mayores. Esta población necesita modelos teóricos que ayuden a la práctica clínica y herramientas para poder

desarrollar estrategias clínicas, desde la creación de test estandarizados que permitan evaluar y conocer de forma objetiva y específica las características de la población, hasta estrategias de abordaje de necesidades. Actualmente, los profesionales de atención a estas personas no contamos con instrumentos estandarizados que nos ayuden a evaluar la funcionalidad de estas personas, ni tampoco con información de cómo aplicar los apoyos necesarios para poder desempeñar una correcta ejecución de la vida diaria.

El tener disponible información sobre la funcionalidad y sobre el nivel de función cognitivo-motora de las personas con DI permitirá además que futuras investigaciones puedan realizar comparativas atendiendo a otros factores relacionados, como la edad mental o la edad cronológica de esta población. También sería importante realizar estudios de intervención dentro de la terapia ocupacional para poder evaluar la eficacia de los planes de apoyo desarrollados con la población. Así como herramientas específicas de trabajo con la población que permitan establecer datos objetivos sobre las características de las personas. La investigación en esta población es importante para la sociedad debido a que forman parte de un grupo de personas que con una formación y un plan de apoyos adecuado podría ofrecer servicios a la comunidad, pasando de depender social y económicamente de otros a contribuir y aportar en el crecimiento socio-económico del país. Las personas con discapacidad tienen derecho a: 1) un sistema de salud que promueva su funcionamiento como parte importante de la sociedad, 2) tener oportunidades para desarrollar todas las áreas de ocupación, 3) poder decidir en cualquier dimensión de su vida, 4) acceder a la formación reglada que permita la profesionalización, 5) acceder al empleo digno y 6) llevar una vida autónoma e independiente.

# 5 JUSTIFICATION FOR THE THESIS

Occupational therapy aims to enable people to develop meaningful occupations throughout their lives in order to achieve optimal health and well-being. This is achieved by supporting the development of intervention plans that enable people to set their own goals, develop meaningful activities and participate in the community in which they live.

The development of occupations in the group of people with ID can be affected due to limitations in the functioning of the disability condition and the few opportunities offered by the context to develop their skills. Assessments on cognitive and motor components are important throughout the life of the person in order to establish training plans that facilitate the learning of skills and the acquisition of competences. Skills training allows to offer different challenges to the person that will increase their cognitive and physical ability, allowing them to be more autonomous in their daily life.

The lack of opportunities to perform ADL can also affect the functionality of people with ID. From an occupational therapy perspective, participation in activities involves various volitional components. Sometimes the presentation of opportunities for the development of these motivational aspects is prevented or facilitated by the context of people with ID. Institutional environments offer different opportunities than living in the community or in a family. These opportunities will either enhance or limit the person's functioning throughout his or her life. For example, cognitive and motor skills can be conditioned by the opportunity to learn or to develop activities for a lifetime. In an institutionalised environment, social care methodologies reduce the opportunity to develop ADL through intervention plans that seek to make the person's life easier by reducing the number of opportunities to develop activities that promote autonomy.

These methodologies ensure that people can enjoy an acceptable level of quality of life, but lead to a reduction in people's participation in normative life. As a result of this evidence, current care methodologies focus on developing the support plans necessary for the person to be an active participant in their lives, promoting their autonomy and participation in society.

The study of the cognitive and motor components associated with the performance of daily activities provides information about optimal strategies for skills training and competence acquisition. The aim will be for people with disabilities to develop a satisfactory participation in their roles, which will allow them to develop opportunities for participation in a context and in society. Under this perspective, people can access employment and independent living, becoming a resource for society and generating a fairer and more inclusive society. The progress of research in this area and the change in the current vision of disability has been reflected in the language used by different agents in society, moving from the use of concepts such as mental retardation to others such as functional diversity. This change allows society to see people from a more positive point of view, highlighting diversity and not the limitations classically associated with this population. In the case of young people, schools need scientific support to establish programmes and content adapted to the level of all children, regardless of their characteristics. At present, people with disabilities find it difficult to access official training that allows them to develop as workers, because there are few training courses with contents adapted to the individualised learning needs of each person. The situation that can be observed in training becomes more complicated if the person with a disability wants to access employment. Although social policies favour the employment of people with disabilities, it is necessary to establish operating protocols in companies that allow for the development and training of skills for the

development of the profession. Although in many cases it is necessary to adapt jobs, investing in this training will allow us to have a more specialised and trained workforce.

In terms of research, this thesis is based on the need for new information about the levels of human functioning, cognitive components and motor skills of people with ID. It would be important that once the knowledge about this population and their functioning in daily life is established, it would be important to promote support plans that allow the collection of data on how these affect their quality of life. In this way, we could establish models of how people with ID function at different stages of their lives. As people with ID grow older, a loss of functionality is observed, affecting cognitive and motor development. Therefore, research in this area is important to slow the loss of functionality in older adults. This population needs theoretical models to support clinical practice and tools to develop clinical strategies, from the creation of standardised tests that allow objective and specific assessment and knowledge of the characteristics of the population, to strategies to address needs. Currently, care professionals do not have standardised instruments to help us assess the functionality of these people, nor do we have information on how to apply the necessary support to be able to carry out a correct execution of daily life.

Having information on the functionality and level of cognitive-motor function of people with ID will also allow future research to make comparisons based on other related factors, such as the mental age or chronological age of this population. It would also be important to carry out intervention studies within occupational therapy to evaluate the effectiveness of support plans developed with the population, as well as specific tools for working with the population to obtain objective data on people's characteristics. Research on this population is important for society because they are

part of a group of people who, with training and an appropriate support plan, could provide services to the community and move from being socially and economically dependent on others to contributing to the socio-economic growth of the country. People with disabilities have the right to 1) a health system that promotes their functioning as an important part of society, 2) the opportunity to develop all areas of occupation, 3) the ability to make decisions in every dimension of their lives, 4) access to formal training that enables professionalisation, 5) access to decent employment, and 6) an autonomous and independent life.

# 6 HIPÓTESIS DE LA TESIS DOCTORAL

- Hipótesis general de la tesis doctoral:

La hipótesis general de esta tesis doctoral es que la funcionalidad y los factores del cliente -específicamente los componentes cognitivo y motor- están relacionados con la autonomía en la realización de las actividades de la vida diaria de las personas con discapacidad intelectual.

- Hipótesis específicas de la tesis doctoral:

La hipótesis principal para el primer estudio de la tesis es que el desempeño de actividades instrumentales de vida diaria está relacionado con el rendimiento de los componentes cognitivos de la función ejecutiva en personas con discapacidad intelectual.

La hipótesis principal para el segundo estudio de la tesis es que el desempeño de actividades básicas e instrumentales de vida diaria está relacionado con el rendimiento de los componentes cognitivos de atención en personas con discapacidad intelectual.

La hipótesis principal para el tercer estudio de la tesis es que las alteraciones en la coordinación y la fuerza manual influyen en el desempeño de las actividades de vida diaria en personas con discapacidad intelectual.

# 7 HYPOTHESES OF THE DOCTORAL THESIS

- General hypothesis of the doctoral thesis:

The general hypothesis of this doctoral thesis is that functionality and client factors —specifically cognitive and motor components— is related to autonomy in the performance of activities of daily living of people with intellectual disability.

- Specific hypotheses of the doctoral thesis:

The starting hypothesis for the first study of the thesis is that the performance of instrumental activities of daily living will be related to the performance of cognitive components of executive function in people with intellectual disability.

The starting hypothesis for the second study of the thesis is that the performance of basic and instrumental activities of daily living will be related to the performance of cognitive components of attention in people with intellectual disability.

The starting hypothesis for the third study of the thesis is that impairments in coordination and manual strength affect the performance of activities of daily living in people with intellectual disability.

# 8 OBJETIVOS GENERALES Y ESPECÍFICOS

- Evaluar los niveles de funcionalidad, así como las funciones cognitivas y habilidades motoras en personas con discapacidad intelectual.
    - Evaluar el nivel de desempeño en las actividades de vida diaria de las personas con discapacidad intelectual.
    - Analizar el rendimiento de la función ejecutiva en las personas con discapacidad intelectual.
    - Observar el funcionamiento de los recursos atencionales de las personas con discapacidad intelectual.
    - Conocer los niveles de coordinación de los miembros superiores en los individuos con discapacidad intelectual
    - Valorar el grado de fuerza manual de las personas con discapacidad intelectual.
- Investigar si existe relación entre la funcionalidad y las funciones cognitivas y motoras en personas con discapacidad intelectual.
    - Valorar la posible la relación entre los procesos de función ejecutiva y el desempeño en las actividades de vida diaria en personas con discapacidad intelectual.
    - Evaluar la relación potencial entre los recursos atencionales y el desempeño en las actividades de vida diaria en personas con discapacidad intelectual.

# 9 GENERAL AND SPECIFIC OBJETIVES

- To assess the levels of functionality, as well as cognitive functions and motor skills in people with intellectual disabilities.
    - Evaluate the performance of activities of daily living in people with intellectual disabilities.
    - Analyse the performance of executive function in people with intellectual disabilities.
    - Observe the functioning of the attentional resources of people with intellectual disabilities.
    - Know the levels of coordination of the upper limbs in individuals with intellectual disabilities
    - Assess the degree of manual strength of people with intellectual disabilities.
- To investigate whether there is a relationship between functionality and cognitive functions and motor skills in people with intellectual disabilities.
    - Assess the possible relationship between executive function processes and performance in daily living activities in people with intellectual disabilities.
    - To evaluate the potential relationship between attentional resources and performance in daily living activities in people with intellectual disabilities.

# 10 METHOD

## 10.1 Study "The Association between Executive Function and Performing Instrumental Daily Activities in People with Intellectual Disabilities".

The methods section of the study, included in the present PhD thesis, is summarized and described below. The study has been published in a scientific journal Healthcare. Table 1 provides a detailed summary of the methodology employed.

**Table 1.**

*Summary of material and methods in Study 1.*

| PAPER | STUDY DESING | PARTICIPANTS | PROCEDURE | MEASURES | METHODS |
|---|---|---|---|---|---|
| **Study 1: The Association between Executive Function and Performing Instrumental Daily Activities in People with Intellectual Disabilities.** | Cross-sectional study | Individuals adults with ID (n= 90).<br><br>Inclusion criteria:<br><br>- Over 18 years of age.<br>- Voluntary participation.<br>- Diagnosis of moderate ID.<br><br>Exclusion criteria:<br><br>- Severe Behavioural disturbances.<br>- Severe mental disorder.<br>- Severe language impairment.<br>- Severe cognitive impairment. | 1) Screening to identification selection criteria.<br>2) Sociodemographic information was registered.<br>3) Evaluation was performed between July 2019 and May 2020.<br>4) Participants were subdivided into two groups:<br>- Individuals adults with ID (n= 90).<br>- Individuals adults without ID (n= 79). | Outcome measures were:<br><br>• Lawton and Brody Scale.<br>• The INECO Frontal Screening Test. (Spanish versión:<br><br>- Motor programming.<br>- Conflicting instructions.<br>- Go-no-go task.<br>- Backward digit span.<br>- Verbal working memory.<br>- Spatial working memory.<br>- Reasoning task.<br>- Verbal inhibitory control.<br>• The similarities subtest. Wechsler Adult Intelligence | Sample size was calculated.<br><br>Statistical analysis were:<br><br>1) To describe the sample of ID.<br>2) To compare the group with ID and without ID by sociodemographic and clinical characteristics of the subjects.<br>3) To analyse the differences between groups with and without ID in the performance of instrumental activities of daily living and |

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|---|---|---|---|
| | | Scale (WAIS-IV).<br>• The semantic verbal fluency test.<br>• Test 'key search. The Behavioural Assessment of the Dysexecutive Syndrome (BADS) battery. | executive functions.<br>4) The group of subjects with ID was divided into two groups (dependency for IADLs vs. independent for IADLs) using the median of the sample in the Lawton and Brody scores.<br>5) To analyse the differences between groups with dependence and independence for executive functions in individuals with moderate ID.<br>6) To know the relationship between the ability to carry out instrumental activities of daily living and executive functions in individuals with moderate ID.<br>7) To know if executive functions can be predictors of IADL performance in institutionalized individuals with moderate ID. |

### *10.1.1 Participants*

A total of 286 adults were recruited from several community centers in the province of Granada, Spain. The final sample consisted of 169 individuals. The sample of individuals with ID comprised 90 adults (48 men and 42 women) with an average age of 39.86 years. These participants were recruited from four centers for people with ID. The sample of individuals without ID comprised 79 adults (37 men and 43 women) from two municipal community centers, with an average age of 36.95 years.

The inclusion criteria for both groups were: over 18 years of age and voluntary participation. The additional criterion for the group of individuals with ID was a diagnosis of moderate ID. The diagnosis was made by the Andalusian Public Health System, which is the regional public health system to which the geographical area where the study was conducted belongs. The participants were screened by checking the medical reports available at the center where the participants were recruited. The exclusion criteria for both groups were: (i) severe Behavioural disorders having an impact on the evaluation process (determined by Maladaptive Behavior Scale, MABS) (Alsina et al., 2003), (ii) severe mental disorder, based on psychiatric evaluation records, (iii) severe language impairment, and (iv) severe cognitive impairment, determined by a score of ≥24 points in the Lobo Mini-Mental State Examination. Potential participants with language alterations, both in comprehension and expression, having a severe cognitive impairment or a mother tongue other than Spanish were excluded to ensure the correct administration of questionnaires.

### *10.1.2 Procedures*

This is a multicentre, cross-sectional study. The study took place between July 2019 and May 2020. Permission for recruitment within each participating centre was granted by its respective directors. A written document detailing the study's procedures and objectives was provided to the individuals overseeing each centre. Subsequently, the researchers visited each centre to acquaint themselves with the monitors and users, observe the facilities, and directly elucidate the study to the personnel responsible for each participant. Both study cohorts were sourced from each centre using a consecutive sampling approach. This methodology involves enrolling participants sequentially as they become available, ensuring a continuous influx of participants into the study. The study's particulars, aims, and procedures were comprehensively communicated to each potential participant and/or their legal guardian. Consent for participation was obtained in writing after explaining the study details. The informed consent package encompassed the participant's information sheet, a register of informed consent forms, and a revocation letter. This protocol adheres to the precepts and principles outlined in the Declaration of Helsinki. The local Ethics Committee of CEI-Granada (Granada-Spain) with reference: 1271-N-19 approved the protocol of this study.

### *10.1.3 Measures*

The evaluation sessions were conducted in a well-lit room located outside the occupational workshop, in the case of individuals with ID, and in the workshops held in the community centres occupied by subjects in the group of people without ID. Each session was divided into two parts. In the initial part of the session, participants were provided with an explanation of the study's objectives and purpose. They were also informed of their right to withdraw from the study at any point as per their preference.

During the latter segment of the session, lasting approximately 40–45 min, the assessment tools were administered by a researcher endowed with extensive expertise in individuals with ID. The instruments used in the present study were in a language-free version making them more suitable in cross-cultural and special needs contexts. The researchers were trained to ensure the consistency and integrity of data collection. An ad hoc sociodemographic questionnaire was used to collect information on sex, age, educational level, years of education, and literacy skills. In addition, we register clinical data such as manual dexterity and the presence of motor or sensory/perceptual disturbances by asking the participant or legal guardian, and by checking the medical reports. The executive functions and the ability to perform ADL were evaluated by the following instruments.

The Lawton and Brody Scale was used to evaluate the ability to perform IADLs and the need for support in their performance (Graf, 2008; Lawton & Brody, 1970). This scale consists of eight items that measure functioning in use of the telephone, shopping, food preparation, housekeeping, laundry, mode of transportation, responsibility for medication, and handling finances. Total scores range from 0 (maximum dysfunction) to 8 points (total functionality) (Graf, 2008; Lawton & Brody, 1970). The scale was used in two complementary formats simultaneously: (i) an informant-based questionnaire completed by the occupational therapist working in the institution with the criterion of having known the person for at least three months before the evaluation in terms of the ability to perform the activity; (ii) observation of the level of function during performance of these activities. Observing the ability to perform IADLs is crucial in occupational therapy in order to determine an individual's level of functioning. This scale has been validated for the Spanish population, showing good reliability and validity and obtaining a Cronbach's alpha coefficient of 0.70 (Vergara et

al., 2012). Currently, there is no other scale or instrument within the field of occupational therapy that is validated for the adult Spanish population to evaluate the level of functioning in IADLs.

Global executive control was evaluated using the total score of the INECO Frontal Screening (IFS) test in its Spanish version. The total score of the IFS test is 30 points, with the higher score indicating better executive functioning. On the other hand, this test consists of various domains of executive function: (i) motor programming, where the subject has to perform a sequence of hand movements; ii) conflicting instructions, where the subject performs a sequence of movements that are the opposite of those performed by the evaluator; (iii) motor inhibitory control by go-no-go task, where the subject has to repeat the same sequence of movements performed by the evaluator; (iv) temporary cognitive information processing by backward digit span, where the subject must repeat a string of digits in reverse order; (v) verbal working memory, in which the subject is asked to list the months of the year in reverse order; (vi) spatial working memory, in which the evaluator presents the subject with four cubes and points at them in a given sequence. The subject is then asked to repeat the sequence in reverse order; (vii) reasoning task, in which three proverbs are read to the subjects, and they are asked to explain their meaning; (viii) verbal inhibitory control, which measures the subject's capacity to inhibit an expected response. This test also estimates overall working memory, which is the total of the scores of the verbal and spatial working memory subtests. The IFS has been validated for Spanish population, with a Cronbach's alpha of 0.80 (Torralva et al., 2009).

Abstraction capacity was evaluated using the similarities subtest from the fourth edition of the Wechsler Adult Intelligence Scale, (WAIS-IV)-. This subscale comprises

18 items, in which the individual is presented with two apparently unrelated words and must identify their common characteristic. The total score ranges from 0 to 36 points, with a high score indicating a high level of abstraction (Wechsler, 2013). This test has been validated for Spanish population, with a Cronbach's alpha of 0.79 (Bell-McGinty et al., 2002).

Mental processing was evaluated by the semantic verbal fluency test. This test consists of eliciting spontaneous words under a restrictive condition using category, or semantic, fluency. Subjects are asked to name as many items belonging to a certain category, in our case animals, as they can within 1 min. This test measures perseverations, intrusions, spelling errors, and paraphrases enunciated by the subject during the 1 min test duration. For this study, the maximum number of words verbalized without error was recorded in both groups (Carone, 2007; Tombaugh, 1999).

Action planning ability was evaluated by using the test 'key search' from the Behavioural Assessment of the Dysexecutive Syndrome (BADS), battery. In this test, subjects have 95s to draw with a pencil the path they would follow to find a key in an area delimited on the paper, starting from a pre-determined point. The maximum score is 16 points, with the higher score indicating greater planning capacity. The scores of this subtest were calculated for inclusion in the statistical analyses (Norris & Tate, 2000).

### *10.1.4 Statistical analyses*

The statistical analyses were performed on SPSS (Version 21.0). Descriptive data were presented as mean and standard deviation, in the case of continuous variables, and as a frequency in the case of categorical variables. Variables were assessed for

normality through the Kolmogorov-Smirnov test ($p > 0.05$) or visual inspection of histograms. The group of subjects with ID was divided into two groups (dependency for IADLs vs. independent for IADLs) using the median of the sample in the Lawton and Brody scores (4 points). This dichotomization coincided in turn with one of the possible interpretations of the test scores that divides the individuals' scores in dependency vs. independence for IADLs (Ollero-Baturone et al., 2018). The categorical sociodemographic and clinical characteristics of the subjects were compared using the chi-square test. The student's t for independent samples was used to compare age and test scores between groups (ID vs. controls) and between dependent vs. independent individuals. The equality of variance was analysed using the Levene test ($p > 0.05$). We calculated the effect size (Cohen's d) for variables that showed statistically significant differences in order to determine the magnitude of the differences between groups. The Pearson and Spearman bivariate correlation tests were used to determine the possible correlation between the degree of functioning in IADLs (Lawton and Brody Test) and the remaining variables (sociodemographic, clinical, and executive functions). A linear regression analysis using a Stepwise method was performed to determine which variables predicted functioning in IADLs in the group of subjects with ID. The scores on the Lawton and Brody Scale were included as dependent variables, and variables that correlated significantly with this test were included as explanatory variables. Any explanatory variables that showed collinearity with each other, and that did not meet the assumptions of the regression model, were excluded. Statistical significance was set at $p<0.05$ in all cases.

## 10.2 Study "Attentional resources and independence in basic and instrumental activities of daily living in individuals with intellectual disabilities".

The methods section of study included in the PhD thesis is summarized and described below. The study has been published in a scientific journal Healthcare. Table 2 provides a detailed summary of the methodology employed.

**Table 2.**

*Summary of Material and Methods in Study 2.*

| PAPER | STUDY DESING | PARTICIPANTS | PROCEDURE | MEASURES | METHODS |
|---|---|---|---|---|---|
| **Study 2: Attentional resources and independence in basic and instrumental activities of daily living in individuals with intellectual disabilities.** | Descriptive, cross-sectional, correlational and observational study. | Individuals adults with ID (n= 88).<br><br>The sample is made up of three groups:<br>- People with moderate ID (n= 39).<br>- People with mild ID (n= 49).<br>- People without ID (n= 78).<br><br>Inclusion criteria:<br>- Over 18 years of age.<br>- Voluntary participation.<br>- Diagnosis of moderate or mild ID.<br><br>Exclusion criteria:<br>- Severe Behavioural disturbances.<br>- Severe mental disorder.<br>- Severe | 1) Screening to identification selection criteria.<br>2) Sociodemographic information was registered.<br>3) Evaluation was performed between July 2019 and May 2020.<br>4) Participants were subdivided of three groups:<br>- People with moderate ID (n= 39).<br>- People with mild ID (n= 49).<br>- People without ID (n= 78). | Outcome measures were:<br>• Barthel index.<br>• Wechsler Adult Intelligence Scale (WAIS-IV).<br>- "Digits Span" subtest.<br>- Forward digit subtest.<br>- Backward digit subtest.<br>- Letter-number sequencing subtest.<br>• The "A" test.<br>• Color trail test. | Sample size was calculated.<br><br>Statistical analysis were:<br>1) To describe the sample of ID.<br>2) To compare the group with ID and without ID by sociodemographic of the subjects.<br>3) To analyse the differences |

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| | language impairment.<br>- Severe cognitive impairment.<br>- Mother tongue other than Spanish.<br>- Being over 65 years of age.<br>- Neurodegenerative disorder.<br>- Uncorrected perceptual impairments. | | between groups with moderate, mild and without ID in attentional resources.<br>4) To analyse the differences between the group with moderate ID and the group with mild ID, the group with moderate ID and the group without ID, and the group with mild ID and the group without ID in attentional resources.<br>5) To know if attentional resources can be predictors of ABDL performance in individuals with ID.<br>6) To know if attentio |

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| | nal resources can be predictors of AIDL performance in individuals with ID. |

### *10.2.1 Participants*

The initial sample consisted of 253 people from the province of Granada. The sample analysed after applying the selection criteria consisted of 166 people. The sample is made up of three groups. The sample of people with moderate ID includes 39 adults (20 women and 19 men), with an average age of 41.21 years; the group of people with mild ID is made up of 49 adults (21 women and 28 men) with an average age of 39.31 years. The group of people without ID is made up of a total of 78 adults (42 women and 36 men) with an average age of 37.01 years. Participants were recruited from three ID Granada associations and through community services (civic centres) in the province of Granada. The procedure for selecting samples is indicated in Figure 1.

Regarding the selection criteria, the general inclusion criteria for the three groups were: 1) being over 18 years old, 2) voluntary participation. The additional criteria for the sample of people with ID were, 1) having a diagnosis of ID that meets the criteria of the World Health Organization (World Health Organization, 2001). 2) have a moderate or mild degree of ID according to the evaluation of the assessment and guidance centre of the Autonomous Government of Andalusia (Salvà et al., 2007).

The exclusion criteria for both groups were: 1) presenting behavioural disturbances, 2) suffering from a mental disorder, 3) presenting severe language

impairments, both in comprehension and expression, 4) presenting cognitive impairment (through a score of ≥24 points in the Mini-Examination Cognitive of Lobo's test), 5) mother tongue other than Spanish, 6) being over 65 years of age, 7) suffering from some neurodegenerative disorder, 8) uncorrected perceptual impairments (touch sensation, vision or hearing).

### *10.2.2 Procedures*

The study has a descriptive, cross-sectional, correlational and observational design. This study followed the guidelines and principles of the Declaration of Helsinki and was approved by the local Ethics Committee of Granada (Granada - Spain), reference: 1271-N-19. The evaluation sessions were carried out in a well-lit room with no noise. Each session was divided into two parts: first, information on the study and its purpose was provided to the participant, and they were told they could stop or abandon it whenever they wanted, and the second part consisted of the administration of all tools for approximately 20-30 minutes. The centre's records were reviewed to compare and collect the necessary information for the study. The level of ID was taken from the medical records of each of the participants.

### *10.2.3 Measures*

The evaluation sessions included individual assessments for each participant, which comprised two parts. First, participants were informed concerning the study and its purpose, with the assurance that they could discontinue their participation at any time. The second part involved the administration of the evaluation instruments and lasted for approximately 20–50 min, with an average duration of 30 min. To assess attentional resources, the evaluation room was well-lit and free from noise. The

information necessary for the study was collected by reviewing the records from the centre. Several instruments used in this study were language-free, making them more suitable for cross-cultural and special needs contexts. The researchers were trained to ensure the consistency and integrity of data collection. The degree of ID was obtained from each participant's medical records.

Sociodemographic data were obtained regarding age, sex, completed studies, years of education, and literacy. In addition, clinical data, such as manual dexterity and sensory status (including touch sensation, vision, and hearing), were recorded.

The 10-item Barthel index was used for BADL and the total score ranged from 0 to 100 points, with a higher score indicating greater independence. This scale was validated for the Spanish population, obtaining a Cronbach's alpha of 0.86–0.92 (Mahoney & Barthel, 1965; Solís et al., 2005). The Lawton and Brody scale, which is composed of eight items, was used to assess independence in IADL. The score ranges from 0 to 8, with the former being the level of maximum dependence and the latter being the level of total independence (Graf, 2008; Lawton & Brody, 1970). This scale was validated for the Spanish population, confirming its reliability and validity, with a Cronbach's alpha coefficient of 0.70 (Vergara et al., 2012). Both scales were implemented in two concurrent formats: (i) an informant-based survey administered by the occupational therapist at the institution, who met the criterion of being acquainted with the participant for a minimum of three months before the assessment, assessing the individual's capability to engage in these activities, and (ii) direct observation of the participants' functional level during the execution of these activities.

The evaluation of attentional resources was structured according to a functional multidimensional model of attention (González de la Torre-Benitez, 2002). The

instruments used were implemented in a language-neutral version, adapted to ensure proper understanding of the instructions. This adaptation enhances its applicability in cross-cultural and special needs contexts. All instruments were administered in a hetero-guided manner in which the evaluator guided the assessment and recorded participants' performance.

The span of verbal attention was assessed using the "Digits Span" subtest, derived from the WAIS- IV Test (Amador, 2013). The maximum possible score was 12 points (Wechsler, 2013). This subtest exhibited adequate internal consistency in the Spanish population with a Cronbach's alpha coefficient of 0.73 (Renteria et al., 2008).

The "A" test was used to evaluate sustained attention. This instrument consisted of a series of letters, including the letter A. The participants were requested to tap on the table when they heard the letter A. This test measured the number of correct items and recorded the number of perseverations, omissions, and commissions. More than two errors in this test are usually interpreted as the presence of alterations in sustained attention (Amador, 2013).

The color trail test was used to evaluate divided and alternating attention. This test consisted of two parts: Part A and Part B. A standard score was obtained by correcting the raw scores for age and schooling time, with higher scores indicating greater attention (Bowie & Harvey, 2006; Dugbartey et al., 2000).

Forward digit, backward digit, and letter-number sequencing were used to assess executive attention. These subtests were conducted using the Wechsler Adult Intelligence Assessment Scale-IV. The maximum possible score for each subtest was 12 points. These subtests show adequate reliability with a Cronbach's alpha coefficient of

0.73, and the letter-number sequencing subtest has a Cronbach's alpha coefficient of 0.62 (Renteria et al., 2008).

### *10.2.4 Statistical analyses*

Statistical analyses were performed in SPSS (Version 21.0). The Kolmogorov – Smirnov test was used to see whether the variables showed a normal distribution ($p > 0.05$). An evaluation was performed to determine whether there were differences between the groups for the sociodemographic variables by means of an analysis of variance for one factor (ANOVA) for quantitative variables and Chi-square for categorical variables. An ANOVA analysis was used to determine whether there were differences between groups in ADLs and attentional resources. Subsequently, a post-hoc analysis was performed and a Bonferroni-adjustment used. The effect size (Cohen's d) was calculated to discover how great the differences were between groups. Finally, Pearson's bivariate correlation analysis was carried out to assess whether the functionality for basic and instrumental ADL is related to attentional resources in people with ID.

## 10.3 Study "Upper limb coordination and hand muscle strength in adults with intellectual disabilities".

The methods section of study included in the PhD thesis is suummarized and described below. Table 3 provides a detailed summary of the methodology employed.

**Table 3.**

*Summary of Material and Methods in Study 3.*

| PAPER | STUDY DESING | PARTICIPANTS | PROCEDURE | MEASURES | METHODS |
|---|---|---|---|---|---|
| **Study 3: Upper limb coordination and hand muscle strength in adults with intellectual disabilities** | Descriptive and cross-sectional study. | Individuals adults with ID (n= 65).<br><br>The sample is made up of three groups:<br><br>- People with moderate ID (n= 34).<br>- People with mild ID (n= 31).<br>- People without ID (n= 49).<br><br>Inclusion criteria:<br><br>- Over 18 years of age.<br>- Voluntary participation.<br>- Diagnosis of moderate or mild ID.<br><br>Exclusion criteria:<br><br>- Severe Behavioural disturbances.<br>- Severe mental disorder.<br>- Severe language impairment.<br>- Severe cognitive impairment.<br>- Mother tongue | 1) Screening to identification selection criteria.<br>2) Sociodemographic information was registered.<br>3) Evaluation was performed between July 2019 and May 2020.<br>4) Participants were subdivided of three groups:<br>- People with moderate ID (n= 34).<br>- People with mild ID (n= 31).<br>- People without ID (n= 49). | Outcome measures were:<br><br>• Nine Hole Peg Test (NHPT).<br><br>• Mechanical Pinch Gauge (MPG) | Sample size was calculated.<br><br>Statistical analysis were:<br><br>1) To describe the sample of ID.<br>2) To compare the group with ID and without ID by sociodemographic of the subjects.<br>3) To analyse the differences between groups with moderate, mild and without ID in motor |

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| | other than Spanish.<br>- Being over 65 years of age.<br>- Neurodegenerative disorder.<br>- Uncorrected perceptual impairments. | | skills variable.<br>4) To analyse the differences between the group with moderate ID and the group with mild ID, the group with moderate ID and the group without ID, and the group with mild ID and the group without ID in motor skills variable. |

### *10.3.1 Participants*

The initial sample comprised 125 individuals hailing from the Granada province. Following the application of our selection criteria, the analysed sample was narrowed down to 114 individuals. This sample is delineated into three distinct groups. The group of individuals with moderate ID consists of 34 adults (17 women and 17 men), with an average age of 43.6 years. The group of individuals with mild ID is composed of 31 adults (10 women and 21 men), with an average age of 40.6 years. The third group, consisting of individuals without ID, comprises a total of 49 adults (25 women and 24 men), and an average age of 40.9 years. Participants were recruited from three ID associations and through community services (civic centres) in the province of Granada.

The procedure for selecting samples is depicted in Figure 1. The study was conducted between July 2019 and May 2022.

Regarding the selection criteria, the general inclusion criteria for the three groups were: 1) being over 18 years old, 2) voluntary participation. The additional criteria for the sample of people with ID were, 1) having a diagnosis of ID that meets the criteria of the World Health Organization (World Health Organization, 2001), 2) have a moderate or mild degree of ID according to the evaluation of the assessment and guidance centre of the Autonomous Government of Andalusia (Salvà et al., 2007).

The exclusion criteria for both groups were: 1) presenting behavioural disturbances, 2) suffering from a mental disorder, 3) presenting severe language impairments, both in comprehension and expression, 4) presenting cognitive impairment (through a score of ≥24 points in the Mini-Examination Cognitive of Lobo's test), 5) mother tongue other than Spanish, 6) being over 65 years of age, 7) suffering from some neurodegenerative disorder or acquired brain injure, 8) uncorrected perceptual impairments (touch sensation, vision or hearing).

### *10.3.2 Procedures*

The study has an observational descriptive and cross-sectional design. This study followed the guidelines and principles of the Declaration of Helsinki and was approved by the local Ethics Committee of Granada (Granada - Spain), reference: 1271-N-19. The evaluation sessions were carried out in a well-lit room with no noise. Each session was divided into two parts: first, information on the study and its purpose was provided to the participant, and they were told they could stop or abandon it whenever they wanted, and the second part consisted of the administration of all tools for approximately 15-20

minutes. The centre's records were reviewed to compare and collect the necessary information for the study. The level of ID was taken from the medical records of each of the participants.

### *10.3.3 Measures*

Sociodemographic data was obtained on age, gender and level of education. In addition, clinical data such as preference or manual dexterity were collected, if the person presents corrected perceptual alterations (touch sensation, vision or hearing). Several instruments used in the present study were in a language-free version making them more suitable in cross-cultural and special needs contexts. The researchers were trained to ensure the consistency and integrity of data collection.

Nine Hole Peg Test (NHPT) is commonly used as measurement of finger dexterity (Grice et al., 2003). The NHPT consists of a square board with 9 holes, spaced 3.2em apart measured centre to centre. The subjects were seated with the shoulder adducted and neutral rotated, elbow flexed 90°, forearm in neutral position, wrist with 0° dorsiflexion and ulnar deviation between 0° and 15°. The pegboard was presented in front of the subject, with the pegs placed in the container next to the board on the same side as the hand being tested (Mathiowetz et al., 1984). The dominant hand was tested first. The following instructions were given to the subject: pick up the pegs one at a time. Using your right (later repeated with the left hand) hand only and put them into the holes in any order until all the holes are filled. Then remove the pegs one at a time and return them to the container. The time it takes for the subject to do so is measured. In addition to the finger dexterity, NHPT probes also the hand-eye coordination in patients with ID (Grice et al., 2003). The validity of the test, measured by Pearson's correlation, obtained a significant inverse relationship for the right hand (r=-0.61) and

for the left hand (r=-0.53), this scale was validated for the student population Spanish (Grice et al., 2003).

The assessment of grip strength in the hand was conducted using the Mechanical Pinch Gauge (MPG). For the study, a calibrated dynamometer was used three point, lateral (key) and palmar strength were measured. Firstly, the subject was presented with the dynamometer, secondly, the way in which he had to grip was explained, and finally, he was asked to exert force on the instrument. First time, the subject use dominant hand and after, the subject use non dominant hand. This scale was validated for the Spanish population (MacDermid et al., 2001; Mathiowetz et al., 1984).

### *10.3.4 Statistical analyses*

Statistical analyses were performed in SPSS (Version 21.0). The Kolmogorov–Smirnov test was used to see whether the variables showed a normal distribution ($p > 0.05$). An evaluation was performed to determine whether there were differences between the groups for the sociodemographic variables by means of an ANOVA for quantitative variables and Chi-square for categorical variables. An ANOVA analysis was used to determine whether there were differences between groups in manual dexterity. Subsequently, a post-hoc analysis was performed and a Bonferroni-adjustment used. The effect size (Cohen's d) was calculated to discover how great the differences were between groups.

# 12 RESULTS

## 12.1 Study "The Association between Executive Function and Performing Instrumental Daily Activities in People with Intellectual Disabilities".

The results section of the study is showed below.

### *12.1.1 Participants*

A total of 286 adults were recruited from several community centers in the province of Granada, Spain. After applying the selection criteria, a sample of 90 individuals with ID and 79 individuals without ID were included. In the group of people with ID, 48 (53.3%) were men and 42 (46.7%) women, with a mean (SD) age of 39.86 (11.31) years. In the group of people without ID, 37 (46.8%) were men and 43 (53.2%) women, with an average (SD) age of 36.95 years. Figure 1 shows the flow diagram of subjects who participated in the study according to the strengthening the reporting of observational studies in epidemiology (STROBE) statement.

The sample with ID was divided into 2 groups, based on their degree of dependency for IADLs: dependent (n = 57) and independent (n = 33). In the ID group, 63.33% were dependent for IADLs, and 36.67% were independent for these activities. The sociodemographic and clinical characteristics and the comparison between the group with and without ID are shown in Table 4.

**Table 4.**

*Mean (SD) and frequency (%) for sociodemographic and clinical characteristics of subjects with and without ID*

| Sociodemographic and clinical characteristics | Group with ID | Group without ID | Student's t / chi-square |
|---|---|---|---|

| | **Mean (SD)/ Frequency (%) n = 90** | **Mean (SD)/ Frequency (%) n = 79** | **($\chi^2$)** |
|---|---|---|---|
| Age (years) | 39.86 (11.31) | 36.95 (14.59) | 1.432 |
| Sex | | | |
| - Women | 42 (46.7) | 42 (53.2) | 0.711 |
| - Men | 48 (53.3) | 37 (46.8) | |
| Level of education | | | |
| - No schooling | 4 (4.4) | 0 | 51.535** |
| - Incomplete primary | 24 (26.7) | 4 (5.1) | |
| - Primary | 34 (37.8) | 16 (20.3) | |
| - Secondary | 28 (31.1) | 32 (40.5) | |
| - Technical training | 0 | 13 (16.5) | |
| - University | 0 | 14 (17.7) | |
| Years of education | | | |
| - None | 4 (4.4) | 0 | 9.015* |
| - < 5 years | 9 (10.0) | 4 (5.1) | |
| - From 5 to 10 years | 32 (35.6) | 20 (25.3) | |
| - > 10 years | 45 (50.0) | 55 (69.6) | |
| Literacy | | | |
| - Does not read or write | 23 | 0 | 58.081** |
| - Reads and writes (with difficulty) | 30 | 3 | |
| - Reads and writes (fluently) | 37 | 76 | |
| Handedness | | | |
| - Right-handed | 76 | 68 (86.1) | 3.027 |
| - Left-handed | 12 | 6 (7.6) | |
| - Ambidextrous | 2 | 5(6.3) | |
| Motor disorders | | | |
| - Yes | 8 | 0 | 7.371* |
| - No | 82 | 79 (100) | |
| Sensory disorders | | | |
| - Yes | 1 | 0 (0) | 0.883 |
| - No | 89 | 79 (100) | |
| Corrected visual disturbances | | | |
| - Yes | 8 | 0 (0) | 7.371* |

| | | | |
|---|---|---|---|
| - No | 82 | 79 (100) | |
| Corrected auditive disturbances | | | |
| - Yes | 0 (0) | 0 (0) | - |
| - No | 90 (100) | 79 (100) | |

Note. *$p$<0.05; **$p$<0.001.

### *12.1.2 Differences between groups with and without intellectual disability in performing instrumental activities of daily living and executive functions*

Our results showed statistically significant differences between the two groups (with and without ID) in mean scores for the Lawton and Brody scale, the similarities subtest, the IFS test, semantic verbal fluency, and the key test ($p < 0.001$). The calculation of Cohen's d values (difference of means between groups) showed a moderate to large effect size between groups (minimum d = 0.653, maximum d = 3.064). The mean and SD of the results of these measurement variables for participants with and without ID, together with the effect sizes (difference of means between groups), are shown in Table 5.

**Table 5.**

*Mean (SD) and differences between groups with and without ID in performance of instrumental activities of daily living, abstraction, working memory, motor programming, verbal and motor inhibitory control, verbal fluency, and planning*

| **Variable** | **Group with ID** **Mean (SD)/ N = 90** | **Group without ID** **Mean (SD)/ N = 79** | ***Student's t*** | **Cohen's *d*** |
|---|---|---|---|---|

| | | | | |
|---|---|---|---|---|
| Lawton and Brody scale (total) | 3.74 (2.20) | 8 (0.00) | 18.343** | 2.738 |
| Similarities subtest | 7.30 (5.84) | 18.98 (6.33) | 10.214** | 0.653 |
| IFS test (total) | 8.94 (8.18) | 24.58 (3.32) | 10.441** | 2.505 |
| - WM Index | 1.36 (1.96) | 6.03 (1.91) | 11.393** | 2.413 |
| - Motor programming | 1.34 (1.28) | 2.69 (0.64) | 5.615** | 1.334 |
| - Conflicting instructions | 0.94 (1.21) | 2.86 (0.49) | 8.630** | 2.079 |
| - Motor inhibitory control (*Go-No-Go*) | 1.09 (1.30) | 2.73 (0.75) | 6.625** | 1.545 |
| - Backward digit span | 0.61 (1.00) | 3.03 (1.52) | 9.570** | 1.881 |
| - Verbal WM (*months backwards*) | 0.37 (0.70) | 1.86 (0.46) | 10.894** | 2.515 |
| - Visual WM | 0.75 (1.11) | 3.00 (0.90) | 10.105** | 2.226 |
| - Abstraction (*proverbs*) | 0.51 (0.90) | 2.72 (0.48) | 13.109** | 3.064 |
| - Verbal inhibitory control | 3.31 (4.27) | 5.70 (0.62) | 3.132* | 0.783 |
| Semantic verbal fluency | 9.40 (7.36) | 26.00 (7.94) | 9.190** | 2.168 |
| Key test | 2.81 (3.52) | 9.98 (3.68) | 8.441** | 1.991 |

Note. IFS: Ineco Frontal Screening; WM: Working memory.

**$p<0.001$.

Statistically significant differences in scores in all the executive function tests ($p < 0.05$) were also observed between groups with dependency and independence for IADLs. The effect sizes were moderate to large, with a minimum d value of 0.506 and a maximum d of 2.516. These results are shown in detail in Table 6.

**Table 6.**

*Mean (SD) and differences between groups with dependency and independence for executive functions in institutionalised individuals with moderate ID.*

| Variable | Dependency for IADLs Mean (SD)/ n = 57 | Independent for IADLs Mean (SD)/ n = 33 | Student's *t* | Cohen's *d* |
|---|---|---|---|---|
| Similarities subtest | 6.14 (5.44) | 9.06(6.08) | -2.253* | 0.506 |
| IFS test (total) | 3.95 (4.07) | 17.25 (6.27) | -7.298** | 2.516 |
| - WM Index | 0.30 (0.80) | 3.13 (2.07) | -4.532* | 1.803 |
| - Motor programming | 0.75 (1.16) | 2.33 (0.78) | -4.171** | 1.598 |
| - Conflicting instructions | 0.40 (0.88) | 1.83 (1.19) | -3.895* | 1.366 |
| - Motor inhibitory control (*Go-No-Go*) | 0.45 (0.76) | 2.17 (1.34) | -4.071* | 1.578 |
| - Backward digit span | 0.10 (0.45) | 1.46 (1.12) | -4.023* | 1.593 |
| - Verbal WM (*months backwards*) | 0.15 (0.49) | 0.75 (0.87) | -2.199 | 0.849 |
| - Visual WM | 0.20 (0.52) | 1.67 (1.23) | -3.921* | 1.556 |
| - Abstraction (*proverbs*) | 0.10 (0.31) | 1.21 (1.12) | -3.361* | 1.237 |
| - Verbal inhibitory control | 1.80 (1.61) | 5.83 (5.99) | -2.870* | 0.918 |
| Semantic verbal fluency | 5.80 (4.41) | 15.42 (7.48) | -4.598** | 1.566 |
| Key test | 1.00 (2.13) | 5.83 (3.35) | -5.007** | 1.720 |

Note. IADL: instrumental activities of daily living; IFS: Ineco Frontal Screening; SD: standard deviation; WM: Working memory.

*$p$<0.05. **$p$<0.001.

### *12.1.3 Relationship between the ability to perform instrumental activities of daily living and executive functions in people with intellectual disabilities*

In the group of institutionalized individuals with moderate ID, bivariate tests showed a direct correlation between the degree of IADL functioning and scores for the similarities subtest ($p < 0.001$), the overall score, and the scores obtained for different dimensions of the IFS test ($p < 0.05$), verbal semantic fluency ($p < 0.001$), and the key test ($p < 0.001$). These results are shown in detail in Table 7.

**Table 7.**

*Correlation between capacity to perform IADLs and executive functions in institutionalised individuals with moderate ID (n = 90)*

| **Variable** | **Pearson correlation (*r*)** |
|---|---|
| Age (years) | -0.108 |
| Similarities subtest | 0.486** |
| IFS test (total) | 0.854** |
| - WM Index | 0.679** |
| - Motor programming | 0.596** |
| - Conflicting instructions | 0.577* |
| - Motor inhibitory control (*Go-No-Go*) | 0.639** |
| - Backward digit span | 0.610** |
| - Verbal WM (*months backwards*) | 0.540* |
| - Visual WM | 0.649** |
| - Abstraction (*proverbs*) | 0.677** |
| - Verbal inhibitory control | 0.554* |
| Semantic verbal fluency | 0.628** |
| Key test | 0.731** |

Note. IFS: Ineco Frontal Screening; WM: Working memory.

*$p$<0.05; **$p$<0.001.

### *12.1.4 Executive skills that may influence the performance of IADLs in people with intellectual disabilities.*

Linear regression analysis, meanwhile, showed that global executive control (total score on the IFS test) and the key test scores predicted the degree of IADL performance (total scores on the Lawton and Brody scale), predicting 81% of the total variance (R2 = 0.806) in the ability to perform these activities for the group with ID. The linear regression model is presented in Table 8.

**Table 8.**

*Linear regression model of the IFS and key tests as predictors of performance of IADLs in institutionalised individuals with moderate ID*

| **Independent variables** | **Lawton and Brody scale ($r^2$=0.806)** | | | | | |
|---|---|---|---|---|---|---|
| | ***B*** | **95% *CI*** | | ***β*** | ***SE*** | ***p-value*** |
| | | **Lower limit** | **Upper limit** | | | |
| IFS test (total score) | 0.228 | 0.155 | 0.301 | 0.649 | 0.036 | 0.000 |
| Key test | 0.281 | 0.111 | 0.450 | 0.344 | 0.083 | 0.002 |

Note. $r^2$, regression coefficient of determination; B, regression coefficient; CI, confidence interval; β, adjusted coefficient from multiple linear regression analysis; SE coefficient standard error.

## 12.2 Study "Attentional resources and independence in basic and instrumental activities of daily living in individuals with intellectual disabilities".

The results section of the study is showed below.

### *12.2.1 Participant*

The final sample consisted of 166 individuals, of whom 88 had ID and 78 had no ID. The sociodemographic and clinical characteristics of the three groups are presented in Table 9. No differences were observed between the groups concerning any of these variables ($p > 0.05$).

**Table 9.**

*Mean (SD) and frequency (%) for sociodemographic and clinical characteristics of participants with and without ID.*

| Sociodemographic and clinical characteristics | Group with ID N = 88 | | Group without ID N = 78 | | |
|---|---|---|---|---|---|
| | Group with moderate ID N = 39 | Group with mild ID N = 49 | | | |
| | Mean (SD) / frequency (%) | Mean (SD) / frequency (%) | Mean (SD) / frequency (%) | F / chi-square ($\chi^2$) | p-value |
| Age (years) | 41.21 (12.15) | 39.31 (9.53) | 37.01 (14.67) | 1.49 | 0.23 |
| Sex | | | | 1.49 | 0.47 |
| - Women | 20 (51.3) | 21 (42.9) | 42 (53.8) | | |
| - Men | 19 (48.7) | 28 (57.1) | 36 (46.2) | | |
| Level of education | | | | 12.43 | 0.05 |
| - No schooling | 2 (5.1) | 2 (34.1) | 0 | | |
| - <5 years | 6 (15.4) | 3 (6.1) | 4 (5.1) | | |
| - 5–10 years | 14 (35.9) | 17 (34.7) | 19 (24.4) | | |
| - >10 years | 17 (43.6) | 27 (55.1) | 55 (70.5) | | |
| Handedness | | | | 4.04 | 0.40 |

| | | | | | |
|---|---|---|---|---|---|
| - Right-handed | 33 (84.6) | 42 (85.7) | 67 (85.9) | | |
| - Left-handed | 6 (15.4) | 5 (10.2) | 6 (7.7) | | |
| - Ambidextrous | 0 | 2 (4.1) | 5 (6.4) | | |
| Touch sensation impairment | | | | 3.28 | 0.19 |
| - Yes | 1 (2.6) | 0 | 0 | | |
| - No | 38 (97.4) | 49 (100) | 78 (100) | | |
| Visual impairment | | | | - | - |
| - Yes | 0 (0) | 0 (0) | 0 (0) | | |
| - No | 39 (100) | 49 (100) | 78 (100) | | |
| Auditory impairment | | | | - | - |
| - Yes | 0 (0) | 0 (0) | 0 (0) | | |
| - No | 39 (100) | 49 (100) | 78 (100) | | |

Note. SD: standard deviation

*p<0.05, **p<0.001.

### *12.2.2 Group differences in attentional resources*

The one-way ANOVA analyses indicated differences between the groups (moderate, mild and no ID) for all attentional resources: digit span [F = 82.87; p <0.001], forward digit test [F = 85.17; p <0.001], correct A test [F = 68.86; p <0.001], test A errors [F = 29.65; p <0.001], test A omission [F = 12.28; p <0.001], commission test [F = 8.87; p <0.001], color trail test part A [F = 48.50; p <0.001], color trail test part B [F = 48.52; p <0.001], backward digit test [F = 46.64; p <0.001], sequencing digits test [F = 65.43; p <0.001], and letter-number sequencing test [F = 66.09; p <0.001]. The results of the ANOVA model and mean (SD) scores for attentional resources are presented in Table 10.

**Table 10.**

*Mean (SD) and group differences in attentional resources among individuals with moderate ID, mild ID, and without ID.*

| Variable | Group with moderate ID N = 39 | Group with mild ID N = 49 | Group without ID N = 78 | | | | |
|---|---|---|---|---|---|---|---|
| | Mean (SD) | Mean (SD) | Mean (SD) | F | Lower limit | Upper limit | *p*-value |
| Digit span (total) | 5.50 (6.16) | 13.04 (7.18) | 27.83 (7.37) | 82.87** | 12.81 | 17.16 | <0.001 |
| Digit forward test | 2.39 (2.78) | 4.48 (2.85) | 10.40 (2.80) | 85.17** | 5.18 | 6.75 | <0.001 |
| Test A | | | | | | | |
| - Correct | 6.54 (11.03) | 8.40 (11.64) | 32.90 (6.10) | 68.86** | 11.86 | 17.63 | <0.001 |
| - Mistakes | 22.45 (19.28) | 5.82 (9.04) | 0.00 (0.00) | 29.65** | 6.17 | 11.90 | <0.001 |
| - Omission | 11.63 (15.17) | 3.36 (7.71) | 0.00 (0.00) | 12.28** | 2.91 | 6.97 | <0.001 |
| - Commission | 5.87 (10.91) | 0.95 (1.49) | 0.00 (0.00) | 8.87** | 0.89 | 3.35 | <0.001 |
| Color Trail Test | | | | | | | |
| - Part A<br>- (Standard Score) | 56.61 (5.19) | 55.00 (0.00) | 90.38 (18.67) | 48.50 ** | 70.78 | 81.30 | <0.001 |
| - Part B<br>- (Standard Score) | 56.94 (5.66) | 57.83 (6.83) | 91.95(18.40) | 48.52** | 72.22 | 82.80 | <0.001 |
| Digit backwards | 1.81 (2.35) | 4.38 (2.53) | 7.95 (3.21) | 46.64** | 4.29 | 5.64 | <0.001 |
| Digit sequencing | 1.21 (1.47) | 3.71 (2.91) | 7.67(2.55) | 65.43** | 3.80 | 5.11 | <0.001 |
| Letters-number sequencing | 2.51 (3.84) | 7.43 (6.60) | 17.02 (5.39) | 66.09** | 7.83 | 10.75 | <0.001 |

Note. SD: standard deviation. F: F-value, coefficient of variance.

*$p$<0.05, **$p$<0.001.

Regarding the post-hoc comparisons between groups, the results indicated significant differences between individuals with moderate and mild ID for the following attentional variables: digit span (t = 7.54, p <0.001), forward digit test (t = 2.08, p = 0.005), test A errors (t = 16.63, p <0.001), test A omission (t = 8.27, p = 0.001), commission test (t = 4.91, p = 0.002), backward digit test (t = 2.57, p <0.001), sequencing digits test (t = 2.49, p <0.001), and letter-number sequencing (t = 4.91, p =

0.001). These differences ranged in effect sizes (Cohen's d) from small to large (d = 0.256, 1.154).

The post-hoc comparison between the groups of individuals with moderate ID and the group without ID also showed significant differences in all attentional resources: digit span (t = 22.33, p <0.001), forward digit test (t = 8.01, p <0.001), correct A test (t = 26.36, p <0.001), test A errors (t = 22.45, p <0.001), test A omission (t = 11.64, p <0.001), Test A commission (t = 5.87, p = 0.001), color trail test part A (t = 33.77, p <0.001), color trail test part B (t = 35.00, p <0.001) backward digit test (t = 6.13, p <0.001), sequencing digits test (t = 6.44, p <0.001), and letter-number sequencing (t = 14.51, p <0.001). The effect size (Cohen's d) varied from moderate to large according to the variables (d = 0.761, 4.337).

The post-hoc comparison between the mild ID group and the group without ID indicated significant differences in all attentional resources: digit span (t = 14.78, p <0.001), forward digit test (t = 5.92, p <0.001), correct A test (t = 24.51, p <0.001), color trail test part A (t = 35.38, p <0.001), color trail test part B (t = 34.12, p <0.001), backward digit test (t = 3.57, p <0.001), sequencing digits test (t = 3.95, p <0.001), and letter-number sequencing (t = 9.59, p <0.001). The effect size (Cohen's d) varied from moderate to large according to the variables (d = 0.616, 2.679). The means (SD) of the results of these measurement variables for the three groups and the effect sizes of the differences between the groups are presented in Tables 10 and 11.

**Table 11.**

*Mean (SD) and differences between the moderate ID group and mild ID group, the moderate ID group and the group without ID, and the mild ID group and the group*

*without ID in attentional resources.*

| Variable | Moderate ID – Mild ID | | | Moderate ID – Without ID | | | Mild ID – Without ID | | |
|---|---|---|---|---|---|---|---|---|---|
| | ***t*** | ***p*-value** | **Cohen d** | ***t*** | **p-value** | **Cohen d** | ***t*** | ***p*-value** | **Cohen d** |
| Digit span (total) | 7.54** | <0.001 | 1.127 | 22.33** | <0.001 | 3.288 | 14.78** | <0.001 | 1.127 |
| Digit forward | 2.08* | 0.005 | 0.742 | 8.01** | <0.001 | 2.871 | 5.92** | <0.001 | 2.095 |
| Test A | | | | | | | | | |
| - Correct | 1.84 | 1.00 | 0.164 | 26.36** | <0.001 | 2.957 | 24.51** | <0.001 | 2.636 |
| - Mistakes | 16.63** | <0.001 | 1.104 | 22.45** | <0.001 | 1.647 | 5.82 | 0.125 | 0.910 |
| - Omission | 8.27* | 0.001 | 0.687 | 11.64** | <0.001 | 1.084 | 3.37 | 0.429 | 0.616 |
| - Commission | 4.91* | 0.002 | 0.632 | 5.87** | 0.001 | 0.761 | 0.95 | 1.00 | 0.901 |
| Color Trail Test | | | | | | | | | |
| - Part A<br>- (Standard Score) | 1.61 | 1.00 | 0.439 | 33.77** | <0.001 | 2.464 | 35.38** | <0.001 | 2.679 |
| - Part B<br>- (Standard Score) | 0.88 | 1.00 | 0.142 | 35.00** | <0.001 | 2.572 | 34.12** | <0.001 | 2.458 |
| Digit backwards | 2.57** | <0.001 | 1.052 | 6.13** | <0.001 | 2.183 | 3.57** | <0.001 | 1.235 |
| Digit sequencing | 2.49** | <0.001 | 1.084 | 6.44** | <0.001 | 3.104 | 3.95** | <0.001 | 1.084 |
| Letter-number sequencing | 4.91** | 0.001 | 0.256 | 14.51** | <0.001 | 3.101 | 9.59** | <0.001 | 1.591 |

Note. SD: standard deviation, t: t-test

*$p$<0.05, **$p$<0.001.

### *12.2.3 Association between attentional resources and BADL and IADL in individuals with ID*

The linear regression analysis, conducted for the moderate and mild ID groups, indicated that age (in years), degree of disability, and errors on “A test” were predictors of the level of performance on BADL (total scores on the Barthel index). This model

explained 40% of the total variance (R2 = 0.397) in individuals with ID's ability to perform these activities. Table 12 presents the linear regression analysis results.

**Table 12.**

*Lineal multiple regression between capacity to perform basic ADL and attention resources for individuals with ID.*

| **Explanatory Variables** | **Barthel index (R2 = 0.397)** | | | | | |
|---|---|---|---|---|---|---|
| | **B** | **95% CI** | | **β** | **SE** | **p-value** |
| | | **Lower Limit** | **Upper Limit** | | | |
| Age (years) | -0.357 | -0.693 | -0.021 | -0.279 | 12.938 | 0.038 |
| Degree of ID | 15.717 | 7.764 | 23.670 | 0.571 | 12.121 | <0.001 |
| A test (mistakes) | -0.382 | -0.638 | -0.126 | 0.451 | 11.079 | 0.004 |

Note. ID: intellectual disability, R2: regression coefficient of determination, B: regression coefficient, CI: confidence interval, β: adjusted coefficient from multiple linear regression analysis, SE: coefficient standard error**.**

*p<0.05, **p<0.001.

The linear regression analysis, conducted on individuals with ID, found that A test (correct items and mistakes), direct forward, backward digit, and sequencing digits were predictors of the level of performance in IADL (Lawton and Brody scale scores). This model accounted for 68% of the total variance (R2 = 0.684) in individuals with ID's

ability to perform these activities. Table 13 presents the linear regression analysis results.

**Table 13.**

*Lineal multiple regression between capacity to perform IADL and attention resources for individuals with ID.*

| **Explanatory Variables** | **Lawton and Brody Scale ($R^2$ = 0.684)** | | | | | |
|---|---|---|---|---|---|---|
| | **B** | **95% CI** | | **β** | **SE** | ***p*-value** |
| | | **Lower Limit** | **Upper Limit** | | | |
| A test (correct items) | 0.057 | 0.027 | 0.087 | 0.295 | 1.648 | <0.001 |
| A test (mistakes) | -0.056 | -0.082 | -0.029 | -0.414 | 1.575 | <0.001 |
| Digit forward | -0.343 | -0.509 | -0.178 | -0.469 | 1.401 | <0.001 |
| Digit backwards | 0.348 | 0.099 | 0.597 | 0.438 | 1.321 | 0.007 |
| Digit sequencing | 0.268 | 0.048 | 0.488 | 0.329 | 1.276 | 0.018 |

Note. $R^2$: regression coefficient of determination, B: regression coefficient, CI: confidence interval, β: adjusted coefficient from multiple linear regression analysis, SE: coefficient standard error.

*$p$<0.05, **$p$<0.001.

## 12.3 Study "Upper limb coordination and hand muscle strength in adults with intellectual disabilities".

The results section of the study is showed below.

### *12.3.1 Participants.*

The final sample consisted of 114 people, of which 65 had an ID and 49 people had no ID. The sociodemographic and clinical characteristics were similar in the three groups. These results are shown in detail in Table 14.

**Table 14.**

*Mean (SD) and frequency (%) for sociodemographic and clinical characteristics of subjects with and without ID.*

| | **Group with ID N=65** | | **Group without ID N=49** | | |
|---|---|---|---|---|---|
| **Sociodemographic and clinical characteristics** | **Group people with ID moderate N=34** | **Group people with ID mild N= 31** | | | |
| | **Mean (SD) /frequency (%)** | **Mean (SD)/ frequency (%)** | **Mean (SD) / frequency (%)** | **F / Chi square** | **P Value** |
| Age (years) | 43.68 (8.19) | 40.61 (11.82) | 40.94 (14.62) | 0.66 | 0.520 |
| Sex | | | | 3.07 | 0.215 |

| | | | | | |
|---|---|---|---|---|---|
| - Women | 17 (50.0) | 10 (32.3) | 25 (51.0) | | |
| - Men | 17 (50.0) | 21 (67.7) | 24 (49.0) | | |
| Level of education | | | | 28.88** | p<0.001 |
| - No schooling | 8 (23.5) | 4 (12.9) | 0 | | |
| - < 5 years | 9 (26.5) | 7 (22.6) | 4 (8.2) | | |
| - Between 5 a 10 years | 14 (41.2) | 14 (45.2) | 20 (40.8) | | |
| - > 10 years | 3 (8.8) | 6 (19.4) | 25 (51) | | |
| Handedness | | | | 5.5 | 0.234 |
| - Right-handed | 25 (73.5) | 25 (80.6) | 43 (87.8) | | |
| - Left-handed | 8 (23.5) | 5 (16.1) | 3 (6.1) | | |
| - Ambidextrous | 1 (2.9) | 1 (3.2) | 3 (6.1) | | |
| Motor disorders | | | | 3.54 | 0.171 |
| - Yes | 4 (11.8) | 7 (22.6) | 4 (8.2) | | |
| | | | 20 (40.8) | | |
| - No | 30 (88.2) | 24 (77.4) | 45 (91.8) | | |
| | | | 29 (59.2) | | |
| Sensory disorders | | | | 2.37 | 0.305 |
| - Yes | 1(2.9) | 0 | 0 (20) | | |
| - No | 33 (97.1) | 31 (100) | 49 (100) | | |
| Corrected Visual disorders | | | | 3.37 | 0.185 |

| | | | | | | |
|---|---|---|---|---|---|---|
| - | Yes | 4 (11.8) | 3 (9.7) | 1 (2.0) | | |
| | | | | 20 (40.8) | | |
| - | No | 30 (88.2) | 28 (90.3) | 48 (98.0) | | |
| | | | | 29 (59.2) | | |
| Corrected auditive disturbances | | | | | 8.25 | 0.16 |
| - | Yes | 0 | 4 (12.9) | 0 | | |
| | | | | 20 (40.8) | | |
| - | No | 34 (100) | 27 (87.1) | 49 (100)29 (59.2) | | |

*Note*. ***p*<0.001

### *12.3.2 Differences between groups with intellectual disabilities in motor skills variable.*

The one-way ANOVA analyses have shown differences between the groups (moderate, mild and no ID) for the NHPT dominant hand [F(2,114)=24.82; p<0.001], NHPT non dominant hand [F(2,111)=17.28; p<0.001], MPG three point dominant hand [F(2,114)=26.44; p<0.001], MPG three point non dominant hand [F(2,112)=26.13; p<0.001], MPG lateral (key) dominant hand [F(2,114)=26.45; p<0.001], MPG lateral (key) non dominant hand [F(2,112)=25.23; p<0.001], MPG palmar dominant hand [F(2,114)=27.40; p<0.001] and MPG palmar non dominant hand [F(2,112)=25.96; p<0.001]. The results of the ANOVA model, the M (SD) for the variables of manual dexterity are shown Table 15.

**Table 15.**

*Mean (SD) and differences between groups with moderate PDI, mild PDI and without ID in motor skills variable.*

| Motor skills variable | Group people with ID moderate N= 34 | Group people with ID mild N= 31 | Group people without ID N=49 | | | | |
|---|---|---|---|---|---|---|---|
| | Mean (SD) | Mean (SD) | Mean (SD) | F | Lower limit | Upper limit | p-value |
| *Nine Hole Peg Test* | | | | | | | |
| - Dominant hand | 48.06 (24.02) | 44.27 (31.64) | 18.95 (3.02) | 24.82** | 31.20 | 40.11 | <0.001 |
| - Non dominant hand | 54.98 (39.83) | 48.71 (45.9) | 19.74 (2.88) | 17.28** | 33.33 | 45.80 | <0.001 |
| *MPG: Three point strength* | | | | | | | |
| - Dominant hand | 3.53 (1.65) | 3.83 (1.91) | 6.12 (2.08) | 26.44** | 4.21 | 5.00 | <0.001 |
| - Non dominant hand | 3.21 (1.46) | 3.75 (2.39) | 5.92 (1.88) | 26.13** | 4.03 | 4.83 | <0.001 |
| *MPG: Lateral strength* | | | | | | | |
| - Dominant hand | 5.21 (1.80) | 5.74 (2.64) | 8.26 (1.96) | 26.45** | 6.09 | 6.99 | <0.001 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| - Non dominant hand | 4.93 (1.94) | 5.38 (2.82) | 8.00 (1.93) | 25.23** | 5.80 | 6.74 | <0.001 |
| *MPG: Palmar strength* | | | | | | | |
| - Dominant hand | 4.32 (1.84) | 4.73 (2.77) | 7.70 (2.26) | 27.40** | 5.31 | 6.29 | <0.001 |
| - Non dominant hand | 4.10 (1.96) | 4.53 (2.98) | 7.33 (1.90) | 25.96** | 5.05 | 6.01 | <0.001 |

*Note.* MPG: Mechanical Pinch Gauge

*$p$<0.05; **$p$<0.001

Regarding post-hoc comparisons between groups, people with moderate ID and the group without ID shows significant differences in manual dexterity variables: NHPT dominant hand (t=-6.27, p<0.001) and NHPT non dominant hand (t=-5.14, p<0.001), MPG three point dominant hand (t=6.289, p<0.001), MPG three point non dominant hand (t=7.37, p<0.001, MPG lateral (key) dominant hand (t=7.18, p<0.001), MPG lateral (key) non dominant hand (t=7.08, p<0.001), MPG palmar dominant hand (t=7.20, p<0.001) and MPG palmar non dominant hand (t=7.51, p<0.001). The effect size (Cohen d) is large across all variables (d=1.248, 1.700). Comparison of the group of people with mild ID and the group without ID shows significant differences NHPT dominant hand (t=-4.44, p<0.001) and NHPT non dominant hand (t=-3.33, p=0.002), MPG three point dominant hand (t=4.93, p<0.001), MPG three point non dominant hand (t=4.45, p<0.001), MPG lateral (key) dominant hand (t=4.56, p<0.001), MPG lateral (key) non dominant hand (t=4.43, p<0.001), MPG palmar dominant hand

(t=4.99, p<0.001) and MPG palmar non dominant hand (t=4.53, p<0.001).The effect size (d Cohen) is large across all variables (d=0.890, 1.175). However, the results show significant no differences between the groups of people with moderate and mild ID. The means and SD of the results of these measurement variables for the three groups, and the effect sizes of the difference between groups are shown in Tables 15 and 16.

**Table 16.**

*Mean (SD) and differences between group IDP moderate and IDP mild; group IDP moderate – group without ID and group IDP mild - group without ID in* motor variable.

| **Motor variable** | **Group IDP moderate - Group IDP mild** | | | **Group IDP moderate – Group without ID** | | | **Group IDP mild - Group without ID** | | |
|---|---|---|---|---|---|---|---|---|---|
| | **t** | **p-value** | **Cohen d** | **t** | **p-value** | **Cohen d** | **t** | **p-value** | **Cohen d** |
| *Nine Hole Peg Test* | | | | | | | | | |
| - Dominant hand | -0.521 | 0.604 | 0.134 | -6.272** | <0.001 | 1.700 | -4.444** | <0.001 | 1.126 |
| - Non dominant hand | -0.702 | 0.485 | 0.145 | -5.148** | <0.001 | 1.248 | -3.333* | 0.002 | 0.890 |
| *MPG: Three point strength* | | | | | | | | | |
| - Dominant hand | 0.688 | 0.494 | 0.168 | 6.289** | <0.001 | 1.379 | 4.931** | <0.001 | 1.147 |
| - Non dominant hand | 1.059 | 0.295 | 0.272 | 7.375** | <0.001 | 1.610 | 4.446** | <0.001 | 1.009 |
| *MPG: Lateral strength* | | | | | | | | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| - Dominant hand | 0.932 | 0.355 | 0.234 | 7.177** | <0.001 | 1.620 | 4.556** | <0.001 | 1.084 |
| - Non dominant hand | 0.708 | 0.482 | 0.186 | 7.083** | <0.001 | 1.586 | 4.429** | <0.001 | 1.084 |
| *MPG: Palmar strength* | | | | | | | | | |
| - Dominant hand | 0.702 | 0.486 | 0.174 | 7.200** | <0.001 | 1.640 | 4.990** | <0.001 | 1.175 |
| - Non dominant hand | 0.661 | 0.512 | 0.170 | 7.506** | <0.001 | 1.673 | 4.527** | <0.001 | 1.120 |

*Note.* *$p$<0.05; **$p$<001

# 13 DISCUSSION

## 13.1 Discussion regarding the first overarching objective of the thesis

The first objective of this thesis was to assess the levels of functionality, as well as cognitive functions and motor skills in people with ID. Client factors are the capacities and characteristics that reside in individuals, groups or populations. These client factors are conditioned by performance capabilities and disability conditions. Cognitive functions enable the individual to select relevant information from the environment and adapt performance to environmental demands. For this purpose, it was analysed the performance of executive function and attentional resources in people with intellectual disabilities. Furthermore, the motor performance of these individuals was explored, as clinical observations indicate lower performance in this population compared to other populations without ID.

With regard to the performance of ADLs in individuals with ID, the thesis' results show that this population shows no differences for the performance of BADLs, while they seems to have moderate-large lower levels of functioning in IADLs compared to the sample of individuals without ID. The performance of BADLs requires less cognitive processing and are activities that people develop from childhood (King et al., 2017). However, the possible explanations for this difference between groups for IADLs are that: (i) adults with ID may experience greater difficulty in performing activities that require more complex cognitive processing and interaction with their physical and social environment. These activities involve a higher level of planning, inhibitory control in social situations, problem solving, and even memory processes (King et al., 2017; Lechowska et al., 2022); (ii) the structured care and support provided by staff in the institution could limit individuals' opportunities to participate in certain

activities and prevent them from learning and performing such tasks (Janicki et al., 2002; Jones et al., 1999). IADLs such as mobility in the community, shopping, bank transfers, or caring for others are usually planned and resolved by the institution. Institutionalized care could be eroding any such skills acquired at some point in their lives, because of disuse (Janicki et al., 2002); (iii) individuals with ID presenting functional impairment from childhood may have elicited paternalistic attitudes toward them. The paternalist behaviours may have persisted into adulthood, thus limiting their chances of exploring and successfully performing daily activities; (iv) these behaviours could limit their capacity to develop and engage in certain roles such as parent, worker, or volunteer (Jones et al., 1999). These roles are usually vehicles for maintaining a satisfactory level of participation in the activity.

Regarding the executive functions, the individuals with ID exhibited poorer performance in abstraction, working memory, motor programming, verbal and motor inhibitory control, mental processing, cognitive flexibility, and action planning ability compare to people without ID. The magnitude of these differences ranged from moderate to high for all variables. This finding may be explained by different reasons. Context enables the development of skills and provides opportunities that may affect the acquisition of higher cognitive processes throughout an individual's life. In turn, low participation in activities may erode existing capacities in these functions as a consequence of disuse or the absence of learning (Marshall et al., 2011; Vaughan & Giovanello, 2010).

Several investigations have also found impairment of executive functions in individuals with ID (Gligorović & Buha Urović, 2014; Loveall et al., 2017; Pritchard et al., 2015). One study (Gligorović & Buha Urović, 2014) observed impairment of

divided attention and verbal fluency after a 5-year follow-up of individuals with Down syndrome; however, in line with other studies, no impairment was observed in planning ability (Gligorović & Buha Urović, 2014; Lifshitz et al., 2016). Similarly, another study (Pritchard et al., 2015) reported that this population experience difficulties in all dimensions of executive function. In line with the present thesis results, other researchers (Loveall et al., 2017) have also observed a lower level of executive function performance and functionality in people with Down syndrome compared with a control group. More specifically, impairment has been observed in planning, spatial working memory, and verbal fluency, among other cognitive functions, using the same tests as those used in this thesis (Willner et al., 2010). However, while previous research identified impairments in various cognitive functions in ID, the relationship between executive functioning and the performance of daily activities was not explored in those studies.

In relation to the performance of attentional resources between individuals with mild and moderate ID, the evaluation of this thesis revealed differences in the capacity for selective, sustained, and executive attention on a scale ranging from small to large; however, there were no differences among divided and alternating attention. The ID group exhibited an impaired ability to focus on relevant information in contexts with a high number of stimuli, that is, the ability to select relevant information within a given context diminished when there was a high stimulus level. This may indicate a slower attentional speed and a decrease in inhibitory control processing when responding to stimuli. When comparing the groups with ID to those without it, the results showed moderate to large differences in all attentional resources evaluated in this study. These differences may be attributed to individuals with ID tending to have fewer opportunities to engage in more complex activities (Hallgren & Kottorp, 2005). Performing more

complex activities results in improved learning and performance of daily activities (Su et al., 2008). Since these activities are executed daily, constant training positively impacts the development of cognitive performance because it promotes cognitive processing activation (King et al., 2017; Su et al., 2008).

Similar studies conducted on adolescents and young individuals with ID support this thesis' results by showing that adolescents and young individuals with ID exhibit a generalized deficit in attentional resources (Danielsson et al., 2010; García-Madruga et al., 2016; Zagaria et al., 2021). This may be explained by an overprotective environment created by their relatives or by the institutional care. These cares may restrict cognitive processing development and participation in daily living activities (Dean et al., 2016; Galán Jiménez et al., 2017). A study conducted on children with ID revealed a lower performance in attentional processing during a walking task compared with individuals without ID. Given that the walking task involves high attentional demands, this study suggested that these individuals exhibited lower ability to simultaneously perform a secondary task with the same efficiency (Jansen et al., 2013).

In reference to motor skills, the thesis' results, obtained from the evaluation of the levels of coordination of the upper limbs in people with ID show differences between the hand coordination of people with and without ID. Relevant findings were observed when analysing the time to perform the proposed task, where participants with ID took on time average twice as long as participants without ID, indicating a lower hand dexterity in the population with ID. These differences may be attributed to adults with ID scoring lower on manual tasks requiring motor and visual skills, which is taken into account as a consequence of the own ID (Cantone et al., 2018). In particular, people with ID show these coordination disorders more noticeably when faced with an

unfamiliar task or a task in which they have no previous experience, which could indicate that this task is not correctly pre-organised in their motor cortex (Hermsdörfer et al., 2008). From the perspective of the International Classification of Functioning, Disability, and Health model, this finding can be justified because functionality is typically built upon the integration of body systems and anatomical structures (Taylor et al., 2024). Within the body systems construct, psychological aspects such as cognitive functions are considered as an essential part that influences the rest of the systems.

Other investigations have documented impairments in manual dexterity among individuals with ID (Carmeli et al., 2008; Vuijk et al., 2010). For instance, Carmeli et al. (2008) conducted a study to delineate the sensorimotor deficits in individuals with ID through the administration of coordination tests. Their findings revealed that this population achieved notably lower scores than the control group in all sensorimotor assessments, particularly those pertaining to upper limb function. In another study, the motor skills of children aged 7-12 years with mild ID and borderline intellectual functioning were compared with the skills of typically developing children using the Movement Assessment Battery for Children. Their findings indicate that children with ID had deficits in manual dexterity and motor impairments compared to the typically developing sample (Vuijk et al., 2010). Hence, motor impairments that manifest during childhood may continue to be present in adult life of people with ID.

In the evaluation of the degree of manual strength of people with ID, the present thesis reports that people with ID scored poorer than people without ID. These score differences could be explained by the fact that individuals with ID tend to have a less active lifestyle and participate less in physical activity compared to the general population (Borland et al., 2020). Borji et al. (2014) reported in their study that

alterations in muscle strength in people with ID may be related to a failure of the central nervous system to activate motor units and abnormal intrinsic muscle properties (Borji et al., 2014). Consistent with the results of our study, other research assessing manual strength in people with ID (Cabeza-Ruiz & Castro-Lemus, 2017; Cuesta-Vargas & Hilgenkamp, 2015; Merchán-Baeza et al., 2019) reported lower manual strength performance than in people without ID. Finally, no differences were found when comparing coordination and manual strength between the moderate and mild ID groups. These results differ from the findings of Vuijk et al. (2010) that compared motor performance in children with ID and children with Borderline Intellectual Functionality (Vuijk et al., 2010). These authors reported that the level of severity in motor impairments depends on the degree of ID. Differences between the current results and previous research could be explained by the age of the study participants. The sample of this study included adult people that probably had more opportunities of motor learning than the population based on children. These differences can be also attributed to the fact that younger populations are at early stage of neurodevelopment. Therefore, younger people probably show lower levels of neuromuscular function (Vuijk et al., 2010a).

## 13.2 Discussion regarding the second overarching objective of the thesis

The second general objective of this thesis was to examine the potential relationship between functionality and cognitive functions in people with ID.

In evaluating the possible relationship between executive functioning processes and ADL performance in people with ID, it was observed that the degree of functional dysfunction in IADLs was directly related to all executive functions, in that poor performance in these functions was associated with greater dysfunction in IADLs. The

global executive control and the action planning abilities predicted 81% of the explained variance of IADLs performance. Therefore, it could be argued that a decrease in executive function performance influences the degree of function in complex ADL, or vice versa. However, we cannot confirm the directionality of this association, since our data were collected transversally. One explanation for this correlation is that higher cognitive functions are involved in processes that govern and monitor human behaviour and conduct, enabling each person to interact with the world around him or her.

In assessing the possible relationship between attentional resources and ADL performance in people with ID, the limitation of attentional processing in people with ID was associated with ADL dysfunction. Specifically, performance in the ABVD in the sample with mild to moderate ID was related to age of participants, level of disability and sustained attention. However, the directionality of this association could also not be confirmed because the data in the present study were collected cross-sectional. Older age, higher degree of disability, and lower levels of sustained attention appeared to be related to the level of functioning in BADL. Conversely, the level of functioning could also influence the cognitive function of this population. A possible explanation for these results is that these attentional functions are integral to the processes that govern and monitor human behaviour, facilitating the interaction of individuals with their environment. In contrast, sustained, divided, and executive attention explained the level of IADL performance in the individuals with ID. This finding may be understood because, based on the definition of IADL, these are tasks that involve greater cognitive processing (Hallgren & Kottorp, 2005; King et al., 2017). Therefore, the execution of these activities requires selecting relevant information in the presence of distractors, maintaining attention for a period, the ability to simultaneously

focus on two stimuli, or shifting attention to meet the needs of other contexts (King et al., 2017).

These findings are in line with previous results in the literature since similar patterns have been observed in different populations, such as individuals with Alzheimer's disease (Marshall et al., 2011), elderly people living in the community (McDougall et al., 2019), or individuals with acquired frontal lobe injury (Pride et al., 2017). One study (Marshall et al., 2011) found a significant correlation between executive dysfunction and functioning in IADLs. Another (Vaughan & Giovanello, 2010) found that psychomotor speed and mental flexibility are indicators of a decrease in functional capacity. However, other authors (Pride et al., 2017) have shown that slow thinking, impairment of selective attention (increased sensitivity to interference), and impairment of prospective memory may be the main predictors of performance of IADLs in individuals with frontal lesions, excluding sequencing, action planning ability, or mental flexibility. Another research revealed that executive functions such as changing mental attitudes, updating and monitoring information, and inhibiting responses contribute in varying degrees to the performance of complex tasks (Miyake et al., 2000). On the other hand, a study conducted among older adults living in a community reported an association between attentional demands and the ability to manage ADLs. The authors observed that attentional demands were linked to the management of ADL, which required selective attention, such as climbing stairs, furnishing houses, or obtaining information on health procedures (Jansen et al., 2013). Less related to the present thesis sample but equally important to its findings, it has been reported that individuals affected by breast cancer exhibited attentional fatigue as a predictor of their work capacity. Therefore, this population may perform worse on tasks requiring sustained attention at work (Von Ah et al., 2017).

In summary, this thesis provides valuable insights into the interaction between executive function processes and attentional resources within specific ADLs, while acknowledging the importance of considering the particular demographic group under study.

### 13.3 Limitations of this PhD thesis

The present thesis has the following limitations that should be taken into account when interpreting the results. Firstly, the cross-sectional design prevented establishing a cause-effect relationship between the variables studied. Secondly, longitudinal studies should be carefully designed to establish causality. Alternatively, studies with larger and more diverse samples should be conducted to improve the generalisability of the findings. Therefore, studies with larger and more diverse samples are needed to extend and validate the thesis findings to larger populations. Thirdly, the samples included in the present thesis were selected consecutively, which may affect the representativeness or external validity of the results in relation to the general population of people with ID. Fourthly, some authors argue that comparative groups should be equal in terms of mental age. However, this factor may be less significant than chronological age in sample selection, as both groups would have had equal opportunities to accumulate life experiences or episodes. Fifthly, another limitation could be the lack of validated and reliable measures of cognitive components and ADL performance based on performance in Spanish. Although the current results suggest the potential usefulness of this type of measures to understand the relationship between the variables assessed, to the best of our knowledge, there is currently a limited availability of instruments available in Spanish that meet the required standards of validity and reliability. Sixthly, neuroleptics/antipsychotics usually have a direct effect on the pyramidal tracts or on the

individual's level of consciousness; this aspect was not included as a possible confounding variable. However, this population was controlled for having a mental disorder. Finally, in the study of upper limb coordination and hand muscle strength in adults with ID, a potential limitation may be the lack of exploration of the potential association between manual dexterity and ADL performance. Therefore, it could be valuable to investigate the extent of deficits found when performing specific activities.

# 14 CONCLUSIONES

- Las personas con discapacidad intelectual mostraron niveles de rendimiento menor para las funciones cognitivas de: abstracción, memoria de trabajo, programación motora, control inhibitorio, procesamiento mental, flexibilidad cognitiva planificación, atención selectiva, atención sostenida y atención ejecutiva. Sin embargo, no mostraron diferencias en el rendimiento de las funciones cognitivas de atención dividida y atención alternante.
- Las personas con discapacidad intelectual tardaron el doble de tiempo en realizar la tarea de coordinación y obtuvieron menor puntuación en la tarea de fuerza en las manos, en comparación con los participantes sin discapacidad. Esto sugiere una menor destreza manual en la población de personas con discapacidad intelectual.
- El control ejecutivo global y las habilidades de planificación de la acción explicaron el 81% de la varianza en el rendimiento de las actividades instrumentales de la vida diaria. La edad, el nivel de discapacidad y la atención sostenida explicaron el 40% del rendimiento en las actividades básicas de la vida diaria. Los recursos atencionales de atención sostenida, dividida y ejecutiva explicaron el 64% e la varianza en el rendimiento de las actividades instrumentales de vida diaria.
- La función cognitiva y motora deben ser elementos clave en la elaboración de programas de apoyo destinados a mejorar el desempeño de las actividades de la vida diaria en las personas con discapacidad intelectual.

# 15 CONCLUSIONS

- People with intellectual disability showed poorer performance in several cognitive domains, such as: abstraction, working memory, motor programming, inhibitory control, mental processing, cognitive flexibility, planning, selective attention, sustained attention and executive attention, while no significant differences were observed in divided attention and alternating attention.

- People with intellectual disability took twice as long to perform the coordination task as participants without intellectual disability, and scored lower on hand strength, suggesting lower manual dexterity in the intellectual disability population.

- Global executive control and action planning skills predicted 81% of the explained variance in IADL performance. Age, level of disability and sustained attention predicted 40% of BADL performance, whereas sustained, divided and executive attention resources predicted 64% of the variance in IADL performance.

- Cognitive and motor function should be included as key elements in the design of support programmes aimed at improving ADL performance in people with intellectual disability.

# 16 FUTURE RESEARCH

Future research should focus on validating these data with a larger population, through studies that allow the execution of activities to be observed over a period of time. Furthermore, it is important to develop and validate appropriate measures based on the performance of daily living activities for the Spanish population, thus allowing us to have a real evaluation of the activities we carry out on a daily basis in our society. On the other hand, future studies could determine the mental age of the subjects to compare chronological and mental age in relation to cognitive and motor performance, and their ability to perform ADL. Finally, greater knowledge is required about the degree of personalized and personalized support that these people need within a developmental approach. In this sense, the use of a compensatory-substitution approach could be avoided when there may still be the possibility of framing the treatment within a developmental approach.

# 17 CLINICAL MESSAGES

The findings of the study hold significant implications for rehabilitation, highlighting the importance of evidence-based intervention programs designed to address specific cognitive and motor deficits. These programs aim to enhance functional independence and overall quality of life. In clinical practice, these implications have a range of potential applications. The insights from the findings offer valuable input for creating evidence-based healthcare and occupational therapy programs, covering educational, personal, and community skills, as well as cognitive stimulation and motor training interventions. Furthermore, the presented information has the potential to inspire innovative strategies tailored to meet individual needs. Lastly, the results can play a vital role in optimizing resource allocation and support for individuals with ID and their families. It is necessary to understand and generate support plans that enable the development of behaviour compatible with the demands of the environment and consistent with the skills that need to be deployed in the community. The present thesis results will also facilitate the design of strategies aimed at calibrating the real support that these people need. The more suitable and better tailored the support provided to a person with ID, the better the training of person's functionality will be.

On the other hand, the study results may represent a breakthrough in “activity analysis” models in occupational therapy, especially when working with individuals with ID. These findings suggest that individuals with ID exhibit poor performance across various cognitive domains, including abstraction, working memory, motor programming, inhibitory control, mental processing, cognitive flexibility, planning and, all attentional variables. Activity analysis in occupational therapy involves evaluating how a person performs daily tasks and activities to identify problem areas and develop appropriate interventions. The study’s results indicate that individuals with ID may face

specific challenges in performing these activities. Therefore, occupational therapists need to consider these cognitive and motor components when designing individualized treatment plans. These approaches could include training in strategies to improve working memory, inhibitory control, cognitive flexibility, and task organization. Additionally, social skills training and problem-solving techniques could be used to address difficulties in mental processing and abstraction. As well as promoting training in manipulative skills that develop manual dexterity. It is also essential to consider that each individual is unique, so occupational therapists must conduct comprehensive and personalized assessments to identify the specific needs of each person.

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