UNIVERSITA' DEGLI STUDI DI PADOVA

Dipartimento di Psicologia dello Sviluppo e della Socializzazione

Corso di Laurea Magistrale in Psicologia Clinica dello Sviluppo

Tesi di Laurea Magistrale

Adaptive behaviours as measures of the vineland adaptive behaviours interview 3rd edition and fine motor skills as measures of the Mullen Scale of early learning: possible correlations between these two measures and Autism Spectrum Disorder's symptoms.

Relatrice

Prof.ssa Irene Mammarella

Correlatrice esterna

Dott, Ellen Demurie

Laureanda: Vendramin Melanie

Matricola:1234338

Anno Accademinco 2021/2022

I would like to dedicate this thesis to those who stayed by my side, loved and supported me before, now and always.

"Sometimes a scream is better than a thesis"

Ralph Waldo Emerson

Abstract

Autism Spectrum Disorder is a neuroatypical development presenting a significant heterogeneity in its phenotype. ASD is a condition that produces impairments in the functioning of the individual. An important area of deficit for this neurodevelopmental disorder is the adaptive behaviours area, including social, communication, daily living, and motor areas. An interesting correlation we found in this study is the one between these areas of disorders, and the fine motor skills area. In fact, from previous studies we saw how fine motor skills are early detectable signs in childhood; in particular, deficits in this area can impact future communication, social and daily living skills development.

In our study, we wanted to investigate the correlation that fine motor skills have with the adaptive behaviours domains previously mentioned, in typical and atypical development pre-schoolers. Based on existing literature and theoretical implications, the following hypotheses are derived:
1. Low possible scores in the VABS 3rd-ed subscale of Fine Motor Skills and in the MSEL fine motor skills scale may be correlated with low scores in the other three domains of the VABS 3rd-ed: Socialisation, daily living skills and comunication domains.
2. High scores in the SRS-2, so strong presence of autism traits, may be correlatd with low scores in the MSEL and VABS fine motor skills scales, so presenting a negative linear correlation.

It was interesting considering the MSEL and VABS instruments, related to the fine motor skills, and the adaptive behaviours in general, and the SRS to have a comparison with possible autistic traits of the individual. The sample of our study was including both typical and atypical pre-schoolers, which were considered as a single group during the correlational analysis; the reason behind that was that we wanted to have a general view on how fine motor skills interact with adaptive behaviours. Each individual was assessed with all the three instruments, with the difference that the MSEL was assessed by the experimenter, and the VABS and SRS were assessed by the experimenter too, but the answers were given by the parents/caregiver of the child.

Our results were agreeing with the studies we analysed in our literature, showing that fine motor skills present a correlation with communication and daily living skills, already in the pre-school age of the development. Differently from the literature, we did not find a significant correlation between fine motor skills and the socialisation area. However, it is important to consider that the sample of our

study was including only pre-schoolers, which is an early stage of development. It would be interesting to investigate the same correlations later in age, to analyse how these variables develop and interact with each other, and if these correlations become stronger and more evident with the development. It would be also interesting to analyse how fine motor skills impact the area of adaptive behaviours and the direction of this impact.

Introduction

1. **Autism spectrum disorder: an atypical development**

Autism Spectrum Disorders are part of the neurodevelopmental disorders (American Psychiatric Association (APA), 2013). According to the Diagnostic and Statistical Manual of Mental Disorder-5 (DSM-5; APA, 2013), a neurodevelopmental disorder is a condition that causes deficits that produce impairments in the functioning of the individual; the onset of this disorder must be during the developmental period of an individual. In specific, the Autism Spectrum Disorder (ASD) refers to deficits in the area of social interaction and social communication, and in the area of restricted, repetitive patterns of behaviour, interests, or activities (APA, 2013; Mughal et al., 2020). Furthermore, in some cases, adaptive capabilities are minimal and this leads to the fact that small changes in the surrounding environment can be felt with distress (APA, 2013; Mughal et al., 2020). Talking about adaptive capabilities, we can introduce the concept of adaptive behaviour, which is a fundamental topic for the understanding of this symptomatology; with adaptive behaviour, we refer to daily activities that an individual should be able to perform, to be enough independent. These activities involve self-individual care, so being able to manage minimal responsibilities like living in a community with other individuals, taking care of tasks or obligations and self-autonomy (Rebuttini, 2015).

People with ASD may communicate, interact, behave and learn in a way that is different from most other neurotypical people (APA, 2013). ASD can also involve language impairments and intellectual disabilities (Mughal et al., 2020).

Another important aspect to remember when we are talking about ASD is motor skills. Motor skills are skills that allow our movement; we can talk about fine motor skills as those require more control and precision, and gross motor skills as those for bigger movements such as walking (Mauro, 2022). In ASD children, we can see motor skills impairments as one of the first possible signals of atypical development.

We can, then, affirm that ASD implies complex needs, which can be different from one individual to another. As we said before, ASD individuals can show deficits in the communicative and interactive areas; some of the features of ASD, involved in communication and interaction, that we can find with different intensity and expressions within the ASD population, are difficulties to communicate, ex

pressing feelings, understand other people's feelings, difficulties to filter environmental stimuli (Arpinati et al., 2008). Other types of difficulties can be on playing role games, deficits in imagination, repetitive behaviours, hypersensitivity to noise, and intellective deficits (Arpinati et al., 2008). These features are not present in the same way, or with the same intensity, in the whole ASD population, and not all of them are always present in an individual with ASD.

We don't know yet the exact causes of this neurodevelopmental condition, but we can assert that, due also to the big heterogeneity of ASD, the etiopathogenesis is multifactorial. We can find internal genetic factors origins, and external environmental factors origins (Rebuttini, 2015).

During this research, we are going to investigate more deeply the aspects of adaptive behaviours and motor skills deficits in typical and atypical development (TD and AD) pre-schoolers. More in detail, we will approach the adaptive behaviours as measured by The Vineland Adaptive Behavior Scale-3° edition (VABS-3ed; Sparrow et al., 2016), the fine motor skills, as measured by the Mullen Scale of Early Learning (MSEL; Mullen, 1995), and the level of autistic traits as measures of the Social Responsiveness Scale-Preschool version (SRS-2), a parent-report measure of autistic traits, in specific deficits in social behaviours, in children aged 2.5-4.5 years (Bruni, 2014). This rating scale can be used both as a screener and as a clinical diagnostic instrument (Aldridge et al., 2012). We will, then, try to find a possible correlation between three domains of the VABS-3ed, the communication, socialisation and daily living skills domains, and the fine motor skills subdomain measured from the same instruments. We also want to analyse the scores of the fine motor skills area, both from the AD and TD group, obtained from the MSEL and compare them with the scores obtained from the three domains and fine motor skills subscale of the VABS-3ed. After these correlations, we will analyse the relationship between the level of ASD symptomatology, measured with the SRS-2, so the SRS total score, and the fine motor skills, both from the MSEL and VABS; moreover, to give more validity and reliability to our experiment, we will also calculate the correlation between the SRS social-communication area's score, and the MSEL and VABS fine motor skills' score, and between the SRS total score and the VABS composite behaviour score.

1.1. Briefly introduction on the history of the term "Autism"

The term autism was born for the first time as a mere symptom of a schizophrenic spectrum, and it was used for the first time, in these terms, by Eugen Bleuler at the beginning of the XX century.

Bleuler was using this term, to indicate the isolation from the society which can be related to individuals who suffered from a psychiatric condition in the schizophrenic spectrum (Militerni, 2006). The first time that we can associate the word autism with a separate condition is in 1943 by Leo Kanner, who studied a group of children between the age of 2 and 10 years old, discovering that they were presenting a symptomatic picture not related to other known conditions. He was talking about "childhood autism" (Rebuttini, 2015). An interesting discovery was found by Muratori and Bizzarri (2021) in their article about the origin of Autism. During their research, these authors found that in the same period as Kanner, a paediatrician from Austria, Hans Asperger, was studying the same topic on children. Asperger also used the term "autism". The two men did not know each other, but they did arrive at the same conclusion. A possible explanation that Muratori and Bizzarri (2021) found for this, was that another author was studying the topic of this new symptomatology: George Frankl. George Frankl first worked with Asperger, talking about an affection impairment in these observed children; but Asperger did not recognise his ideas (Muratori & Bizzarri, 2021). Due to Second World War persecutions, Frankl decided to move to Baltimora, where he found Kanner, to which he proposed his ideas. The two collaborated, even if with a different focus: Frankl was more interested in the affective language of verbal and non-verbal children (Muraturi & Bizzarri, 2021).

Another important moment in the history of Autism is during the fifth decade of the XX century with Bettelheim, who was defining the mothers of Autistic children as the only ones responsible for their kid's condition (Silberman, 2016). It is only at the end of the XX century, that psychiatrists decided to abandon all the blaming theories against the mothers to arrive at more multifactorial theories (Silberman, 2016).

1.2. Etiopatogenesis and diagnosis

In the Diagnostic and Statistical Manual of Mental Disorders – 5 (DSM-5; APA, 2014) Autism Spectrum Disorder (ASD) is classified as a distinct diagnostic category. To be diagnosed with ASD, based on the DSM-5 criteria, an individual must meet all the symptoms of impairments in social interaction and communication, as well as at least two signs of repetitive behaviours (APA, 2013). The child's behaviour and development are the key elements to making a diagnosis, but many children do not receive a final diagnosis early, in this way children with ASD might not get the appropriate help they need (APA), 2013). Normally, the diagnosis is around three years of age, but this number can vary

based on the severity of symptoms, the environment in which the child is growing up, and a series of other factors, however people can get diagnosed at every age (Lasala, 2017). A way to investigate this condition of neuroatypical development, and to make progress in the way to have an earlier diagnosis, is to study the etiopathogenesis of these disorders. Having an early diagnosis is important because early diagnosis, combined with appropriate treatments, can positively affect the outcome of ASD (Yochum, 2016). Etiopathogenesis can give us useful pieces of information about a condition or a disorder, it can help us to better contextualize a syndrome, and to set earlier interventions.

In the beginning, the main cause of ASD was thought to be related to the relationship between the child and the parents, in specific to the relationship that a child has with the mother (Pincherle, s.d.). We are talking of a period in which Autism was first discovered as a separate syndrome, and in which psychiatrists and experts were starting to study it (Muratori & Bizzarri, 2021). Thanks to the innovative discoveries in the field of neurobiology and neurophysiology, this belief plunged, to arrive at one of the main theories in the field of Autism: the theory of mind (Pincherle, s.d.). The theory of mind is the theory according to which an individual should be able to confer to himself and other people's states of mind and interpret other's people behaviour in terms of states of mind (Pincherle, s.d.). A possible explanation of this comes from some studies on the mirror neurons in the pre-motor cortex, which seems to be neurofunctional different in ASD individuals than in typical development individuals; in fact, mirror neurons are involved in the understanding and imitating of other people's behaviours. Another important factor in the etiopathogenesis is the environment, both internal to the individual, so genetic factors, and external to the individual, so family, factors influencing the mother during the pregnancy etc (Rolla, 2015). In her study, Rolla (2015), investigate the possible factors influencing the pregnancy, to understand which one of these could have had a relevant impact on the development of the ASD. The participants in the study were 27 pre-schooler with ASD, and other two control groups, one with 28 typical children, and the other one with 18 siblings of children with ASD. From the result of her study, Rolla (2015), after an interview with the mothers of these children, found that the only relevant statistical difference between mothers of ASD children, and mothers of typical children, were the average of stressful events that they had during the pregnancy. From the results of these studies, we can then see how stress on pregnant women can be an important factor to consider when we are thinking about ASD etiopathogenesis.

The causes of ASD are multiple, we can talk about a multifactorial etiopathogenesis (Rolla, 2015). Not only the stress during the pregnancy can be a unique reason for an ASD diagnosis, but also a

neurofunctional predisposition is a factor to consider (Rolla, 2015), as well as pre, peri or postnatal infections and also genetic factors (Russo, 2020). Russo (2020) in his study highlights an important and interesting part of the causes of this different pathway of development being the ASD a neuro-atypical pathway of the development, we have to consider that also a dysfunctional organisation of some brain structures can lead to an ASD diagnosis (Russo, 2020). The reason for this deviation of the development is that if we have a starting point already organised differently from what should be the normal way, and if this organisation is dysfunctional, it will lead to a distortion, which will have the main influence on all the brain development, creating an anomalous modality of perceiving and elaborate external stimulus, having as result an atypical brain, which will work in an atypical way (Russo, 2020).

We can, then, see how the causes can be multifaced and different. This is why it is important to consider and investigate all the possible explanations, and to remember that the etiopathogenesis when we are talking of the Autism Spectrum Disorder, is always a combination of different factors.

1.3. Different levels of severity

ASD can encompass a broad range in severity from classic autism behaviour to the more highly functional presentation of the spectrum(Levi et al., 2013). We can identify three different levels of severity of ASD (Levi et al., 2013):

High functioning ASD (HFA): This category presents good cognitive functioning. In HFA individuals, it is still possible to find deficits involving the communicative and the interactive areas, including also repetitive and stereotyped behaviour, as well as for the other level of severity. Some HFA individuals can acquire language in an atypical way and time, which could be poor and stereotyped. People with HFA can also find it difficult to involve others in the conversation. In part of the HFA population, we can also find atypical social behaviour and an atypical way of understanding social rules; other possible deficits could be problems with starting and managing a conversation or ritualistic symptoms with panic and stress (Levi et al., 2013).

Medium cognitive functioning ASD: ASD with slight or medium intellectual disability.

Low cognitive Functioning ASD: ASD with serious or really serious mental retardation.

We can identify also another type, which is ASD not specified because in these cases we have an extreme neuro-cognitive, developmental and behavioural variability. We can find some autism symptoms, but it is not a classic ASD diagnosis. They often have a borderline profile, slightly developmental delay, or average intelligence, with specific difficulties in specific areas (Levi et al., 2013).

With these different levels of severity, we can notice that intellectual disability has an important role in ASD because it determines global functioning. The level of intellective functioning is very important also in determining the gap between chronological and mental age; if we know the children's chronological age and the children's actual mental age, we can better work with them and their needs (Levi et al., 2013).

Over the years, ASD became a more common diagnosis among the population. This is probably due to the more knowledge that we have about it, and also to the new instruments of diagnosis, and new techniques developed with research and studies on this condition. In the general population, the prevalence of the ASD population is currently around 6:1000 (Murgia, 2021, slides). The percentual varies across different countries and cultures, but studies in Asia, Europe and North America have identified people on the Autism Spectrum with an average of between 1% and 2% (Centers for Disease Control and Prevention, 2016). A recent study conducted in several European countries conducted by Autism Europe on 631,619 children between 7 and 9 years old determined an estimated average prevalence of 12.2 per 1000 (one in 89). The value of the various countries varies between 4.4 and 19.7 per 1000 (Autism Spectrum Disorders in the European Union (Narzisi et al., 2018).

1.4. Approaches and therapies for the ASD population

The approaches and therapies useful for ASD try to maximize the functions of the individual, promote child independence and improve the quality of life.

To have a wide perspective on the child we are starting the therapy with, it can be useful to obtain from the parents, teachers, and therapists the complete medical history of the child. Another important aspect to go deeper on is going through a 3-generation family history (Yochum, 2016). Cog-

nitive skills are measured by directly testing the individual, whereas adaptive functioning is researched via interviews or questionnaires to the respondents who are very familiar with the examinee (Wells et al., 2009). We can observe these skills during the typical routine of daily life. As we have said before, people not directly involved in the individual's daily life cannot see the way he/she acts during the typical routine. For this reason, it is important to ask the caregivers, examiners, family members, and educators, pieces of information about him/her (Wells et al., 2009).

2. Adaptive behaviours

2.1. Adaptive behaviours: An introduction

In the field of developmental disorders, including autism, adaptive behaviours are essential to the understanding of individuals with these conditions (Wells et al., 2009). We can think about adaptive behaviours as a collection of skills, age-appropriate, that the person uses to be functional in daily situations (Oakland, 2008). With "adaptive behaviour" we refer to skills in conceptual, social, and practical domains that an individual can demonstrate daily (Wells et al., 2009). This field is really important to investigate from early childhood onwards because measures of adaptive functioning can yield relevant information that helps identify core features of ASD (Floyd et al., 2015). Adaptive behaviour is defined by the extent to which a person is capable of being self-sufficient in real-life situations (Kanne, 2010), and for this reason, they are important to investigate, since they could indicate underlying deficits (Oakland, 2008). Talking about the adaptation of the individual, an important thing to keep in mind is also the environment in which a person is growing up; different types of environments could require different types of adaptive skills (Oakland, 2008). Adaptation is, so, not only a psychological aspect but also a biological construct; when the individual is adapting to an environment, he/she is acting to productively cope with the demands of that environment. The adaptation of the individual reflects his/her maturation in terms of interaction with learning from the environment surrounding this individual (Taverna, 2011).

2.2. Adaptive behaviour: Social competence and social skills

Adaptive behaviours involve also social skills and social competence; with the use of adaptive behaviour, an individual meets social and cultural independence, as well as social responsibility (Gresham & Elliot, 1987).

Before talking about social skills and social competence, it is necessary to define social behaviour. Social behaviours include both adaptive social skills and all the kinds of behaviours involved in social functioning (Matson, 2009). In this way, social skills become behaviours that predict important social outcomes for children (Gresham & Elliot, 1987).

Now that we have a definition of social behaviour, we can go to analyse the skills that a social behaviour involves, and how they can influence individuals' life. In his book "Social behaviour and

skills in children", Johnny L. Matson reports how social skills can influence and determine good academic achievement, psychological adjustment, coping skills, and employment. A failure in the use of social skills can be a social skills deficit (Matson, 2009). Social skills deficits can lead to adaptive behaviour deficits (Matson, 2009). Social skills are part of adaptive behaviours, and a consequence of deficits in social skills can be deficits in other areas of adaptive behaviours. As a part of the adaptive behaviours, Matson in his book (2009), defines social skills as "specific behaviours needed to perform a task competently" (Matson, 2009).

Another construct involved in this field is social competence. Social competence represents a multidimensional construct that includes cultural, demographic, adaptive behavioural, and social skills variables. But social competence is a wider concept than social skills. While with social skills we can determine the social ability in a specific task, with social competence we determine a group of social skills, which together go to satisfy environmental demands (Gresham & Elliot, 1987). So we can suggest that competence in a specific social request, does not entail competence in all the social situations.

We can, then, consider social competence as a multifaceted construct, which involves different variables like social assertion, frequency of interaction, positive self-concept, social cognitive skills, and popularity with peers (Dodge, 1985).

In his study Cavell (1990) defined adaptive behaviours, as well as social competence, as a social adjustment. In a particular or relevant situation, a social performance meets important developmental goals (Cavell, 1990). With the term "developmental goals", Cavell (1990) meant when social responses are adequated to the related social situation, based on socially valid criteria. He also defined social skills as specific abilities that allow competent performance in social situations, overt behaviour, social cognitive skills, and emotional regulation (Cavell, 1990). We can now say that social skills are not just a behaviour performed competently in a specific task; instead, social competence is a more general construct, which also involves an individual adequate performance on a particular social task. Competence in one social situation doesn't signify that a child will be socially competent in all the situations (Matson, 2009).

2.3 Adaptive behaviours in children with Autism Spectrum Disorder

The reason why we are talking about adaptive behaviours in this research is that they are an important construct to consider when we are talking about ASD. The study of Adaptive behaviour, in ASD children and individuals, may be difficult to do; this is because many individuals with ASD present difficulties in communication and intellectual functioning (Wells et al., 2009). In this way, an important step to investigate this is the use of interviews with parents or caregivers of ASD individuals. The adequacy of an individual's adaptive behaviour can be the judge for those who live, work and interact with this person the most (Taverna, 2011). Pine et al., (2006) use a sample with 2 groups of individuals: a control randomized group, and a group including individuals with ASD individuals. The authors found a strong correlation between quantitative scores on the SRS, and scores for social impairments and adaptive functioning in the VABS composite behaviours score. Another confirmation of this correlation comes from Papadopoulus et al., (2012) in which higher autistic traits or social impairments in ASD children were correlated with lower fine motor control ability

Through the use of these instruments, administered to those who are in daily direct contact with the ASD individual, we can obtain information about the way this individual acts and adapts him/herself to the environment (Wells et al., 2009). There are widely used interviews for adaptive behaviours: Vineland Adaptive Behaviour Scales-Classroom Edition (VABS-Classroom; Sparrow et al., 1985) but also versions of Vineland Adaptive Interview that are not school-related, like the Vineland Adaptive Interview -3rd Edition (Sparrow et al., 2017).

Adaptive behaviours and skills as measured by the Vineland Adaptive behaviours Scales Survey Edition (Sparrow et al., 1984) seem to be highly associated with ASD characteristics outcomes (Kanne, 2010).

In their study, Perry et al., (2009) have taken a sample of over 1,000 individuals with ASD, aged 4 to 17 years old, across North America and they wanted to examine and clarify how adaptive behaviour profiles in ASD are associated with IQ, age, and symptom severity. They also wanted to investigate what factors could contribute to stronger adaptive behaviour in these individuals. From the results of the study, the researchers discovered that adaptive deficits are present and could be substantially relevant also in intellectually able individuals with ASD; there was, therefore, only a poor association between adaptive behaviours and the level of the current Autism symptomatology. IQ seemed to be higher than VABS composite scores only in high functional individuals, but in low functioning ASD, they found the opposite pattern (Perry et al., 2009). On the other hand, we can find different results

about the relationship between adaptive behaviours impairments and IQ levels from the study of Kanne et al., (2010); according to this study in which the participants were 1089 children between the ages of 4 and 17 years old, taken from families with one of the child in the ASD spectrum, Kanne et al., (2010) found a strong positive relationship between the Vineland subscales scores and level of IQ of the child. In fact, from these results, the IQ of an ASD individual looks to be strongly related to the variance in overall adaptive skills, beyond age and diversity (Kanne, 2010). In support of this study, we can find another research highlighting the relationship between adaptive behaviours and cognitive functioning:

Wells et. Al (2009), in their study, have found correlations between adaptive functioning, cognitive level, and severity in autism. This is why it is really important to investigate these skills when we are dealing with ASD, in this way we can have a better chance to have an earlier diagnosis and improve possible treatment interventions (Wells et al., 2009).

Other interesting results about adaptive behaviours in individuals with ASD, can be found in 10 years study by Baghdali et al., (2011). In this study, the authors have used a sample of 152 children and followed them for ten years. The findings of the study were that most ASD individuals showed improvements in everyday functional communication and daily living skills, and their adaptive gains were related to their cognitive level.

In the field of adaptive behaviours, we also find daily living skills, such as personal hygiene and other daily activities (Hus Bal et al., 2012). Jung Lee et al., (2007), conducted a literature review based on studies on adaptive behaviours in Asperger's individuals. They selected 8 studies from the year 1992 to the year 2006. They selected from 30 to 270 individuals for each study. Among the number of individuals selected, we could find from 9 to 33 of these individuals presenting Asperger syndrome. After the selection, they investigated adaptive behaviours using the Vineland Adaptive Behaviours Scale (VABS; Sparrow et al., 1984), and the Behavior Assessment System for Children (BASC; Reynolds and Kamphaus, 1992). The results about daily living skills, as measures of both the VABS and the BASC, showed a moderately low adaptive level. According to this and the previous studies, we have another evidence from Freeman et al. (1999), who found that in a sample of 210 individuals with ASD ages 3 to 19, there was an improvement in social skills unrelated to their intellectual ability, but as a function of the age. There were also improvements in communication and daily living skills related to intelligence and as a function of age. We can, then, infer that deficits in ASD are not only in the communication and socialization domains but also in daily living skills domains (Kenworthy et al., 2009).

Cognitive functioning and IQ, are not the only factors related to adaptive skills. In a study by Ditterleine et al., (2008) the severity of adaptive behaviour deficits was shown to increase with the severity of emotional disturbance. In fact, in their study, Ditterleine et al., (2008) used a sample of 98 children and students, ages 4 through 14, who met the criteria for special education services based on some disorders, which also included Autism Spectrum Disorder. They found that adaptive behaviours in children with emotional disturbance were more compromised compared to children without emotional disturbance. From the literature reviews mentioned, we can see that there are several aspects of ASD core features related to the level of adaptive behaviours. From a recent study by Williams et al., (2018), we find a correlation also between adaptive behavioural skills and sensory features, which is an area of impairment in ASD individuals. This study discovered that elevated sensory features early in childhood were predicting lower adaptive behaviour skills later in childhood. It seems that sensory features may interfere with the development of adaptive behaviours (Williams et al., 2018).

In this research, we will consider the area of adaptive behaviours related to communication and social interaction skills, and we will investigate the correlation with the motor skills area, which is another important field to consider when we are talking about ASD. Motor skills areas are important variables to consider in this research because we want to investigate a possible correlation between social and communication, so to analyse if possible impairments in one of these areas, could interfere with impairments in the other areas. If this correlation would be found, we could go deeper in the investigation, in possible future research, studying if impairments in a specific area of the adaptive behaviour are a consequence of motor impairments, or are a direct consequence of an ASD symptomatology. When adaptive behaviours develop poorly, there are a series of consequences that goes to influence other areas of the child's development (Hall & Graff, 2011). In this way, low skills in the adaptive behaviours, especially in the area of daily living skills, communication, and socialization, may contribute to more behaviour problems in ASD children and individuals; having a good adaptive behaviours skills competence seems to be related to less supervision from other caregivers or people close to the ASD individual in his adulthood (Hall & Graff, 2011).

2.4. Motor skills: an introduction

When we are talking about "skills" we refer to abilities that allow us to achieve goals, in the way that we acquire this specific ability, in specific domains, with the practice (Rosenbaum et al., 2001). In particular, in this thesis, we are going to talk about motor skills, because motor competence is another crucial point concerning a positive developmental trajectory of health (Logan et al., 2017). As we mentioned in the introduction, motor skills are skills that allow our movement and they can be split into fine motor skills which require more control and precision, and gross motor skills as those for bigger movements such as walking (Mauro, 2022). Fundamental motor skills affect children's physical, social and cognitive development; we can divide the main motor skills into three categories: the stability, like balance skills, locomotor, like walking or running, and the manipulative movements, like using a fork or throwing a ball (Livonen & Saakslahti, 2018). Moreover, it is fundamental for this research to remember that pre-school is a critical period for the development of motor skills, in particular fine motor skills. Good environmental factors, such as supporting caregivers, and an environment which satisfied the different needs of pre-schooler, both with typical and atypical development, are important for the development of these skills (Livonen & saakslahti, 2018).

2.5. Motor skills and adaptive behaviours in children with ASD

 The development of the motor system is critical for an individual to engage with the environment (Wilson et al., 2018). From a study by Valla et al., (2020), who investigated motor skills in infancy, we have information about the importance of these skills during childhood, since they seemed to be important markers for development. More specifically, from their study, the results showed that gross motor skills were positively associated with communication skills at 6 months and fine motor skills at 12 months old. This study supports the associations between early motor development and later communication development (Valla et al., 2020). Deficits in fine and gross motor skills seem to be one of the earliest detectable signs of possible atypical development (MacDonald et al., 2013). This is important to know because early identification of motor impairments can lead to earlier interventions, but also an improvement in the long term functioning (Wilson et al., 2018). Leonard et al., (2014) conducted a systematic review of papers investigating the relationship between motor and social skills in both typical and atypical development. The authors found evidence that developing motor skills can influence the number and types of opportunities that infants and children have to interact

with others and the consequent development of social relationships. Atypical motor development could be an important contributing factor to social interaction (Leonard et al., 2014). According to what the authors found, the identification of motor problems associated with an ASD diagnosis is important also for the identification of possible biomarkers of autism. Biomarkers, or biological markers, are biological variables associated with a disease of interest, and we can directly measure them, on the individual, with reliable and quantitative measures (Ruggeri et al., 2013). Ruggeri et al., (2013) in their study explain how the identification of possible biomarkers is important because they could define homogeneous subgroups, moreover with biomarkers we could predict an autism onset before the outcome of behavioural symptoms, to better predict the developmental trajectory of ASD children. The research about motor skills impairments in children with ASD found that they experience both gross and fine motor delays (Lloyd et al., 2011), but also then the motor skills development is related to the overall individual's development (Wilson et al., 2018). In children with ASD, we find motor deficits in gait and postural control, but also motor planning: there are difficulties to define the goal of the action (MacDonald et al., 2013). Recent research suggests that significant motor difficulties are genetic to all areas of the autistic spectrum disorder and could be present at an early age. (Whyatt & Craig, 2012). A result from the study of Lloyd et al., (2011) indicates that all children with Asperger syndrome met the criteria for a diagnosis of motor impairments. Moreover, the delay becomes more pronounced with age (Lloyd et al., 2011). According to these studies, Hilton et al., (2007), in a project in which Asperger individuals were included and assessed with the SRS, found these individuals, people presenting ASD diagnostic criteria, to have low motor skills scores, measured with the Movement Accessory Battery for Children (MABC); the results showed a strong relationship between impairments levels and severity levels, and subscales t-scores in both the instruments. Provost et al., (2007), conducted a study about the levels of gross and fine motor development in young children with ASD. The participants of this study were 38 children, of which 19 with an ASD diagnosis, and 19 had developmental disabilities and they compared their gross and fine motor skills (Provost, 2007). The main finding of this study was that AS and HFA individuals showed delays or disorders in gross and fine motor skills development, including locomotor and object control (Provost, 2007). Other motor skills impairments that we could find in this population could be clumsy motor movement and clumsy fine motor movement (Jung Lee et al., 2007). Motor skills also interact with deficits in social communication skills, for example with deficits in imitation, joint attention, general social interaction, and functional and symbolic play (MacDonald et al., 2013).

Lloyd et al., (2011), also investigate the impact of these impairments on early learning opportunities and daily living skills, and they found that this impact is relevant to early developmental challenges. In children with ASD, motor skills fell significantly compared to what we would expect for their chronological age, and this seems to happen because they have a significant developmental delay related to their motor skills (Lloyd et al., 2011); this delay appears to become more evident during their growth. (Lloyd et al., 2011).

Another interesting discovery about motor skills impairments in ASD individuals can be found in the study by MacDonald et al. (2013). In their experiment, McDonald et al. (2013) found that the fine motor skills were predictive of daily living skills based on the Vineland Adaptive Behaviour Scale (2nd ed.). This study found a direct relationship between fine motor skills and adaptive social and adaptive communication skills of young children with ASD. From this and the previous studies, we can observe how impairments in motor skills can have an important impact also on daily living skills (Lloyd et al., 2011). In support of these findings we have another study by Zwicker et al., (2012), they found that about 5-6% of school-aged children with developmental coordination disorder present significant interferences with activities of daily living skills, and show difficulty with fine and gross motor skills. The relevance of these discoveries is that they may lead to social-communicative deficits (McDonald et al., 2014). In their study, McDonald et al., (2013), decided to investigate this relationship, and they found a correlation between adaptive behaviours, daily living skills, adaptive and social-communicative skills and motor skills. These authors found that the fine motor skill of ASD children are predictive of all the adaptive scales they used. Moreover, gross motor skills were related to daily living skills scored by the Vineland Adaptive Behavior Scales (2nd ed.).

Fine motor abilities seem to be associated with skills in a variety of domains, both in typical and atypical development (Choi et al., 2018). An interesting result about fine motor skills comes from a longitudinal approach by Choi et al., (2018). The authors investigated the correlation between fine motor skills between age 6 and 24 months, and language outcome at 36 months, using the Mullen Scale of Early Learning. The sample of the research was involving a group of infants at elevated likelihood for ASD and without a diagnosis of ASD, a group of children at elevated likelihood for ASD, which later had a diagnosis for it, and a group at typical likelihood for ASD and without an ASD diagnosis yet. The results suggested that elevated likelihood for ASD infants, compared to their typically developing peers, showed slower growth in motor skills between 6 and 24 months; Elevated likelihood for ASD infants who showed slower growth in fine motor skills, had a higher chance of

later receiving an ASD diagnosis (Choi et al., 2018). Another result from the study was that fine motor skills at the age of 6 months also predicted expressive language outcomes at 3 years of age (Choi et al., 2018).

The same result was also found by LeBarton and Iverson (2013) in infants siblings of children with ASD. The authors found also another interesting result about fine motor skills impairments in high-risk children of 24 months, or rather that only the children who had a later ASD diagnosis, the early impairments were persisting (LeBarton and Iverson, 2013). This goes to underline the correlation between fine motor skills deficits, and Autism Spectrum Disorder. In another study by Ohara et al., (2019), they found a correlation between fine motor skills and social skills. This is an important result that can give more information about the relation between deficits in motor skills and deficits in adaptive behaviours. Gross motor skills were found to have a lower correlation, compared to fine motor skills, with social skills (Ohara et al., 2019).

 As we can infer from these studies, motor delays in ASD may be used as an early marker (Libertus et al., 2014). However, motor delays are found to be not ASD specific, so they could lead to a wrong diagnosis (Libertus et al., 2014). This is why it is important to investigate this area of impairments both in typical and atypical children. Studying all the possible correlations between the motor area, the fine motor skills in specific, and the other area of impairments typical of ASD individuals and comparing them with a typical pre-schooler group, could suggest more information about these topics. In particular, in this thesis, we will analyse the following questions: are the fine motor skills correlate to the adaptive behaviours? And if yes, which correlations can we find, and which are the level and the direction of these correlations? What do the results of this study tell us in terms of possible causes and consequences of these impairments?

We are going to analyse these research questions in the next chapters of this essay.

3. Thesis goals

One of the goals of this thesis is to investigate the possible correlations between deficits in fine motor skills as measured by the Vineland Adaptive Behaviours Scale-3rd edition (Sparrow et al., 2016) and the other three main domains of the VABS-3rd ed, Communication, Socialization, and Daily living skills, in a group of 60 pre-schoolers including 36 Typical development children and 23 with an autism spectrum disorder's diagnosis.

Another goal is to understand the correlation between the scores in the fine motor skills as measured by the VABS-3rd ed, and the fine motor skills as measured by the Mullen Scale of Early Learning (MSEL; Mullen, 1995), always measured in the same sample of 59 pre-schoolers.

The reason why I want to investigate these research questions is that I want to see if there is a correlation between possible low scores on adaptive behaviours, part of the communication and socialization domain, and low scores in the fine motor skills; if yes, I will investigate the level of this correlation, so if it is significant or not relevant. The idea behind this decision is that I want to investigate how fine motor skills impairments could be the causes of some impairments in the socialization and communication areas, because having motor impairments, in general, could influence the individual's self-perception, especially in social situations. In particular, I'm interested in analysing how fine motor impairments influence ASD individuals, and in checking if the adaptive behaviour impairments could be a consequence of other impairments, more than a specific ASD trait.

An important study from which I had the inspiration for this research project is the one by Hirata et al., (2014). In their paper, the authors mention a neuroanatomical theory, which is about a possibility of common brain dysfunction that could explain the comorbidity between fine motor skills and communication and daily living skills areas of impairments. A second theory that they mentioned is the developmental one, according to which small differences in early motor development are among the essential factors which affect the early social development of toddlers with ASD. Another interesting suggestion comes from the study of Hayley et al., (2014), who validated the hypothesis that the development of motor skills can influence the number and type of opportunities that infants and children have to interact with others for future research could be to include in the study different way to assess fine motor skills and adaptive behaviours

Considering these two theories, the two previous mentioned instruments could be reductive, so I decided to compare the scores to the previous instruments, with the score of another instrument: The Social Responsiveness Scale 2-Pre-school version. the Social Responsiveness Scale (Costantino, 2002), is used to obtain supplementary information about the child's symptoms (Duku et al., 2012). The Social Responsiveness Scale is a parent-completed screening questionnaire often used to measure Autism Spectrum Disorder severity (Hus et al., 2012). The information that the SRS is giving us, is about a child's atypical social behaviour, such as social information processing, reciprocal communication, social anxiety or avoidance, and possible autistic traits (Duku et al., 2012).

Hus et al., (2012), in their study, explain that with the use of the SRS, we have to consider the important influence of behaviours problems, age, and expressive language or cognitive level on scores; this is because the SRS is a quantitative phenotype measure (Hus et al., 2012).

The decision of using the SRS as a comparison measure was because, measuring ASD traits, this instrument could give us a better image of our results. One of the scales of the SRS-2 is the socialisation scale, which is present also in the VABS 3rd-ed. Analysing the correlation between this variable as a measure of two different instruments could highlight the validity or non-validity of this study, moreover, it could give more support to our results. We will investigate the level of the correlation of the socialisation domain as a measure of the SRS-2, related to the fine motor skills subdomain of the VABS 3rd-ed, if this correlation will be similar to the one between the socialisation domain as a measure of the VABS 3rd-ed and the fine motor skills subdomain of the VABS 3rd-ed, we could have more or less proves of the correlation that we are investigating. In the end, we will study also the correlation between the SRS total score, and compare both to the fine motor skills scores measured with the MSEL and the VABS, and with the VABS composite behaviour scores.

To investigate ASD traits, direct observation instruments are the most used way (Duku et al., 2012). An example is The Mullen Scale of Early Learning, which can be administered directly to the child by an expert, like a psychologist, a clinician, or an experimenter, appropriately trained for it. We will look at this instrument more in detail further in this essay.

Indirect observation is also important, as we mentioned before, the best way to investigate an individual's adaptive behaviours is to ask third people who daily or often interact with this individual. The VABS is one of the instruments used to investigate this; in this research, we will use the VABS-3rd

ed, so the version we use when we are dealing with pre-schoolers. This version of the Vineland is assessed with the caregivers of the child.

4. Method

4.1. Participants

The research took place in the department of experimental-clinical and health psychology at Ghent University (Belgium). The sample of this research project consists of 59 pre-schoolers, 36 Typical development and 23 Atypical development, so with ASD.

4.2. Instruments

The experiment was divided into wave 1 and wave 2, in which the children were seen respectively at 2,5/3-4.5 years old and at 3.75-5.75 years old. Each instrument was assessed in both waves. Vineland Adaptive Behaviour Scale -3rd Edition: The Vineland Adaptive Behaviour Scale, 3rd edition is a Parent/ Caregiver Interview form. The VABS-3rd investigates what the individual does in terms of personal and social skills, through four main domains including socialization, communication, daily living and motor skills, and it's divided by topic. Each domain has three subdomains. The item scoring goes from "2" (usually performs the behaviour independently, without physical help or reminders), to "1" (sometimes performs the behaviour independently or partially), and "0" (never performs the behaviour or not independently). The VABS-3rd edition is administered by the parent or caregiver during the study visit. The interview can also be conducted over the phone. The duration of the administration is approximately 45 minutes. For the goals of this research, we will consider only the three domains of the VABS-3rd ed, socialization, communication and daily living skills, and not the subdomains. The only subdomains that we will consider, are the ones included in the motor skills domain, which is the fine motor skills subdomain. The reason for this choice is to search for a possible correlation between the scores obtained from the other three domains, and the scores obtained from this subdomain. The measures of the fine motor skills subdomain of the VABS-3rd ed will be also investigated and compared with the measures of the fine motor skills of the MSEL.

  Mullen Scales of Early Learning: The Mullen Scales of Early Learning (MSEL) is an assessment battery to measure the development of infants and pre-schoolers from birth through to 68 months. The Mullen scales of early learning assess a child's skills in visual, linguistic, and motor domains (gross and fine motor skills), and receptive and expressive domains. Some of the items in the MSEL scoring go from "1" which means a correct item, to "0" which means an incorrect item. Other items include a score of 1,2,3,4 or 5 in some cases. Some items need to be summed, so they contain a "sum

task". In this experiment we focused on the fine motor skills domain, investigating if there are some associations between fine motor skills as measured from the Mullen Scale of Early Learning, and fine motor skills as measures of the Vineland Adaptive Behaviour Scale 3rd edition. The reason for this choice is that fine motor skills, like finger manipulation, are involved in many adaptive behaviours. The duration of the total administration, including all four domains, was about 35-55 minutes, depending also on mental age.

Social Responsiveness Scale –2 - preschool form: The Social Responsiveness Scale-Preschool version is a 65-item quantitative parent-report measure of autistic traits, in specific deficits in social behaviours, in children aged 2.5-4.5 years (Bruni, 2014). This rating scale can be used both as a screener and as a clinical diagnostic instrument (Aldridge et al., 2012). The SRS-2 The items' scores go from ''0'' (not true) to ''3'' (almost always true), with a final total score of max 195. The questions focus on the child's behaviour during the past 6 months and it lasts approximately 15 minutes. This assessment was made online, so the parents were filling it out from home and, after that, sent it to the experimenters. The results are reported as T-scores, with M=50 and SD=10 (Bruni, 2014). T-scores mean that we transform the raw scores into standardized scores. The SRS-2 presents some subscales, which are social awareness (8 items), social cognition (12 items), social communication (22 items), social motivation (11 items), restricted interests and repetitive behaviours (12 items), (Bruni, 2014). We have then an overall total score (Bruni, 2014).

With the SRS-2 we consider the final overall score because it is the most reliable measure for social deficits related to ASD; the reason is that the subscales have a lack of evidence in clinical use (Bruni, 2014). Another important consideration Bruni made in his study (2014), in which he tested the standardization of the SRS across three different ages: pre-schoolers, school-age and adult individuals, was that the variability can interfere with the final evaluation; this is why it is important to also consider the standard error when we look at the T-scores. He also found a strong consistency across the items, but not an internal consistency for specific subscales (Bruni, 2014). According to a cross-cultural study, on the validation of the SRS, by Bolte et al., (2008), there seems to be good to an excellent psychometric properties. Moreover, the main finding of this study was that the cross-cultural validity of the SRS seemed to be sufficiently assured for a large European Sample (Bolte et al., 2008).

The scores for the final evaluation are interpreted in this way:

- T-scores of 76 or higher, indicates clinically significant deficits in social functioning and interaction with other (Costantion et al., 2013).

- T-scores between 66 and 75 can also indicate clinically significant deficits in the social functioning area but are considered moderate (Costantino et al., 2013).

The variability can interfere with the final evaluation, this is why it is important to also consider the standard error when we look at the T-scores (Bruni et al., 2014).

- T-scores of 60 to 65, instead, could indicate mild to moderate deficits in the social interaction field (Bruni et al., 2014).

- T-scores of 59 or below are the suggestion that the individual probably doesn't present difficulties in the social functioning and interaction area, which could be related to an ASD diagnosis (Costantino et al., 2013).

4.3. Procedure

ASD children were recruited through clinical local services, in which the children received a clinical diagnosis of ASD, based on clinical diagnostic criteria. Another way to recruit Autistic children was the use of advertisement via National Autistic Support groups/charities. Typical Development (TD) children's recruitment was based on a specific area and children born in a specific year; the recruitment was made from nurseries/schools, and via social media. For the TD, advertisements were also used, in particular in local nurseries.

After interested families were found, information booklets and consent forms were sent to them. The first contact was made by phone, in which the families could have asked any question about the study and his procedure, and in which information about the child was asked to the parents.

After the screening interview, the staff of this project was sending the families the training materials. The first contact with the child happened during the first institute visit.

The instrument used for collecting data and information was a Case Report File (CFR), which was later entered in the study electronic CRF (eCRF). To identify all the individuals, it was used their family ID, and a personal pseudocode ID.

The scores of the VABS-3rd ed were manually assessed on paper and manually enter into the online administration through the scoring platform Q-global. Q-global organised items with related content by topic. The q-global interview is a Pearson's web-based platform for test administration, scoring, and reporting.

The MSEL was administered on a small and colourful table and chairs, recreating so a childhood setting. The administration plans a list of toys carefully chosen for use with young children. During the

administration of the items, and the use of toys to investigate specific tasks and skills in the child, the experimenter was scoring them in the MSEL items book. After scoring all items, they were transferred from raw scores to T scores and then entered into a computer database.

4.4. Statistical analysis

All statistical analyses were conducted with the software R. Spearman's rank correlation was computed to assess the relationship between the three domains of the VABS, social, daily living and communication domains, and the VABS subdomain of fine motor skills. This correlation was also estimated between the MSEL fine motor skills scores and the VABS fine motor skills scores; we considered the raw scores of the variables important for this research. In addition, the correlation was also calculated between the SRS total score and the VABS composite behaviour scores, moreover than among the MSEL and VABS fine motor skills and the SRS socialisation and communication scale raw scores.

5. Results

Correlations between the MSEL fine motor skills subscale and the VABS domains and fine motor skills subdomain

From the results of this study we found a positive linear correlation between the MSEL fine motor skills and the VABS communication domain: r=.45, p=<.001 (Figure 1); as well as for the MSEL fine motor skills and the VABS daily living skills domain: r=.36, p=.007 (Figure 2).
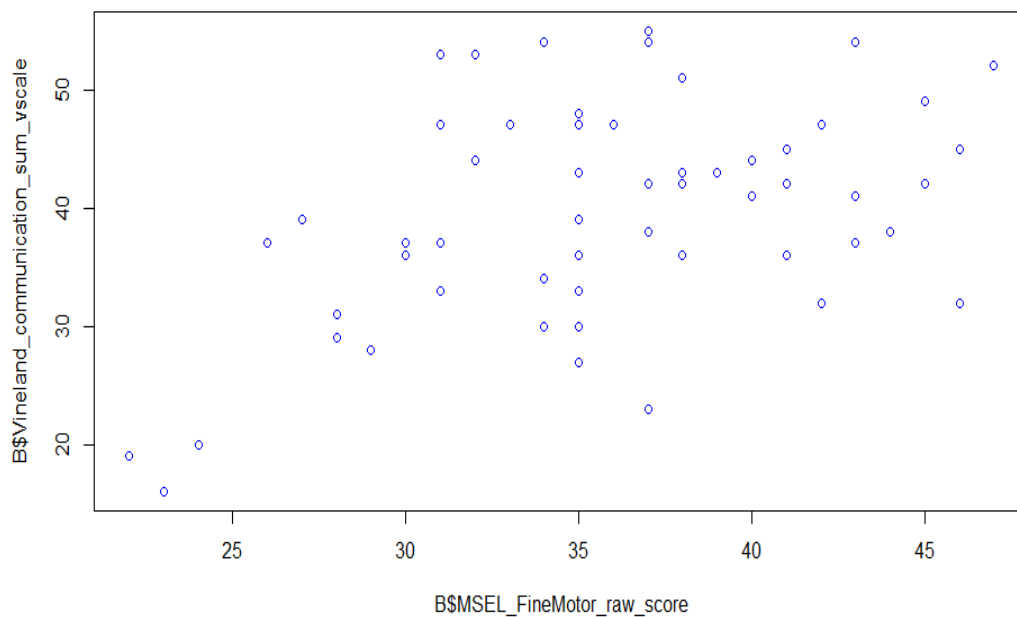

Figure 1. Scatter plot showing the correlation between the VABS "communication domain" raw score and the MSEL "fine motor skills" raw score.
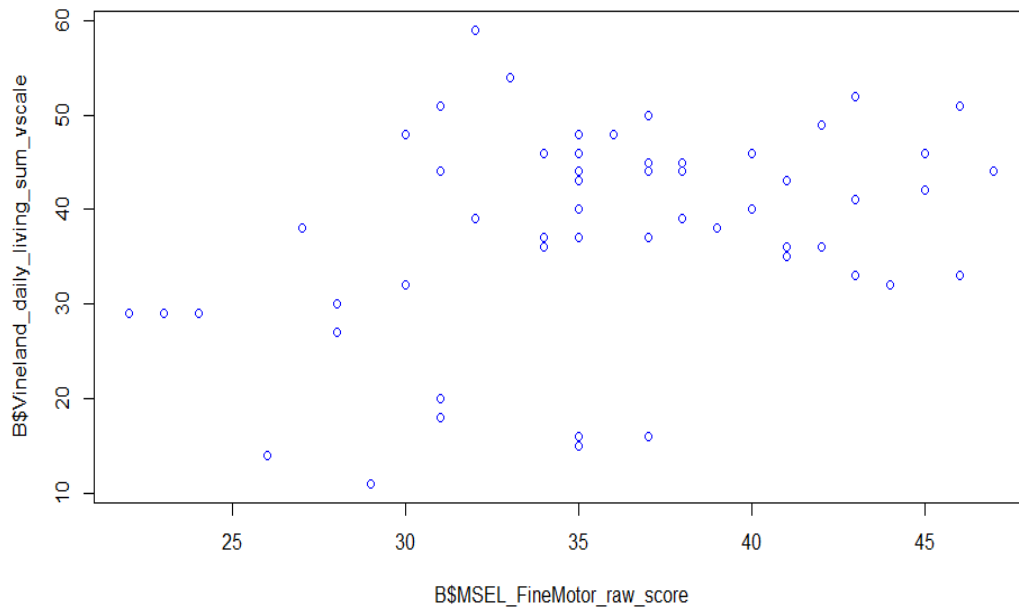
Figure 2. Scatter plot showing the correlation between the VABS "daily living skills domain" raw score and the MSEL "fine motor skills" raw score.

A lower correlation, not significant, was found for the MSEL fine motor skills subscale, and the VABS socialisation domain, with a weak (non-significant) positive linear correlation of r=.19, p=.160 (Figure 3).
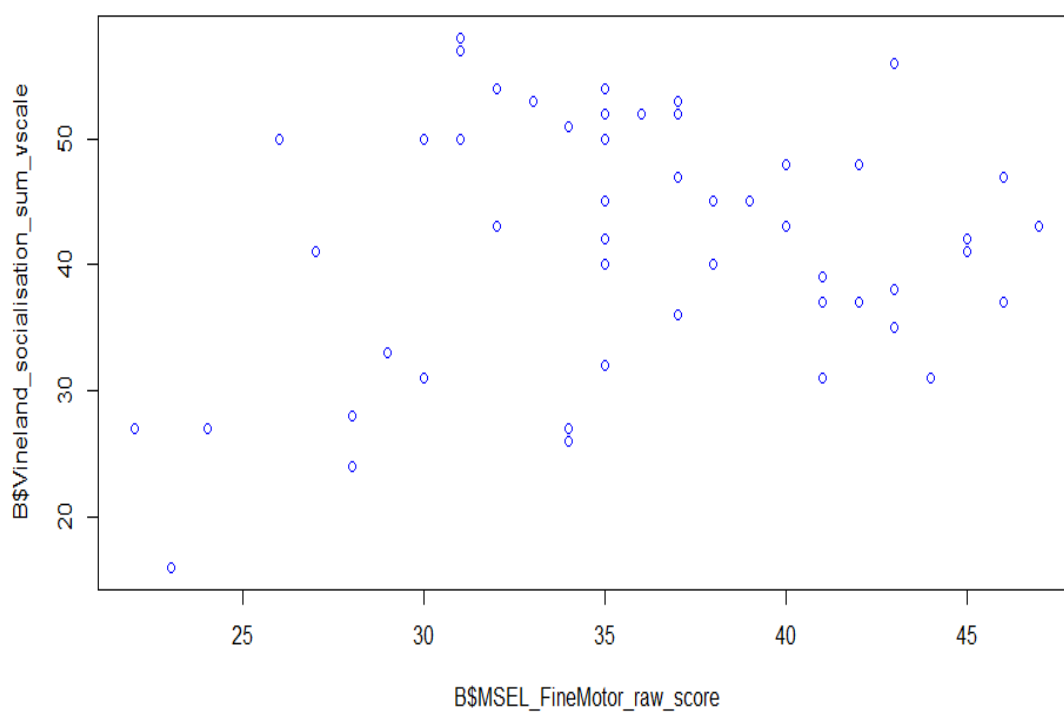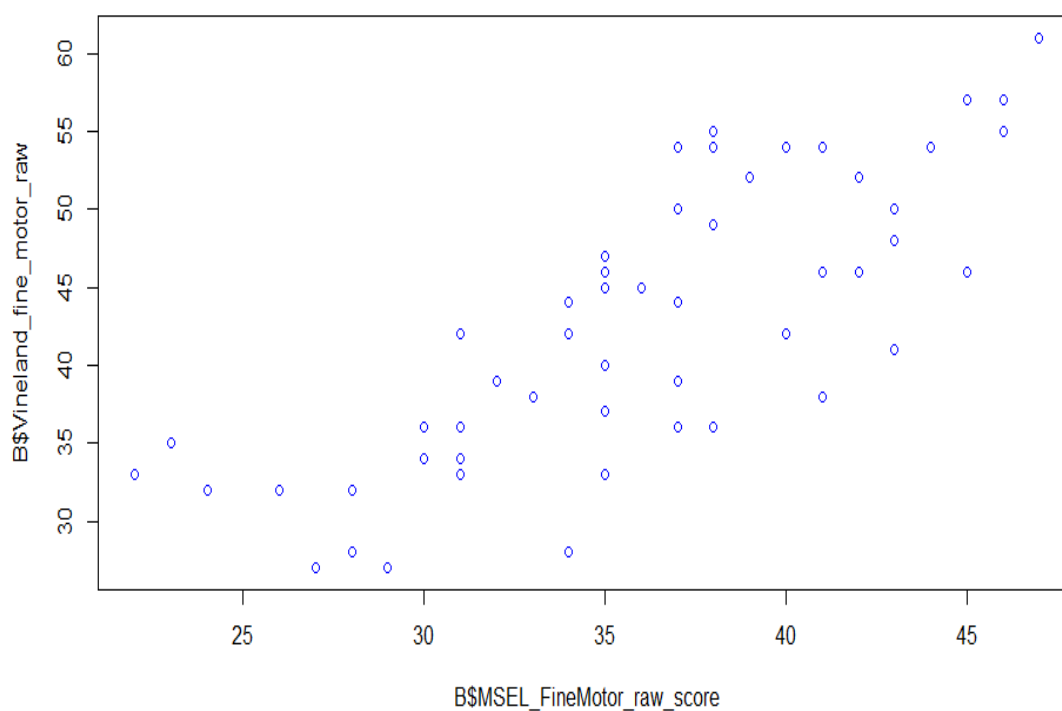

Figure 3. Scatter plot showing the correlation between the VABS "socialisation domain" raw score and the MSEL "fine motor skills" raw score.

A significant positive correlation was found between the MSEL and the VABS fine motor skills sub-scale, r=.78 and p=<.001 (Figure 4), indicating a positive correlation between what was observed by the experimenter, in the MSEL, and what reported by the parent of the child, in the VABS. The correlation between the two instruments in the same variable gives validity to our results, indicating that our results are valid and possibly extendable to other research conductible with the same criteria and instruments.

Figure 4. Scatter plot showing the correlation between the VABS "fine motor skills subdomain" raw score and the MSEL "fine motor skills" raw score.

Correlations between the VABS three domain and the VABS fine motor skills subdomain

A positive linear correlation, in support to the one between MSEL fine motor and VABS communication skills, was found between the VABS communication domain and the VABS fine motor subdomain, r=.47, p=<.001 (Figure 5).
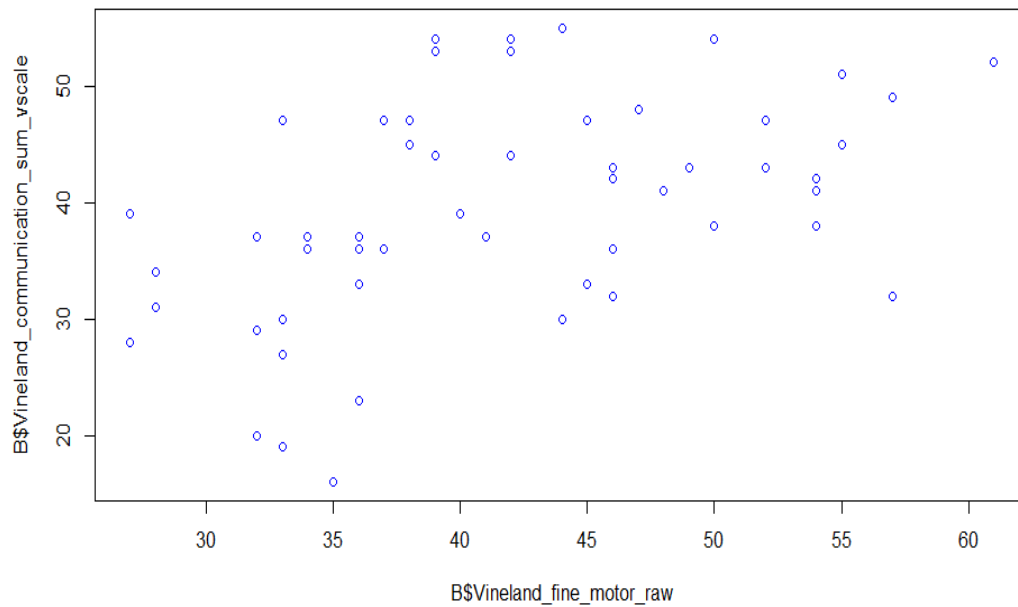

Figure 5. Scatter plot showing the correlation between the VABS "communication domain" raw score and the VABS "fine motor skills subdomain" raw score.

Similar results were found between the VABS daily living and fine motor skills, r=.47, p=<.001 (Figure 6).
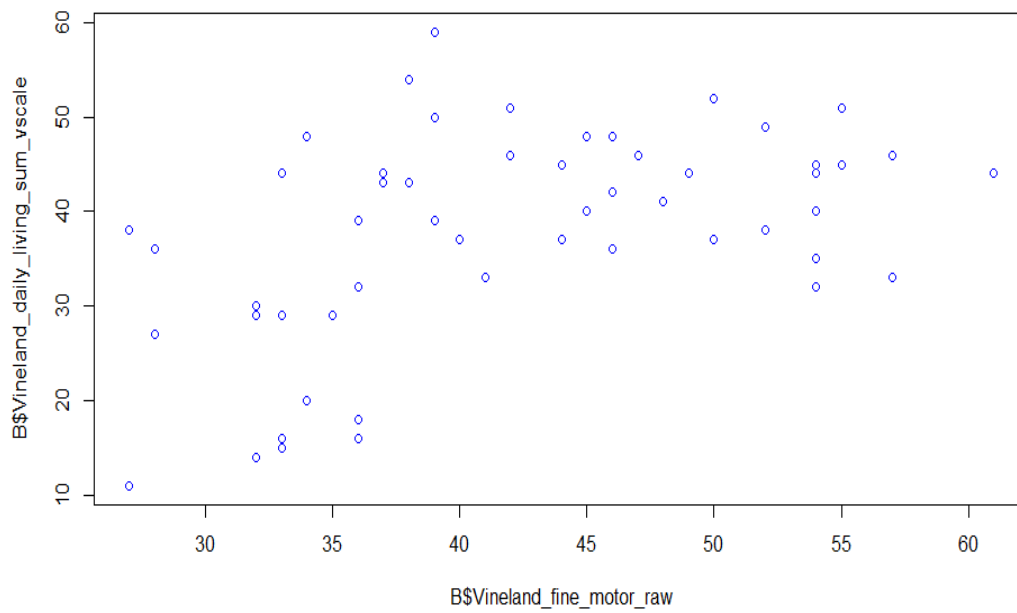

Figure 6. Scatter plot showing the correlation between the VABS "daily living skills domain" raw score and the VABS "fine motor skills subdomain" raw score.

Weak correlation was found, instead, between VABS socialisation and fine motor skills subdomain, r=.16, p=.237 (Figure 7).
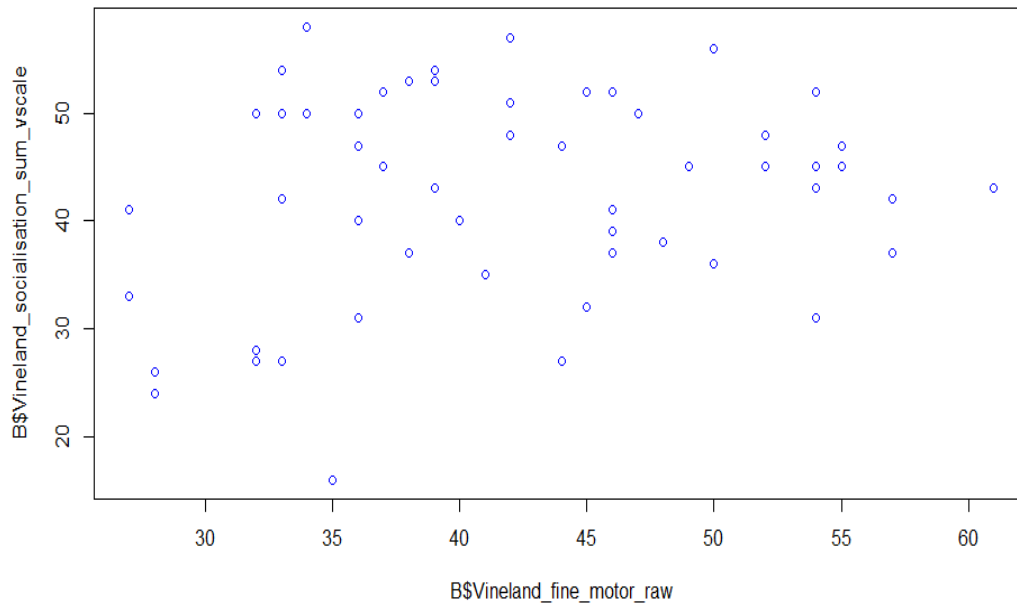

Figure 7. Scatter plot showing the correlation between the VABS "socialisation domain" raw score and the VABS "fine motor skills subdomain" raw score.

Correlation between MSEL fine motor skills and VABS domains and SRS communication area domain

A negative linear correlation was found between SRS total scores and VABS composite scores, r=-.56, p=<.001 (figure 8); and a negative but lower linear correlation between the SRS total score and the MSEL and VABS fine motor subscale, respectively r=-.26, p=.05 (Figure 9), and r=-.19, p=.17 (Figure 10).
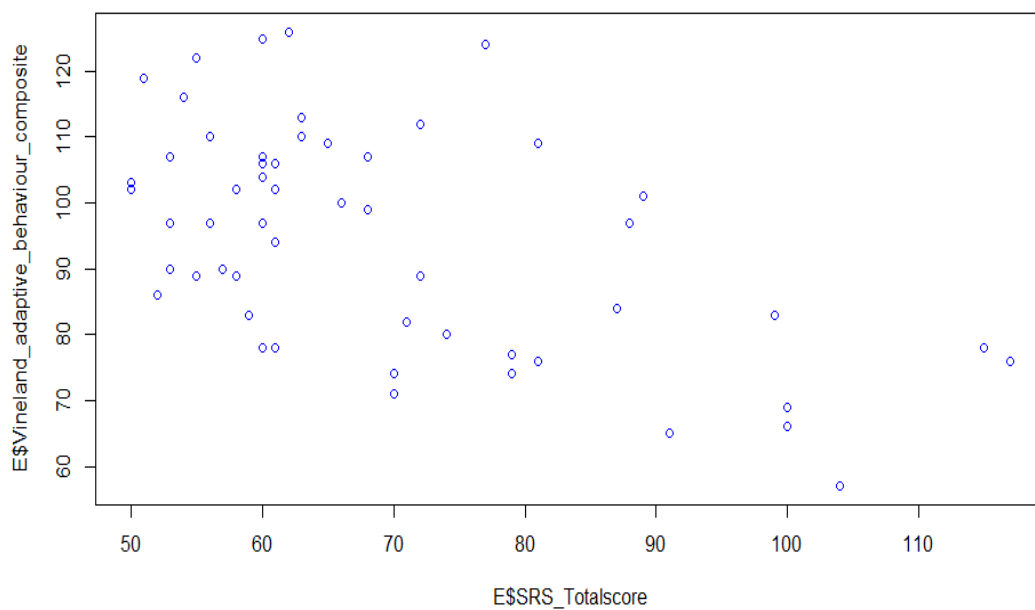

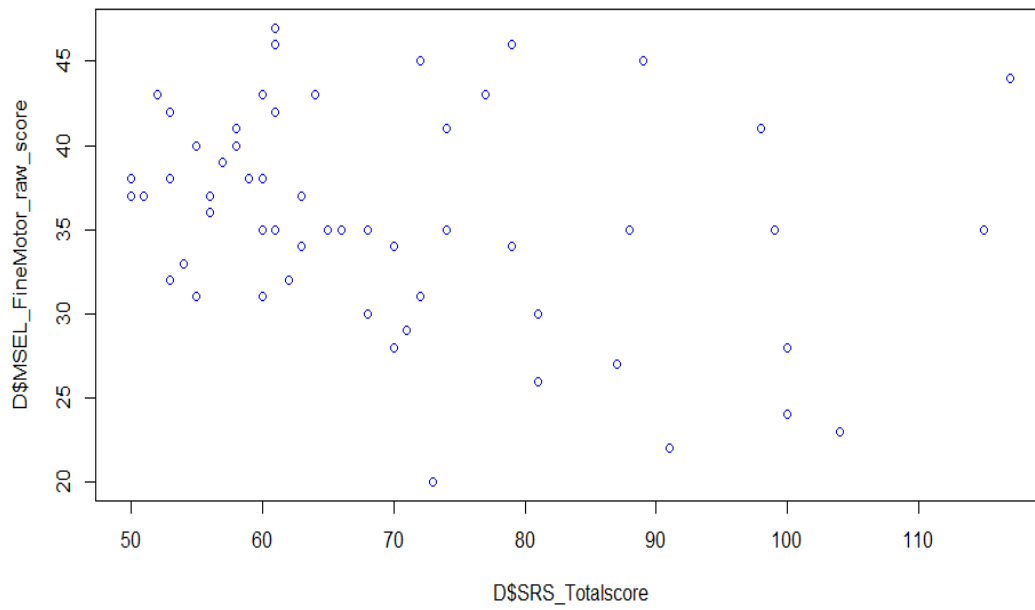*Figure 8. Scatter plot showing the correlation between SRS total score and VABS adaptive behaviours composite.*

Figure 9. Scatter plot showing the correlation between SRS total score and MSEL "fine mtoor skills".
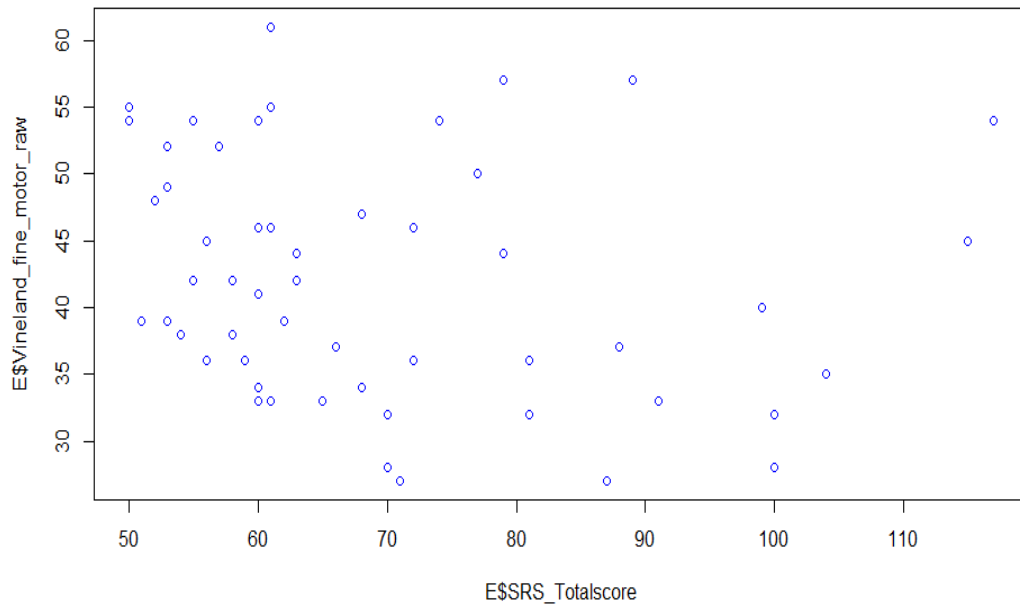
Figura 10. Scatter plot showing the correlation between SRS total score and VABS "fine motor skills subdomain".

In the end, SRS social communication score showed poor negative correlation both with MSEL and VABS fine motor skills, in support to the result previously found between MSEL and VABS fine motor scores and VABS socialisation domain scores; respectively the two correlation, MSEL and VABS, with SRS socialisation skills were: r=-.15, p=.25 (figure 11), and r=-.08, p=.55 (figure 12).
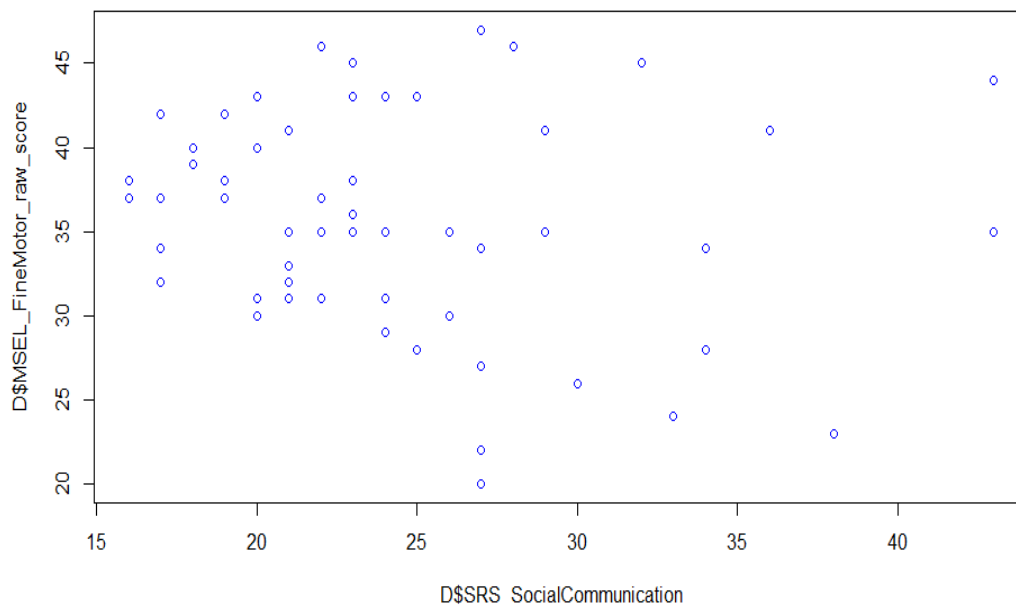

Figure 11. Scatter plot showing the correlation between SRS "Social-Communication" raw score and MSEL "fine motor skills" raw score.
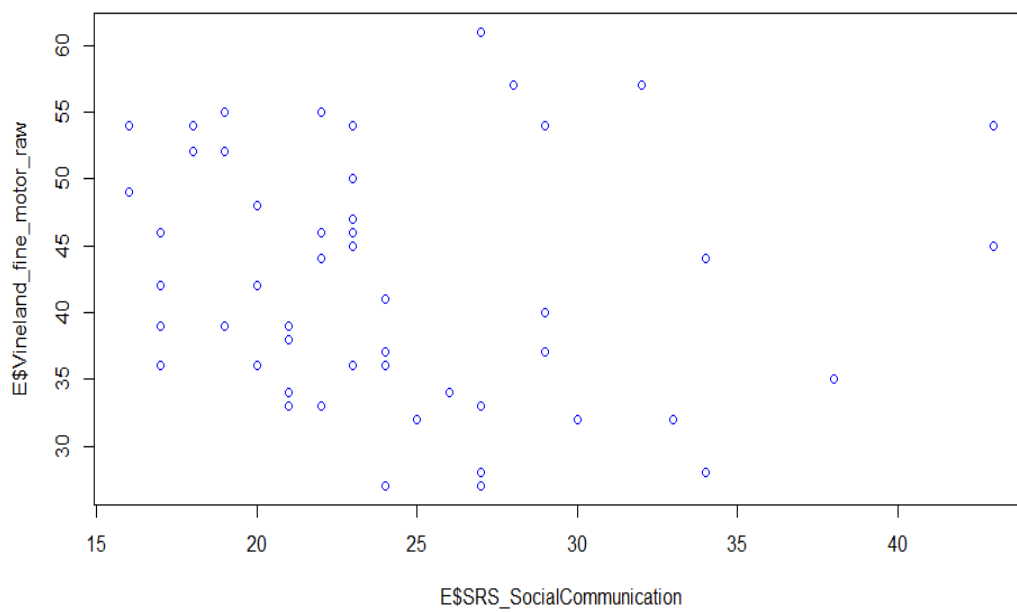
Figure 12. Scatter plot showing the correlation between SRS "social-communication" raw score and VABS "fine motor skills subdomain" raw score.

Table 1. Table of the correlations between the VABS and the MSEL.

VABS/MSEL correlations	MSEL fine motor skills subdomain	VABS fine motor skills subdomain
VABS communication domain	r=.45 p=<.001	r=.47 p<.001
VABS socialisation domain	r=.19 p=.160	r=.16 p=.237
VABS daily living skills domain	r=.36 p=.007	r=.47 p<.001
VABS fine motor skills subdomain	r=.78 p<.001	

Tabella 2. Table of the correlations between the VABS, MSEL and SRS.

SRS/VABS/MSEL correlations	MSEL fine motor skills subdomain	VABS fine motor skills subdomain	VABS composite behaviours score
SRS total score	r=-.26 p=.05	r=-.19 p=.17	r=-.56 p<.001
SRS social-communication	r=-.15 p=.25	r=-.08 p=.55	

6. Discussion, limitations, future research, conclusion

6.1. Discussion

This experiment aimed to investigate the possible correlations between MSEL and VABS fine motor skills subscales, and the VABS three domains: communication, daily living and socialisation skills, in our sample of TD and ASD pre-schoolers. The fact that we consider the two groups as a single group during the correlation analysis is because we wanted to have a more dimensional view on how fine motor skills interact with the adaptive behaviours during the development; so considering the two groups as a single group was a chance to analyse possible early fine motor skills deficits also in typical development toddlers, and including the possible or not possible correlations of these deficits, with their adaptive behaviours areas. In particular, we wanted to investigate if low scores in these areas were correlated with each other. Based on previous studies, we were expecting this; the previously mentioned study from Valla et al., (2020) supports the associations between early motor development and later communication development. The communication domain was part of our experiment. According to this and to the results by Zicker et al., (2012), in which they investigate fine and gross motor skills in school-aged children, we found a positive linear correlation between the MSEL subscale of fine motor skills and the VABS communication and daily living skills domains. More confirmations of our results come from the study of MCDonald et al., (2013), mentioned in the motor skills section of this thesis, in which the author found a direct correlation between motor skills and daily living and communication area of the child's development. this may indicate that impairments in these areas (communication and daily living) or, on the other hand, good skills and high scores could influence each other, in support of the previous literature.

Our research questions were also investigating the possible correlation between the socialisation domain and the fine motor skills domain in our sample; Leonard et al., (2014) also analyse this correlation in their research, and what they found is that a correlation between, more in general, the motor and social area, is existing. Differently from these results, we didn't find a significant correlation between the MSEL and VABS fine motor skills, and the VABS socialisation domain, which seems to be not highly correlated with the scores in the fine motor skills areas. And similar results were also found between the SRS socialisation scale and the MSEL and VBAS fine motor skills subscale. This may indicate that the fine motor skills are correlated to the communication area, but are less influenced, or influence less, in the area of socialisation. The opposite findings could be because in our experiment we considered pre-schoolers; in the study of Leonard et al., (2014), which we mentioned

in the motor skills section of this essay, they are talking about the fact that motor skills could be "contributing factors" to the development of social interaction, which means that in our sample, social interaction impairments could be still not developed yet, and this could be a reason why we still don't have a big correlation with the score in the fine motor skills.

We, then, found a strong correlation between MSEL's fine motor skills and VABS's fine motor skills; it means that these two instruments have good validity in measuring the same variables. The correlation, however, was not extremely strong, and this could be also since the MSEL is assessed by the experimenter, and the scores are based on scientific knowledge and trained skills of the assessor, while the VABS is based on what parents or caregivers report, and this could lead to a different way interpret the items. The VABS is also assessed by a trained individual, but the answer to the item is still given based on what the parent/caregiver reports.

Based on Pine et al., (2006) findings, we found a negative significative linear correlation was found between the SRS total score and the VABS composite behaviours score; this indicates that higher Autism traits correlate with lower adaptive behaviours, and this is in line with the study by Pine et al., (2006)

We, then, found a discrepancy between the study of Hilton et al., (2007), about autistic traits as scores of the SRS and motor skills impairments and our data results. A negative linear correlation was also found between the SRS total score and the MSEL and VABS fine motor skills score; however, the correlation was not significant. In this case, the difference from our results could be due to the fact, again, that in the VABS the items are scored by a professional, but based on what parents and caregivers report.

Our hypotheses were in part confirmed since lower scores in the VABS and MSEL fine motor skills positively correlated with the areas of adaptive behaviours of communication and daily living skills. These findings go in support of two theories mentioned in the article by Hirata et al., (2014).

On the other hand, differently from what we have seen in the study by Papadopolus et al., (2012), the second hypothesis was poorly confirmed; we found a negative linear correlation between SRS total score and VABS and MSEL fine motor skills, but it was a weak correlation. These different results, however, partly confirm the results we have found in our study since fine motor skills seem to be directly correlated with the social and communication areas of impairments.

6.2. Limitations

Despite the results of the study, which partly confirmed our hypothesis, some limitations need to be considered.

First of all, our small sample does not allow us to generalize these results to the population, and to confirm these findings, successive studies should include a higher number of participants.

Another limitation of our study is the use of different instruments, in which the criteria to answer the items are different. In fact, both in the SRS and VABS, the items are scored based on what the parents/caregivers tell us; in addition to this, the SRS was filled out at home and only after this, it was sent to the experimenters. The personal interpretation of the items could lead to some interferences, together with the possible desire of a parent, to describe his or her child in an as good light as he/she can. Moreover, Hus et al., (2012) on their study explain that with the use of the SRS, we have to consider the important influence of behaviour problems, age, and expressive language or cognitive level on scores; this is because the SRS is a quantitative phenotype measure. In our study, we have not considered these three variables, and this could lead to differences or only partially completed results.

One more important thing to consider is that there is only a small size of studies investigating, specifically fine motor skills in relationship with adaptive behaviours. In particular, I have not found a lot of studies explaining a possible correlation between the socialisation area and fine motor skills.

The fact that we only considered a small number of pre-schoolers could be an additional limitation. In fact, at this age, the individual is still developing and starts to have the first interactions with peers at the kindergarten or in other social contexts. The fact that these skills are still developing, could lead to poor correlations and not-completed results.

In the end, it was not possible to find a lot of literature that investigates, in specific, the correlation of our study. Literature about the correlation between motor skills, adaptive behaviour and autism traits was found, but no studies which investigate the correlation between fine motor skills and the socialisation domain, more in detail.

6.3. Future research

Since we only considered pre-schoolers in our study, it would be interesting, for future research, to analyse these skills at a later age. To expand these results, it could be helpful to make a follow-up study, in which the same skills will be assessed with the same instruments, in the same individuals. As we saw from Wilson (2018) the motor area is extremely relevant for the development of an individual, and impairment in this area could lead to lifelong term consequences, which will become more evident with the development of the individual.

According to Halley et al., (2014), It would be interesting to analyse the same variables with both instruments assessed by the experimenter, and instruments assessed by third parties, including a bigger amount of assessments tests than how much we used in our study, to see how these correlations develop and change on time.

From our results, we found that SRS total score was only weakly correlated with the fine motor skills measured by the MSEL and VABS, but other results mentioned in this thesis showed that both autistic traits and social areas are correlated with motor skills impairments and in particular with fine motor skills deficits, it would be interesting for future research to go deeper into this aspect. If fine motor skills do not show a strong correlation with SRS scores, which indicates autistic traits in children and individuals, but fine motor skills showed a correlation with the aspects of adaptive behaviours such as communications and daily living domains, a future hypothesis could be that fine motor skills are more significantly related to adaptive behaviours, than to autistic traits per sè. This is something that should be properly investigated, but it could be a new opportunity to understand how these two areas of impairment in ASD symptomatology interact and influence each other.

6.4. Conclusions

In conclusion, the results showed that fine motor skills have a positive correlation with adaptive behaviours, in particular with communication and daily living skills, in pre-schoolers. As Lloyd et al., (2011) discovered in their study, they were predictive of daily living skills based on the Vineland Adaptive Behaviour Scale (2nd ed.). Impairments in motor skills are significantly relevant for our adaptation to the world, in support of our hypothesis that a correlation exists between low scores in both the area of adaptive and motor functioning, deficits in motor movements impact daily living activities

and abilities (Lloyd et al., 2011). One of the studies about fine motor skills that contributed to creating our hypotheses was the one by Choi et al., (2018) who used the MSEL to investigate fine motor skills. The author also found slower growth in fine motor skills for infants with an elevated likelihood for ASD, and the same results came from LeBarton and Iverson (2013), and Ohara et al., (2019), in which both the studies the results were confirming correlations between fine motor skills impairments and ASD diagnosis.

In the study of Hirata et al., (2014), in which the authors talk about the fact that the correlation between fine motor skills area and communication and socialisation area could be due to a neuroanatomical or developmental reason, we can arrive at the conclusions of our study. The relevance of these studies, in our experiment, was the fact that they showed how fine motor skills were one of the first detectable signs of a possible later ASD diagnosis, and how impairments in these areas, positively correlated with future impairments in the social-communication and daily living areas. Our hypotheses about the correlation between low scores in MSEL and VABS fine motor skills scales were correlated with low scores in the communication, socialisation and daily living domains of the VABS started from these points, and this hypothesis was partly confirmed in our study. The socialisation domain was the only one to show a weak correlation; however, according to the studies previously seen, we can hypothesise that this could be due to the early age of our participants and could become more evident with their development. From the current and the reviewed research, we can also hypothesise a possible direction of the correlation between fine motor skills and adaptive behaviours, in which the second could be a consequence of impairments in the first area, more than a direct consequence of the ASD symptomatology. This remains only a hypothesis, for now, which needs to be deeper investigated in future projects.

7. Literature

Autism prevalence studies | Data | Centers for Disease Control and Prevention. (2021, July 14). Center for Diseases Control and Prevention. https://data.cdc.gov/Public-Health-Surveillance/autism-prevalence-studies/9mw4-6adp

American Psychiatric Association (APA) (2013). Diagnostic and Statistical Manual of Mental Disorders. Fifth Edition (DSM-V). Washington: Author.

Arpinati, A. M., Mariani Cerati, D., Tasso, D. (2008). Autismo. Roma: Armando Editore.

Aldridge, F. J., Gibbs, V. M., Schmidhofer, K., & Williams, M. (2011). Investigating the Clinical Usefulness of the Social Responsiveness Scale (SRS) in a Tertiary Level, Autism Spectrum Disorder Specific Assessment Clinic. *Journal of Autism and Developmental Disorders*, *42*(2), 294–300. https://doi.org/10.1007/s10803-011-1242-9

Baghdadli, A., Assouline, B., Sonié, S., Pernon, E., Darrou, C., Michelon, C., Picot, M. C., Aussilloux, C., & Pry, R. (2011). Developmental Trajectories of Adaptive Behaviors from Early Childhood to Adolescence in a Cohort of 152 Children with Autism Spectrum Disorders. Journal of Autism and Developmental Disorders, 42(7), 1314–1325. https://doi.org/10.1007/s10803-011-1357-z

Baio, J., Wiggins, L., Christensen, D. L., Maenner, M. J., Daniels, J., Warren, Z., Kurzius-Spencer, M., Zahorodny, W., Robinson, C., Rosenberg, White, T., Durkin, M. S., Imm, P., Nikolaou, L., Yeargin-Allsopp, M., Lee, L. C., Harrington, R., Lopez, M., Fitzgerald, R. T., . . . Dowling, N. F. (2018). Prevalence of Autism Spectrum Disorder Among Children Aged 8 Years — Autism and Developmental Disabilities Monitoring Network, 11 Sites, United States, 2014. *MMWR. Surveillance Summaries*, *67*(6), 1–23. https://doi.org/10.15585/mmwr.ss6706a1

Bölte, S., Poustka, F., & Constantino, J. N. (2008). Assessing autistic traits: cross-cultural validation of the social responsiveness scale (SRS). *Autism Research*, *1*(6), 354–363. https://doi.org/10.1002/aur.49

Cavell, T. (1990). Social Adjustment, Social Performance, and Social Skills: A Tri-Component Model of Social Competence. *Journal of Clinical Child & Adolescent Psychology*, *19*(2), 111–122. https://doi.org/10.1207/s15374424jccp1902_2

Choi, B., Leech, K. A., Tager-Flusberg, H., & Nelson, C. A. (2018). Development of fine motor skills is associated with expressive language outcomes in infants at high and low risk for autism spectrum disorder. *Journal of Neurodevelopmental Disorders*, *10*(1). https://doi.org/10.1186/s11689-018-9231-3

Constantino, J. N., & Frazier, T. W. (2013). Commentary: The observed association between autistic severity measured by the Social Responsiveness Scale (SRS) and general psychopathology - a response to Hus et al.(). *Journal of Child Psychology and Psychiatry*, *54*(6), 695–697. https://doi.org/10.1111/jcpp.12064

Costantino, J., N., MD (2011). *Social Responsiveness Scales Pre-School version (SRS-2)*.

Ditterline, J., Banner, D., Oakland, T., & Becton, D. (2008). Adaptive Behavior Profiles of Students with Disabilities. *Journal of Applied School Psychology*, *24*(2), 191–208. https://doi.org/10.1080/15377900802089973

Dodge, K. A., McClaskey, C. L., & Feldman, E. (1985). Situational approach to the assessment of social competence in children. *Journal of Consulting and Clinical Psychology*, *53*(3), 344–353. https://doi.org/10.1037/0022-006x.53.3.344

Duku, E., Vaillancourt, T., Szatmari, P., Georgiades, S., Zwaigenbaum, L., Smith, I. M., Bryson, S., Fombonne, E., Mirenda, P., Roberts, W., Volden, J., Waddell, C., Thompson, A., & Bennett, T. (2012). Investigating the Measurement Properties of the Social Responsiveness Scale in Preschool

Children with Autism Spectrum Disorders. *Journal of Autism and Developmental Disorders*, *43*(4), 860–868. https://doi.org/10.1007/s10803-012-1627-4

Floyd, R. G., Shands, E. I., Alfonso, V. C., Phillips, J. F., Autry, B. K., Mosteller, J. A., Skinner, M., & Irby, S. (2015). A Systematic Review and Psychometric Evaluation of Adaptive Behavior Scales and Recommendations for Practice. *Journal of Applied School Psychology*, *31*(1), 83–113. https://doi.org/10.1080/15377903.2014.979384

Freeman, B. J., Del'Homme, M., Guthrie, D., & Zhang, F. (1999). Vineland Adaptive Behavior Scale Scores as a Function of Age and Initial IQ in 210 Autistic Children. *Journal of Autism and Developmental Disorders*, *29*(5), 379–384. https://doi.org/10.1023/a:1023078827457

Gresham, F. M., & Elliott, S. N. (1987). The Relationship Between Adaptive Behavior and Social Skills. *The Journal of Special Education*, *21*(1), 167–181. https://doi.org/10.1177/002246698702100115

Hall, H. R., & Graff, J. C. (2011). The Relationships Among Adaptive Behaviors of Children with Autism, Family Support, Parenting Stress, and Coping. Issues in Comprehensive Pediatric Nursing, 34(1), 4–25. https://doi.org/10.3109/01460862.2011.555270

Harrison, P. L. (1987). Research with Adaptive Behavior Scales. The Journal of Special Education, 21(1), 37–68. https://doi.org/10.1177/002246698702100108

Hilton, C., Wente, L., LaVesser, P., Ito, M., Reed, C., & Herzberg, G. (2007). Relationship between motor skill impairment and severity in children with Asperger syndrome. Research in Autism Spectrum Disorders, 1(4), 339–349. https://doi.org/10.1016/j.rasd.2006.12.003

Hirata, S., Okuzumi, H., Kitajima, Y., Hosobuchi, T., Nakai, A., & Kokubun, M. (2014). Relationship between motor skill and social impairment in children with autism spectrum disorders. International Journal of Developmental Disabilities, 60(4), 251–256. https://doi.org/10.1179/2047387713y.0000000033

Hus, V., Bishop, S., Gotham, K., Huerta, M., & Lord, C. (2012a). Factors influencing scores on the social responsiveness scale. *Journal of Child Psychology and Psychiatry*, *54*(2), 216–224. https://doi.org/10.1111/j.1469-7610.2012.02589.x

Hus, V., Bishop, S., Gotham, K., Huerta, M., & Lord, C. (2012b). Factors influencing scores on the social responsiveness scale. *Journal of Child Psychology and Psychiatry*, *54*(2), 216–224. https://doi.org/10.1111/j.1469-7610.2012.02589.x

Hyo Jung Lee, & Hye Ran Park. (2007). An Integrated Literature Review on the Adaptive Behavior of Individuals With Asperger Syndrome. *Remedial and Special Education*, *28*(3), 132–139. https://doi.org/10.1177/07419325070280030201

Kanne, S. M., Gerber, A. J., Quirmbach, L. M., Sparrow, S. S., Cicchetti, D. V., & Saulnier, C. A. (2010). The Role of Adaptive Behavior in Autism Spectrum Disorders: Implications for Functional Outcome. *Journal of Autism and Developmental Disorders*, *41*(8), 1007–1018. https://doi.org/10.1007/s10803-010-1126-4

Katagiri, M., Ito, H., Murayama, Y., Hamada, M., Nakajima, S., Takayanagi, N., Uemiya, A., Myogan, M., Nakai, A., & Tsujii, M. (2021). Fine and gross motor skills predict later psychosocial maladaptation and academic achievement. Brain and Development, 43(5), 605–615. https://doi.org/10.1016/j.braindev.2021.01.003

Kenworthy, L., Case, L., Harms, M. B., Martin, A., & Wallace, G. L. (2009). Adaptive Behavior Ratings Correlate With Symptomatology and IQ Among Individuals With High-Functioning Autism Spectrum Disorders. *Journal of Autism and Developmental Disorders*, *40*(4), 416–423. https://doi.org/10.1007/s10803-009-0911-4

Lasala, L. R. (2017, September 13). Tesi etd-08102017-204205. EDT digital archive of theses discussed at the University of Pisa. https://etd.adm.unipi.it/t/etd-08102017-204205/

LeBarton, E. S., & Iverson, J. M. (2013). Fine motor skill predicts expressive language in infant siblings of children with autism. *Developmental Science*, n/a. https://doi.org/10.1111/desc.12069

Leonard, H. C., & Hill, E. L. (2014). Review: The impact of motor development on typical and atypical social cognition and language: a systematic review. Child and Adolescent Mental Health, n/a. https://doi.org/10.1111/camh.12055

Levi, G., D'Ardia, C., Penge, R. (2013). Disturbi dello spettro autistico. Per una Legge-Quadro sulla salute mentale in età evolutiva. In Binetti, P., *Autismo oggi. Lo stato dell'arte*. (pp. 39-44). Roma: Magi srl.

Libertus, K., Sheperd, K. A., Ross, S. W., & Landa, R. J. (2014). Limited Fine Motor and Grasping Skills in 6-Month-Old Infants at High Risk for Autism. *Child Development*, n/a. https://doi.org/10.1111/cdev.12262

Livonen, S., & Sääkslahti, A. (2013). Preschool children's fundamental motor skills: a review of significant determinants. Early Child Development and Care, 184(7), 1107–1126. https://doi.org/10.1080/03004430.2013.837897

Logan, S. W., Ross, S. M., Chee, K., Stodden, D. F., & Robinson, L. E. (2017). Fundamental motor skills: A systematic review of terminology. Journal of Sports Sciences, 36(7), 781–796. https://doi.org/10.1080/02640414.2017.1340660

Lloyd, M., MacDonald, M., & Lord, C. (2011). Motor skills of toddlers with autism spectrum disorders. *Autism*, *17*(2), 133–146. https://doi.org/10.1177/1362361311402230

MacDonald, M., Lord, C., & Ulrich, D. (2013). The relationship of motor skills and adaptive behavior skills in young children with autism spectrum disorders. *Research in Autism Spectrum Disorders*, *7*(11), 1383–1390. https://doi.org/10.1016/j.rasd.2013.07.020

MacDonald, M., Lord, C., & Ulrich, D. A. (2014). Motor Skills and Calibrated Autism Severity in Young Children With Autism Spectrum Disorder. *Adapted Physical Activity Quarterly*, *31*(2), 95–105. https://doi.org/10.1123/apaq.2013-0068

Matson, J. L. (2009). *Social Behavior and Skills in Children* (2009th ed.). Springer.

Mauro, T., Are Your Child's Motor Skills on Track? (2022, January 26). Verywell Family. https://www.verywellfamily.com/what-are-motor-skills-3107058

Militerni, R. (2006). Neuropsichiatria Infantile. Napoli: Idelson-Gnocchi.

Mughal, S. (2020, November 18). *Autism Spectrum Disorder*. PubMed. https://pubmed.ncbi.nlm.nih.gov/30247851/

Mullen, E., M., (1995). *Mullen Scale of Early Learning: AGS edition.* Circle Pines, MN: American Guidance Service.

Muratori, F., Bizzarri, V., (2021). Alle origini dell'autismo: George Frankl tra Asperger e Kanner. *Edizioni Centro Studi Erickson. Autismo e disturbi del neurosviluppo. 18(1), 81-88. doi: 10.14605/AUT1812004*

Murgia A. (2021), *slide del corso di Neuropsichiatria infantile*.

Narzisi, A., Posada, M., Barbieri, F., Chericoni, N., Ciuffolini, D., Pinzino, M., Romano, R., Scattoni, M., Tancredi, R., Calderoni, S., & Muratori, F. (2018). Prevalence of Autism Spectrum Disorder in a large Italian catchment area: a school-based population study within the ASDEU project. Epidemiology and Psychiatric Sciences, 29. https://doi.org/10.1017/s2045796018000483

Oakland, T., & Harrison, P. L. (2008). *Adaptive Behaviors and Skills. Adaptive Behavior Assessment System-II, 1–20. https://doi.org/10.1016/b978-012373586-7.00001-1*

Ohara, R., Kanejima, Y., Kitamura, M., & Izawa, K. P. (2019). Association between Social Skills and Motor Skills in Individuals with Autism Spectrum Disorder: A Systematic Review. *European Journal of Investigation in Health, Psychology and Education*, *10*(1), 276–296. https://doi.org/10.3390/ejihpe10010022

Papadopoulos, N., McGinley, J., Tonge, B. J., Bradshaw, J. L., Saunders, K., & Rinehart, N. J. (2012). An investigation of upper limb motor function in high functioning autism and Asperger's disorder using a repetitive Fitts' aiming task. Research in Autism Spectrum Disorders, 6(1), 286–292. https://doi.org/10.1016/j.rasd.2011.05.010

Pepperdine, C. R., & McCrimmon, A. W. (2017). Test Review: Vineland Adaptive Behavior Scales, Third Edition (Vineland-3) by Sparrow, S. S., Cicchetti, D. V., & Saulnier, C. A. *Canadian Journal of School Psychology*, *33*(2), 157–163. https://doi.org/10.1177/0829573517733845

Perry, A., Flanagan, H. E., Dunn Geier, J., & Freeman, N. L. (2009). Brief Report: The Vineland Adaptive Behavior Scales in Young Children with Autism Spectrum Disorders at Different Cognitive Levels. *Journal of Autism and Developmental Disorders*, *39*(7), 1066–1078. https://doi.org/10.1007/s10803-009-0704-9

Pincherle, M. LE NUOVE ACQUISIZIONI NEUROBIOLOGICHE NELL'EZIOPATOGENESI DEI DISTURBI DELLO SPETTRO AUTISTICO.

Pine, E., Luby, J., Abbacchi, A., & Constantino, J. N. (2006). Quantitative assessment of autistic symptomatology in preschoolers. Autism, 10(4), 344–352. https://doi.org/10.1177/1362361306064434

Provost, B., Heimerl, S., & Lopez, B. R. (2007). Levels of Gross and Fine Motor Development in Young Children with Autism Spectrum Disorder. *Physical & Occupational Therapy In Pediatrics*, *27*(3), 21–36. https://doi.org/10.1080/j006v27n03_03

Rebuttini, A., (2016). Adaptation and Communication in autistic children and teenagers from 6 to 16 years: description of a study. [Master's thesis, Università degli Studi di Parma], https://www.repository.unipr.it/bitstream/1889/3279/1/Tesi%20Alessandro%20Rebuttini.pdf

Rolla, I. (2015). Studio sui fattori di rischio in gravidanza e in epoca perinatale potenzialmente coinvolti nell'eziopatogenesi del disturbo dello spettro dell'autismo.

Rosenbaum, D. A., Carlson, R. A., & Gilmore, R. O. (2001). Acquisition of intellectual and perceptual-motor skills. Annual review of psychology, 52(1), 453-470.

Ruggeri, B., Sarkans, U., Schumann, G., & Persico, A. M. (2013). Biomarkers in autism spectrum disorder: the old and the new. Psychopharmacology, 231(6), 1201–1216. https://doi.org/10.1007/s00213-013-3290-7

Russo, R. C. (2020). Autismo e Sindromi con Spettro Autistico.

Silberman, S. (2016)."Neurotribù. I talenti dell'autismo e il futuro della neurodiversità". LSWR Edizioni

Sparrow, S. S., Domenic, V. Cicchetti, D. V., Saulnier, C. A., (2016). *Vineland Adaptive Behavior Scales. 3Rd edition.* Pearson.

Taverna, L., Bornstein, M. H., Putnick, D. L., & Axia, G. (2011). Adaptive Behaviors in Young Children: A Unique Cultural Comparison in Italy. Journal of Cross-Cultural Psychology, 42(3), 445–465. https://doi.org/10.1177/0022022110362748

Valla, L., Slinning, K., Kalleson, R., Wentzel-Larsen, T., & Riiser, K. (2020). Motor skills and later communication development in early childhood: Results from a population-based study. Child: Care, Health and Development, 46(4), 407–413. https://doi.org/10.1111/cch.12765

van der Fels, I. M., te Wierike, S. C., Hartman, E., Elferink-Gemser, M. T., Smith, J., & Visscher, C. (2015). The relationship between motor skills and cognitive skills in 4–16 year old typically developing children: A systematic review. Journal of Science and Medicine in Sport, 18(6), 697–703. https://doi.org/10.1016/j.jsams.2014.09.007

Wells, K., Condillac, R., Perry, A., Factor, D. C. (2009). *A Comparison of Three Adaptive Behaviour Measures in Relation to Cognitive Level and Severity of Autism,* in "*Journal on Developmental Disabilities*".

Whyatt, C. P., & Craig, C. M. (2011). Motor Skills in Children Aged 7–10 Years, Diagnosed with Autism Spectrum Disorder. Journal of Autism and Developmental Disorders, 42(9), 1799–1809. https://doi.org/10.1007/s10803-011-1421-8

Williams, K. L., Kirby, A. V., Watson, L. R., Sideris, J., Bulluck, J., & Baranek, G. T. (2018). Sensory features as predictors of adaptive behaviors: A comparative longitudinal study of children with autism spectrum disorder and other developmental disabilities. Research in Developmental Disabilities, 81, 103–112. https://doi.org/10.1016/j.ridd.2018.07.002Wilson, R. B., Enticott, P. G., & Rinehart, N. J. (2018). Motor development and delay: advances in assessment of motor skills in autism spectrum disorders. Current Opinion in Neurology, 31(2), 134–139. https://doi.org/10.1097/wco.0000000000000541

Wilson, R. B., Enticott, P. G., & Rinehart, N. J. (2018b). Motor development and delay: advances in assessment of motor skills in autism spectrum disorders. Current Opinion in Neurology, 31(2), 134–139. https://doi.org/10.1097/wco.0000000000000541

Yochum, A. (2016). Autism Spectrum/Pervasive Developmental Disorder. *Primary Care: Clinics in Office Practice*, *43*(2), 285–300. https://doi.org/10.1016/j.pop.2016.01.010

Zwicker, J. G., Missiuna, C., Harris, S. R., & Boyd, L. A. (2012). Developmental coordination disorder: A review and update. *European Journal of Paediatric Neurology, 16*(6), 573–581. https://doi.org/10.1016/j.ejpn.2012.05.005