UNIVERSITY OF PADOVA

Department of Developmental Psychology and Socialisation

Masters' Degree Course in Developmental and Educational Psychology

Final Dissertation

A Study on the Efficacy of Project ImPACT on Imitation Skills of Toddlers with Autism

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Academic Year 2021/2022

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Abstract

The current study wanted to contribute to the current literature on the importance of early intervention in toddlers with ASD. To do so, the effect of Project ImPACT - a parent-mediated naturalistic developmental behavioural intervention – on imitation skills was investigated. Imitation is a pivotal skill for social communication development, thus it is important to find effective treatments to ameliorate it. To do so, 37 toddler-caregiver dyads were recruited, and a randomized clinical trial with three time-points was run, in which 17 participants were assigned to the treatment as usual (TAU) condition, and 20 to the ImPACT condition. The hypotheses were that by implementing ImPACT an increase in imitation would occur and that this increase would be greater compared to those in the TAU condition, and that there would be a significant negative correlation between ASD severity and imitation scores. The expectations of the first hypothesis were not met, whilst we did find a significant negative correlation between ASD symptomatology and imitation skills, which confirms that it is of foremost importance to find interventions which focus on improving imitation skills.

Introduction

In the last few decades, the increasing research on Autism Spectrum Disorder (ASD) has given us important insights on pivotal actions that can be taken in order to guarantee the best interventions possible for those who are diagnosed. ASD is a neurodevelopmental disorder which entails deficiencies in social communication skills and the presence of restricted and repetitive patterns of behaviour starting from a young age (America Psychiatric Association (APA), 2013). In light of the concept of neuroplasticity (Karmiloff-Smith, 1998; Lord et al., 2020; Zwaigenbaum et al., 2013), which is highest early in life, research has been focusing on finding early interventions which are efficient and evidence-based, with high degrees of validity and reliability. It should be of foremost importance to investigate which interventions most ameliorate the developmental trajectories of infants with ASD. For this reason, this research wants to investigate the efficacy of a promising parent-mediated naturalistic developmental behavioural intervention (NDBI), Project ImPACT (Ingersoll & Dvortcsak, 2010). More specifically we want to see if it increases imitation, seen it is often deficient in toddlers with ASD, but has a crucial role in development as it has both a learning and a social function (Bates et al., 1991; Carpenter et al., 1998; Trevarthen et al., 1999; Uzgiris, 1990).

To gain more depth on the core concepts behind the research question, we will first present the current state of the art of ASD research in regards of toddlers and early intervention. In the first chapter we will dive into the definition of ASD, to then focus on age-onset and the great deal of variability that occurs on the spectrum, which has to be taken into account when implementing interventions. Prevalence and etiology will then be discussed, with an eye of regard for environmental and genetic risk factors that research has found to be correlated to later onset of ASD. This is particularly relevant,

together with early signs of ASD, because it helps identifying those most at risk of developing ASD, and it allows to implement early interventions and take advantage of neuroplasticity. For this reason, an overview will also be given on early signs of ASD, with a focus on proximal skills relevant to this research, namely attention disengagement, social engagement, communication, and imitation.

The second chapter will present the interventions for toddlers with ASD which are most relevant to this research. First, the importance of using evidence-based interventions will be underlined. Behavioural interventions are then introduced, which are based on the operant learning theory and use techniques such as prompting and shaping (Sandbank et al., 2020). Moreover, the developmental approach is explained, which relies on the attachment theory and the constructivist theory and sees development as a result of the child being an active explorer of his/her surroundings (Sandbank et al., 2020). Additionally, NDBIs are outlined, which bring together both principles of the behavioural and developmental approach, with a focus on interaction. The benefits of parent-mediated interventions are then explained. Finally, the core principles behind Project ImPACT (Ingersoll & Dvortcsak, 2010), a parent-mediated NBDI, are explained.

The last three chapters focus on the research, a study on the efficacy of Project ImPACT on imitation skills of toddlers with autism. A 2 (intervention groups) x 3 (time-point of measurments) design was used to analyse the effect of the program, and in the first chapter all the information regarding the study are presented: aims of the study, sample description, explanation of the measurements, and procedure. In the second chapter, we proceed to describe the data preparation and analysis we ran, in which we analysed whether the intervention groups were balanced and whether the statistical assumptions were met. We then proceed to report the results of the 3x2 repeated-measure

ANOVA and 2x2 repeated-measures ANOVAs between each pair of time points to see if there was a significant effect of ImPACT between each time point. Ultimately, in the final chapter, the results of the study will be discussed as also its limitations and future implications.

In summary, this study will keep in mind the present literature on ASD in early infancy and the importance of early intervention to gain insights into the efficacy of Project ImPACT and the role of imitation in ASD deficiencies.

1. FIRST CHAPTER 1: AUTISM SPECTRUM DISORDER

1.1 Definition and diagnosis

Autism Spectrum Disorder (ASD) is a heterogeneous neurodevelopmental disorder, and its features can be understood through its main diagnostic criteria: A) persistent deficits in social communication and social interaction; B) restricted, repetitive patterns of behaviour; C) symptoms manifest themselves already at an early age (APA, 2013).

Social impairments can be found in social-emotional reciprocity, which makes it challenging to make conversations and initiate interactions (APA, 2013), even in simple social play (Jones et al., 2014). Deficits in nonverbal communication can also occur, such as avoiding eye contact and difficulties in using and understanding gestures and body language (APA, 2013). Moreover, this often implies struggles in developing peer relationships (APA, 2013). In regard to the restrictive and repetitive behaviour, what can be observed is the necessity to stick to specific routines or patterns of behaviours, and an extreme lack of flexibility. In addition, stereotyped motor mannerisms, use of objects and speech can occur, for example by playing only by lining up toys in a specific way. It is also very common for people with an ASD diagnosis to unusually hyper-fixate on specific topics or objects Hyper- or hyporeactive responses to certain sensory stimuli can also be a sign of ASD (APA, 2013).

Even though language development is not taken into consideration anymore for a diagnosis, research has shown consistent delays in the development of language production. This is also often the first reason behind parents seeking an evaluation. In spite of that, it is not included in the diagnostic criteria anymore due to the extreme variability studies have found in autistic language development (Gernsbacher et al., 2016).

The diagnostic systems of reference are the International Classification of Diseases 11th Revision (ICD-11) (World Health Organization, 2019) and the Diagnostic and Statistical Manual of Mental disorders 5th edition (DSM-5) (APA, 2013), and systematic reviews show that the most reliable diagnostic process for ASD is a clinical assessment by a multi-disciplinary team, also through the use the ADI-R and ADOS-2, the golden standard tools when it comes to ASD diagnosis (Falkmer et al., 2013). Moreover, research indicates that ASD can be reliably diagnosed from around the age of 3-4 years (Brett et al., 2016). It is also important to note that ASD is often diagnosed in comorbidity with ADHD, anxiety, and depression, and can co-occur with epilepsy (Lord et al., 2020).

1.2 Age-onset and variability

As mentioned above, one of the diagnostic criteria of ASD requires symptoms to present themselves already at a young age. A diagnosis can be made as soon as 18 to 24 months of age, when signs of atypical development and delays can be recognised (Zeidan et al., 2022). In fact, even though the average age for a diagnosis of ASD is 4-5 years, parents often already seek professional consults at 2 years of age, because often infants show signs of delayed social, communication and language development (Ozonoff & Iosif, 2019). This is not necessarily the case for all individuals with ASD due to a great variability that has to be taken into account when it comes to ASD. While some show symptoms at an early stage in development, in others they might emerge later (Lord et al., 2020). This is also linked to the severity of ASD, which has to be specified in the diagnosis since the introduction of the DSM-5, and is based on the level of social communication impairment and on restricted and repetitive patterns of behaviour (APA,

2013). The severity is correlated with the onset of symptoms because of the developmental demands a person encounters. In other words, delays may be recognisable only once social demands outweigh the person's abilities, which means that in more severe cases, delays will show sooner, and vice versa (Lord et al., 2020). Moreover, levels of severity can be different for each diagnostic criterion. ASD is often diagnosed in comorbidity with intellectual disability, ADHD, anxiety, and depression, and can co-occur with epilepsy (Lord et al., 2020), and this has a great impact on the level of severity experienced. To give a better insight into the range of variability, intellectual disability varies widely, from intellectual disability in 33.0% of the cases (Zeidan et al., 2022) to above-average intelligence (Chaste & Leboyer, 2012). All this has been kept into consideration in the DSM-5 by introducing changes in the criteria, such as allowing a diagnosis even if symptoms present themselves after 3 years of age (APA, 2013) - unlike the DSM-IV's criteria (APA, 1994) - underlining the developmental feature of ASD (Lord et al., 2020). Additionally, the DSM-5 introduced the concept of "spectrum" (APA, 2013), which is representative of the great variability and heterogeneity within the ASD population, seen that there are no two people who consistently have the same profiles, but they will share struggles that are reliably part of the same core diagnostic areas (Lord et al., 2000). Furthermore, by introducing this term, a lot of diagnostical issues have been resolved. The concept of Autism is relatively new, it has only been introduced in 1943 by Leo Kanner, and it has been evolving quickly since then, thanks to research and clinical experience. Before the introduction of the DSM-5, the great variability was being accounted for by separate diagnoses which are now all included under the umbrella of the "spectrum" (Hodges et al., 2020). In the DSM-IV Autism was classified as a Pervasive Developmental Disorder (PDD), together with Asperger's syndrome, childhood

disintegrative disorder (CDD), Rett syndrome, and pervasive developmental disorder not otherwise specified (PDD-NOS) (APA, 1994). With the DSM-5 this has changed, and all the above-mentioned disorders, except for the Rett syndrome, are now classified as Autism Spectrum Disorder (Hodges et al., 2020). Even though the diagnostic criteria are now more restrictive, they allow a better understanding of differences within the specific domains, in spite of the previous unclear PDDs (Lord et al., 2020). Finally, a new diagnostic category has been introduced, the social communication disorder (SCD), which refers to those who have problems with social communication, but don't present restrictive and repetitive behaviours (APA, 2013).

1.3 Prevalence and etiology: genetic and environmental factors

Autism prevalence worldwide in 2022 has been reported to be 65/10,000 (Zeidan et al., 2022), showing a consistent increase compared to previous years, and the median male-to-female ratio is 4.2:1 (Zeidan et al., 2022), and no significant changes appear in prevalence rates between children and adults (Lord et al., 2020). It has to be considered though, that females can more often be left undiagnosed due to their profile showing less overt symptoms and their ability to cover up more easily their social deficits through "camouflaging" (Volkmar et al., 2014). Moreover, even though ASD is present in all ethnicities and socio-economic groups, its prevalence differs among them seen that it is more often diagnosed in Caucasian children than in black or Hispanic children (Baio et al., 2018). The reason for this is still not certain, but it might be explained by stigma and lack of access to health care (Hodges et al., 2020), or by the use of different definitions of autism and diverse methodological approaches within prevalence studies (Zeidan et al., 2022).

In regard to the etiology of ASD, what results from research is a complex and still unclear interaction between environmental and genetic risk factors which affect and compromise the child‘s structural and functional brain development (Jones et al., 2014). To have a better understanding of this, an overview of today’s literature on the matter will follow.

Heritability contributes largely to ASD, with estimates from 40% to 90% (Sanders et al., 2015). More insight has been gained also through studies on twins which show a concordance between identical twins of 70% for autism in its old definition and 90% for ASD, and a concordance of 5% and 10% respectively in dizygotic twins (Sebat et al., 2007). It is also important to note that a study in 2011 found that siblings of children with autism have a risk between 2% and 8% of having a PDD (Hallmayer et al., 2011). Other genetic factors which have been reliably found to be correlated to ASD are genetic mutations (Chaste & Leboyer, 2012; Kolevzon et al., 2007; Ronemus et al., 2014), which often occur in the presence of advanced paternal age (Kolevzon et al., 2007; Neale et al., 2012; O’Roak et al., 2011; Ronemus et al., 2014; Sanders et al., 2012), and this shows clearly how genetic and environmental factors interact.

When it comes to environmental risk factors, we can see the main contribution coming from parental characteristics and obstetric conditions. In the former, there has often been found a correlation between ASD and increased parental age (Agrawal et al., 2018; Durkin et al., 2008; Gardener et al., 2009; Kolevzon et al., 2007; Wang et al., 2017; Wu et al., 2017). Furthermore, in Kolevzon’s meta-analysis (2007) maternal immigration showed a significant risk for ASD development in children, but insight has still to be gained on this because the studies in question were conducted only in Nordic countries. Antidepressant maternal exposure, during the first semester particularly, has also been

found to increase the risk of ASD (Constantino & Todd, 2003). Increased maternal age has been correlated with obstetric complications (Ezra et al., 1995; Mason-Brothers et al., 1990; Rosenthal & Paterson-Brown, 1998), and in turn, many of these prenatal and perinatal factors have also been associated with infants who later receive an ASD diagnosis. In Lord's review on autism (2020) maternal gestational diabetes, prolonged labour, and delivery by cesarean section revealed negative associations with ASD. Uterine bleeding, preterm delivery, low birth weight and low Apgar scores have also been consistently associated with autism (Newschaffer et al., 2007). Many of these complications seem to have an underlying connection with fetal hypoxia, and both the complications and fetal hypoxia are believed to increase the risk for ASD (Gardener et al., 2009; Kolevzon et al., 2007). This is very important to note that all these phenomena only show a correlational relationship with ASD and not a causational one (Lord et al., 2020), as a consequence further insight has still to be gained.

1.4 Early-signs

Research has shown that already in the first years of life there are behavioural and non-behavioural signs who significantly correlate with a later ASD diagnosis. In their ground-breaking studies, Ozonoff (2010) and Zwaigenbaum (2005) confirmed that after 6 months of age, and even more significantly at 12 months, infants who later receive a diagnosis can be distinguished from those who will not because a declining trajectory in social communication behaviours and loss of skill can be observed.

In the interest of this research, I will outline four crucial proximal social and non-social abilities that contribute to the development of social communication abilities which have been proven to be already impaired in the first years of life in those who later receive

an ASD diagnosis (Canu et al., 2021; Jones et al., 2014). Proximal skills are abilities which are mainly context-bound, but when generalised they are of fundamental support to broader and more complex social and language contexts (Yoder et al., 2013). Those of most relevance are attention disengagement, social engagement, communication and imitation (Canu et al., 2021).

Attention disengagement is considered as the latency to flexibly make an eye movement towards a salient peripheral stimulus while the subject is focused on a central fixation point, it is the ability to reorient one's attention (Canu et al., 2021). Research has shown that this ability is impaired in infants with ASD, and more often in the presence of social stimuli (Canu et al., 2021). Social engagement is the ability to interact with others by either responding or initiating social exchanges (Ingersoll & Dvortcsak, 2010, 2019), and a key aspect relevant to it is joint attention, the ability to shift attention between an object and another person for social purposes (Hood et al., 1998). Also in this case, studies revealed delays in infants with ASD (Jones et al., 2014; Ozonoff et al., 2010; Ozonoff & Iosif, 2019; Zwaigenbaum et al., 2005, 2013). These delays can be observed already at 12 months with significant declines in frequency of gaze to faces, shared smiles and vocalizations to others compared to typically developing infants (Ozonoff et al., 2010). Communication skills also show an atypical development, in fact, delay in the production of the first word is one of the main red flags for ASD (Jones et al., 2014). There is also a reduced use of non-verbal communication, specifically gestures (Zwaigenbaum et al., 2005). Imitation will be discussed more thoroughly further.

Other noteworthy early signs of ASD can be seen in restrictive and repetitive behaviours, temperament, and motor development. In regards to temperament, studies show that infants who later receive an ASD diagnosis, show marked passivity, low levels

of activity and more frequent distress reactions already at 6 months (Visser et al., 2016; Zwaigenbaum et al., 2005). Moreover, infants later diagnosed with ASD show a weaker development of more complex fine motor skills compared to control groups (Canu et al., 2021). All these delays have an impact on play behaviours, which are reported to be atypical at 9 months (Sacrey et al., 2015).

1.4.1 Imitation

Imitation is defined as the repetition by the observer (in the case of this research, of the toddler) of facial expression, movements and actions carried out by someone else (the researcher) (Warreyn et al., 2014). Imitation has a crucial role early in development as it has both a learning function and a social one. The former allows infants to acquire new skills and knowledge, and the latter supports social and emotional interactions through which they develop higher level social communication abilities (Bates et al., 1991; Carpenter et al., 1998; Trevarthen et al., 1999; Uzgiris, 1990). It is also a key mechanism for language development, both expressive and receptive (Charman et al., 2000; Masur, 1995; Masur & Eichorst, 2002; Young et al., 2011). Research has shown that imitation is a good predictor of later language development in toddlers with ASD (Toth et al., 2006). This makes it a crucial tool for social and cognitive development, and for this reason, it might also have an impact on other social and communicative abilities. In fact, it allows children to synchronize with those around them and to interact with them, and this allows them also to become aware that they are alike others (Schreibman et al., 2015). It is not only relevant to interactions with caregivers, but also with peers, and imitation increases and improves the quality of peer interaction in early childhood and remains a strong elicitor of social interests (Ingersoll, 2008).

In typically developing infants, these abilities present themselves during the second year of life and promote two novel behaviours a day (Barr & Hayne, 2003). On the other hand, in toddlers with ASD, deficits in imitation can already be seen during this period (Feldman et al., 2012; Macari et al., 2012; Young et al., 2011). In fact, research shows that imitation is highly correlated with developmental age and severity of ASD symptoms (Rogers et al., 2003). Moreover, given all the above-mentioned information, it is likely that deficiencies in imitation have a severe impact on social-communication development, and for this reason, it should be clear that enhancing imitation in children with ASD is a fundamental target for intervention, and in this research, we will look into how we can improve imitation through a parent-mediated intervention.

2. SECOND CHAPTER: INTERVENTIONS FOR CHILDREN WITH AUTISM

Together with the growing literature on ASD, also a great variety of interventions have been introduced into the clinical setting in order to improve the quality of the development of those who receive a diagnosis. As a consequence, research has been focusing on finding the interventions which are best tailored for the improvement of ASD symptoms, and in the following pages we will gain further insight into those. A general idea which has been gaining a lot of supporting evidence is that early intervention should be a priority. Many toddlers with ASD struggle with socio-communicative skills, and with those being deficient, crucial learning opportunities cannot be exploited properly (Lord et al., 2020). As above-mentioned, research shows atypical developmental trajectories in ASD already in infancy, and from this comes the need to intervene as soon as possible to improve socio-communicative abilities, especially since there is increasing data suggesting that at this age the brain benefits from elevated neuroplasticity, allowing to potentially modify abnormalities so that the infant can take advantage of the numerous social and general learning opportunities that present themselves at this age (Karmiloff-Smith, 1998; Lord et al., 2020; Zwaigenbaum et al., 2013). For this reason, this research focuses on the effects of early intervention on toddlers' proximal skills, specifically imitation. For having a better understanding of the current state of the art of interventions for ASD, an overview of the most relevant interventions will follow, starting from the importance of having evidence-based interventions.

2.1 Evidence-based interventions

In the last decades, it has become more and more important to rely on interventions which are evidence-based in order to optimise functional outcomes and provide effective treatments (Reichow et al., 2008). This is also the case for ASD interventions. Evidence-based practice (EBP) consists of three elements: i) the best available research; ii) individual characteristics, preferences and culture of the patient; iii) clinical expertise (American Psychological Association, 2006). Usually, in light of two independent randomized clinical trials carried out by separate research groups, the research criteria for EBP are met (Reichow et al., 2008). It is also important that these studies show a significant effect compared to a placebo treatment or a well-established effective treatment (Rogers & Vismara, 2008). The second element refers to the need of having a complete view of the patient in order to implement effective interventions, this means the clinician should be responsive to specific problems, strengths, personality, sociocultural context, preferences, values and beliefs, and goals the patient might have (Norcross, 2002). On the other hand, clinical expertise refers to knowledge the psychologist acquired through education, training, and experience, allowing the integration of the best available research evidence with the patient's clinical data and personal profile. By doing so, the clinician is able to deliver a tailored intervention with the highest probability of being efficient for the patient (American Psychological Association, 2006). In other words, EBP is the process of integrating these three elements through a process of clinical decision-making (Spring, 2007). The practice of EBP should be used also for the implementation of interventions for ASD, with the aim of improving the quality of life while decreasing maladaptive behaviours, and to do so it is necessary to focus on the improvement of social-communication skills. In the following pages we will gain further insight on

evidence-based interventions which are most relevant for the treatment of ASD symptomatology.

2.1.1 Behavioural interventions

Behavioural interventions were one of the first approaches gaining popularity in the field of ASD treatment. They are based on behavioural analysis and rely on experimental research principles, such as operant learning theory (Sandbank et al., 2020; Zwaigenbaum et al., 2015). The aim is to get a better understanding of the environmental influences affecting dysfunctional behaviours in order to change them (Vismara & Rogers, 2010). The main intervention is Applied Behavioural Analysis (ABA; Sandbank et al., 2020) which uses prompting, which consists in giving hints to elicit the target response - either increasing or decreasing the likelihood of a specific behaviour - and rewarding the child mainly through positive reinforcement (Sandbank et al., 2020). This is usually conducted intensively in a structured clinical context with a practitioner who targets desired behaviours based on the child's characteristics and functional areas in need of improvement. Once the child shows progress, the interactions start taking place also in more natural settings to allow generalisation of behaviour. Another behavioural approach often used is discrete trial training (DTT) which is also a structured one-to-one intervention based on the same operant principles of ABA. It entails breaking down complex skills into separate sub-skills which are then taught one at a time in discrete trials through prompting and shaping (Eikeseth et al., 2014; Schreibman et al., 2015). In general, these interventions for children with ASD focus on improving their socio-communicative skills and other important skills to increase their adaptive behaviours (Vismara & Rogers, 2010). Even though behavioural interventions have been widely

used, their structured configuration is also accountable for its limits: the child may fail to generalize the acquired skills and show an overdependence on prompting, causing also a lack of spontaneity (Schreibman et al., 2015). Moreover, generalisation is made more difficult by the use of rewards which are not usually found in more natural settings (Koegel et al., 1998).

2.1.2 Developmental interventions

On the other hand, developmental interventions find their theoretical roots in the attachment theory and in the constructivist theory, which states that children's development is a result of active exploration of their surroundings, both physical and social (Sandbank et al., 2020). This is not achieved by themselves, in fact, social interactions are key to this process seen that children's language and socio-communicative abilities are scaffolded by the interaction with someone more experienced than them (Vygotsky, 1978). In toddlers with ASD early social deficits arise and may decrease the fruitfulness of caregiver-child interactions which in turn affect social and language development, therefore in developmental interventions one of the main goals is to improve exchanges between caregiver and child in order to limit delays in the aforementioned areas of development (Sandbank et al., 2020). For this reason, these interventions are mainly staged in learning contexts of everyday routines, for example through moments of play, and targets are decided by comparing the child's development with a typical trajectory of social and communicational development (Sandbank et al., 2020). Unlike the behavioural approach, developmental interventions prefer exploiting a more natural setting which allows toddlers to incorporate their newly acquired skills

directly into their everyday life to improve their adaptive functioning (Schreibman et al., 2015).

2.1.3 Naturalistic Developmental Behavioural interventions

Naturalistic Developmental Behavioural interventions (NDBI) bring together theoretical principles from both the abovementioned behavioural and developmental approaches. This means that ABA principles, such as prompting and shaping, are used in a naturalistic environment with a preference for natural rewards more strictly linked to the task at hand (Sandbank et al., 2020). Once again, interaction is key: in NDBI it is very important that the adult follows the child's lead reciprocally to the objects and activities that draw his/her attention, and by doing so the interaction takes place in a naturally reinforcing learning context (Crank et al., 2021). The main goal for NDBIs is to enable the toddler to engage with others in the best way possible to fully exploit all those important learning opportunities (Sandbank et al., 2020). To achieve this, skills which support later socio-communicative development should be targeted by the intervention (Crank et al., 2021; Schreibman et al., 2015). This is why the importance of proximal skills has been previously underlined in this research, because attention disengagement, social engagement communication and imitation should be crucial targets in NDBIs (Crank et al., 2021; Schreibman et al., 2015).

NDBIs have been gaining substantial supporting evidence for the positive impact they have on children's development trajectory (Schreibman et al., 2015), in particular, research shows toddlers with ASD benefit from it in the areas of socio-communicative abilities, language, play and cognition (Sandbank et al., 2020). Moreover, research shows

larger effects on proximal skills compared to distal skills (Crank et al., 2021). All this evidence has very promising implications for ASD interventions.

2.1.3.1 Parent-mediated interventions

In light of the above-explained approaches, parent-mediated interventions could be a great added value to early interventions for toddlers with ASD. In parent-mediated interventions, a trainer coaches the parents so that they can improve the behavioural and socio-communicative development of their child (Ingersoll & Wainer, 2013). It is particularly relevant for ASD because, as previously mentioned, early intervention is key to allowing toddlers to exploit the pivotal learning opportunities that present themselves in the first years of social interactions (Karmiloff-Smith, 1998; Lord et al., 2020; Zwaigenbaum et al., 2013), and parent-mediated interventions are cost and time-efficient in this sense (Oono et al., 2013; Yoder et al., 2021). They make it possible to implement behavioural strategies on an everyday basis in a natural context by scaffolding core socio-communicative skills through responsive techniques (Ingersoll & Dvortcsak, 2010; Ingersoll & Wainer, 2013). – mainly in the parent-child interaction (PCI) –, and by doing so, learning opportunities are drastically increased seen that parents are those who spend the most time together with their child and generalisation is more easily achieved within different contexts (Carter et al., 2011). Secondary effects include reduced frustration of the child, an increased sense of empowerment and reduced stress levels for the parents who feel more capable once they perceive a better PCI, and an increased sense of family cohesion (Koegel et al., 2002; Oono et al., 2013).

Research has shown positive outcomes for several parent-mediated interventions, more specifically, significant improvements follow in the acquisition of language, both

expressive and receptive (Oono et al., 2013). Furthermore, a strong effect can be seen proximally in the interaction, with greater benefits for parents (Oono et al., 2013). Even though the first results are promising, further insight on the matter has still to be gained.

2.2 Project ImPACT

Project ImPACT ("Improving Parents as Communication Teachers") is an evidence-based parent-mediated NDBI which has been gathering positive results in regard to early interventions for toddlers with ASD or at risk of ASD, from 18 months to six years of age (Ingersoll & Dvortcsak, 2010; Ingersoll & Wainer, 2013). Based on the general descriptions of NDBIs and parent-mediated interventions, what we can gather is that this kind of approach allows interventions to happen in a natural setting, facilitating generalisation, and that interaction is key to reach the treatment's goals. Moreover, it is based on both developmental and behavioural approaches, which means objectives are set based on the trajectories of typical development and that techniques such as prompting and shaping are used.

In Project ImPACT, the main focus is to train parents so that they can improve the social communication skills of their children, with a focus on social engagement, communication, social imitation and play (Ingersoll & Dvortcsak, 2010). These areas specifically have been targeted by this program because if well developed, they facilitate later social-communication development, and research has shown that children with ASD are often deficient in these areas (Ozonoff et al., 2010; Zwaigenbaum et al., 2015), and that early intervention benefits them (Lord et al., 2020; Warreyn et al., 2014; Zwaigenbaum et al., 2013). To achieve this, the program teaches two main techniques: interactive teaching and direct teaching (Ingersoll & Dvortcsak, 2010). Interactive

strategies are based on developmental approaches and aim at enhancing PCI interaction and engagement to create a solid foundation for the use of direct strategies. To do so, it is important that the caregiver learns how to be responsive to the child and how to increase their ability to initiate interactions by doing things spontaneously and by redirecting the parent's attention to their interests. This is why the program teaches parents how to implement seven interactive strategies: 1) "*Follow your child's lead*" in his/her actions and ideas on what to do to increase the child's engagement and length of time they want to play together; 2) "*Imitate your child*" by copying their gestures, movements, play actions, sounds and words, and by doing so they will realise that their behaviour affects how the caregiver acts; 3) "*Animation*" consists in adding more or less energy to actions, voice and facial expressions and by doing so you increase the child's ability to share enjoyment with the caregivers, to initiate, as well as to increase the child's understanding of nonverbal communication such as gestures, facial expressions, and body posture; 4) "*Modeling and expanding language"* by teaching parents to adjust the way they speak so that they can help the child understand and develop new communication skills; 5) "*Playful obstruction"* by interrupting the child's activity playfully so that the child has the opportunity to initiate both verbally and nonverbally, as well as to request and protest; 6) "*Balanced turns*" to teach turn-taking, requesting and play skills; 7) "*Communicative temptations*" by allowing the child to initiate interactions for things he/she wants in a natural context (Ingersoll & Dvortcsak, 2010; Ingersoll & Dvortcsak, 2019). These briefly explained strategies aim at increasing the quality of spontaneous PCIs, and starting from this, the caregiver can scaffold the acquisition of new skills through direct teaching, which consists in prompting and reinforcing techniques, the basis of the ABA approach (Ingersoll & Dvortcsak, 2010; Ingersoll & Dvortcsak, 2019).

There is increasing supporting evidence in regards to the efficacy of NDBIs and parent-mediated interventions (Oono et al., 2013; Sandbank et al., 2020), and also for this specific program research has revealed promising results. Ingersoll and Wainer (2013) investigated the efficacy of Project ImPACT on improving social communication skills and results showed that six out of eight children with ASD had significant improvements in spontaneous language production. Moreover, Yoder et al. (2021) found significant progress in children's motor imitation and communication skills, besides a positive effect on language delays and ASD symptoms. These results are very promising in the context of ASD intervention, and further evidence should be gathered to have a better understanding of the positive impact this could have on early intervention and on ameliorating developmental trajectories in children with ASD.

3. THIRD CHAPTER: THE CURRENT STUDY

Recent research has shown the importance of early intervention for toddlers with ASD in order to ameliorate their atypical developmental trajectory by taking advantage of neuroplasticity (Karmiloff-Smith, 1998; Lord et al., 2020; Zwaigenbaum et al., 2013). Deficits have been found mainly in social-communicative skills, namely attention disengagement, social engagement, communication and imitation (Canu et al., 2021). The focus of this research will be imitation, which has a pivotal role in development due to both its learning and social function (Warreyn et al., 2014), and for this reason, it is important to find early interventions that focus on this. For this purpose, research on parent-mediated NDBIs shows promising results, with Project ImPACT being one of them (Ingersoll & Wainer, 2013; Yoder et al., 2021). It is with these premises that this research wants to gain further insight into the efficacy of the ImPACT program.

3.1 Aims

The aim of the present study was to contribute to the search of effective early interventions for toddlers with ASD. Therefore, the effect of Project ImPACT on the core social communication deficiencies in ASD has been analysed. ImPACT, a parent-mediated NDBI, focuses on four main areas, which are social engagement, communication, social imitation and play (Ingersoll & Dvortcsak, 2010). This research wanted to gain more insight into the effects the intervention has on imitation, because previous studies show that deficits in imitation preclude from exploiting important learning opportunities (Lord et al., 2020), thus, it is crucial to have interventions which focus on enhancing this ability, in order to prevent or reduce the developmental delay, and this is one of ImPACT's main goals. Moreover, the effectiveness of this treatment

would have some important implications for ASD treatment, seen that it would provide caregivers with an intervention which is cost and time-effective, and which can be implemented on an everyday basis (Lord et al., 2020; Oono et al., 2013; Yoder et al., 2021).

We hypothesized, based on previous literature (Yoder et al., 2021), that by implementing ImPACT an increase in imitation would occur, and that this increase would be greater compared to those in the treatment as usual (TAU) condition. In fact, Yoder's (2021) research on the efficacy of ImPACT on later born siblings of children with ASD, which are considered at elevated likelihood, showed that the implementation of this treatment increased motor imitation. Moreover, we wanted to do an explorative analysis of the data and we predicted to see a significant negative correlation between ASD severity and imitation scores, which means that with higher imitation scores lower severity was expected, and with lower scores higher severity was expected. This assumption is based on previous research results showing that imitation is highly correlated with severity of ASD symptoms (Rogers et al., 2003). It is important to specify that this research will look mainly at the efficacy of the program proximally, which means that we will look at the effects on imitation only in the context-bound research environment in which the toddler is tested. This is based on previous literature stating that ImPACT's main effect can be seen first on proximal social communication skills and then distal ones (Yoder et al., 2021). To investigate these hypotheses, a randomized clinical trial (RCT) conducted between 2016 and 2021 was used, with data collected in three different time points – pre-test, post-test and follow-up – and with toddlers with an ASD diagnosis randomly assigned to the two different conditions, either the intervention one or the TAU one.

3.2 Methods

3.2.1 Participants

The research dataset included 56 toddlers with ASD or with presumed ASD, between the age of 18 months and four years old, and with no further neurological or physical impairments. The participants were recruited through a collaboration with home-based support services providing individual sessions across four different Flemish regions of Belgium (Antwerp, Flemish Brabant, East- and West Flanders). The participants were subsequently divided into the two conditions: 27 toddlers-caregiver dyads were assigned to the ImPACT, and the remaining 29 to the TAU condition. Various dyads had missing data across various time-points: three participants had no ADOS-2 baseline measurements (TAU: 3/29); four participants had missing imitation scores at all time points (TAU: 2/26); eight participants had no data collected at the post-test, with one of them having missing data also at the follow up (TAU: 3/24), and four participants had no imitation scores at the follow-up testing (TAU: 4/21). The reason behind these missing measurements can unfortunately be found behind COVID-19 restriction measurements in most cases, then some dyads withdraw their participation, and with one dyad communication problems occurred. We decided to remove all participants with missing information, which means 37 toddler-caregiver dyads were included in the data analysis, 20 in in the ImPACT condition (1 girls and 19 boys, mean age = 36.49 months, SD age = 8.31) and 17 in the TAU condition (3 girls and 14 boys, mean age = 35.52 months, SD age = 7.02). 22 toddlers were diagnosed with ASD at the beginning of the study (TAU: 10/17), 11 at the follow-up (TAU: 4/7), three were suspected of having ASD (TAU: 3/3), and one toddler exhibited developmental delays physically, socially and in language.

Between the two groups no significant differences were found, making them balanced and comparable.

3.2.2 Materials

Autism Spectrum Disorder severity

Autism Diagnostic Observation Schedule - Second Edition (ADOS-2; Lord et al., 2012; Lord et al., 2012). ADOS-2 is a semi-structured standardized test that was administered to gain further depth into the toddlers' ASD symptom severity at the baseline and at the follow-up measurements. It is considered to be the golden standard for ASD diagnosis, and its reliability and validity has been proven in multiple research (Luyster et al., 2009; McCrimmon & Rostad, 2014; Oosterling et al., 2010; Zander et al., 2015). In this research the Dutch version has been administered. Depending on the toddlers' age and verbal skills, different modules were implemented (i.e., toddler module, module 1, 2, 3 or 4). In the current study, the toddler module (only at pre-measurement), as well as modules 1, 2 and 3, were applied. Based on the total score, three categories can be distinguished, *little-to-no concern*, *mild-to-moderate concern* or *moderate-to-severe concern* for the toddler module and *ASD*, *no ASD* or *autism* for modules 1 to 3 (based on the criteria of DSM-IV; Bell, 1994; Lord, Luyster, et al., 2012; Lord, Rutter, et al., 2012). Calibrated Severity Scores (CSS; Gotham et al., 2009) were used to compare ADOS-2 severity scores across the different modules, which entails a scale from 0 (no ADS) to 10 (severe ADS).

Developmental stage

Mullen Scales of Early Learning (MSEL; Mullen, 1995). The MSEL was administered at pre-test and at follow-up to have an overview of the developmental stage of the toddlers. It can be applied from newborn until 68 months (Staples, MacDonald, and Zimmer 2012; Wolraich et al. 2008), but it has not yet been standardized in a Belgian sample.

Imitation

Unstructured Imitation Assessment - Object and Gesture (UIA, Ingersoll, 2008, 2010; Ingersoll & Meyer, 2011). Ingersoll's imitation task has been used to assess the participants' frequency of spontaneous imitation behaviours at each time-point of this research. The Unstructured Imitation Assessment (Ingersoll, 2008) is composed of two scales, the *Object Scale* and the *Gesture Scale*, but for the purpose of this research, only the former has been used. A set of 10 actions with corresponding objects were presented to the toddler by the experimenter. The toys used for the *Object Scale*, as per manual, are the following: 1) three nesting cups; 2) boa; 3) teddy bear and food toy item; 4) sticky ball (rubber ball); 5) fishing net and fish; 6) sound tube; 7) train; 8) slinky; 9) recorder (ukulele); 10) tambourine and jingle bells. Two identical copies of each set of objects were made freely available in the experimenting room. The procedure started by giving the toddler two minutes to warm-up to the setting, with the experimenter imitating all their vocalisations, gestures and object play without modelling actions. After this, the experimenter would start modelling circa one action per minute by saying "Watch me" and by showing the actions three times in a row, with trials presented every five seconds. The action modelled could not be one involving objects the toddler was already holding,

although the object should be in the toddler's field of vision. The participant was not praised for correct imitation but for attending and playing actively with the experimenter. Between the actions being modelled, the experimenter started imitating the child again and narrating the child's play for 45 seconds. The behaviours were scored on a scale from 0 (action not replicated) to 2 (action replicated), and the coding was then carried out by two independent researchers, blinded to the intervention group assignment, with a 20% of overlap to calculate fidelity, and as a result, a score from 0 to 20 is given to the participant's imitation task.

3.2.3 Procedure

The following study is a RCT using both between- and within-subject variables, it is a 2 (intervention: ImPACT or TAU) x 3 (time: pre-test, post-test, follow-up) design. Toddler-caregiver dyads were randomly assigned to either the intervention condition (ImPACT) or the active control group (TAU). Randomization was assured by assigning two participants to the ImPACT condition and two to the TAU condition each four enrollments, therefore dyads had a 50% chance of following the ImPACT program. This served as a very good motivator for parents to take part to the study. As previously mentioned, participants were recruited through Flemish home-based support services for children with ASD. Once the parents expressed their interest in participating in the study, they would then be contacted by the experimenter. The experiment then took place at the *Faculty of Psychology and Educational Sciences* of Ghent University. At the pre-test (T1), after the signed informed consent was collected, the ADOS-2 (Lord, Luyster, et al., 2012; Lord, Rutter, et al., 2012), the MSEL (Mullen, 1995) and the imitation task (Ingersoll, 2008, 2010; Ingersoll & Meyer, 2011) were administered. After this, the home-

based support services would inform the dyads whether they were assigned to the ImPACT condition or to the TAU condition, and the researchers administering the tests remained blinded. One or two weeks after the intervention, which lasts 18 weeks, at the post-test (T2), imitation was tested. Finally, the follow-up measurements (T3) took place 12 weeks after the end of the intervention, in which the ADOS-2 (Lord, Luyster, et al., 2012; Lord, Rutter, et al., 2012), the MSEL (Mullen, 1995) and the imitation task (Ingersoll, 2008, 2010; Ingersoll & Meyer, 2011) were administered again. T3 allowed to see whether, if present, the intervention had a long-term significant effect on the toddler. It is important to note that this study used a dataset from a larger study, and that only the relevant information to the research questions are discussed. For a general overview of the procedures, see Table 1.

Table 1
Overview of research procedure

Pre-test (T1)	**Post-test (T2)**	**Follow-up (T3)**
ADOS-2	BOSCC	ADOS-2
MSEL	UIA	MSEL
BOSCC	ESCS	BOSCC
Imitation task	Vineland Screener	Imitation task
ESCS	N-CDI	ESCS
Vineland Screener		Vineland Screener
N-CDI		N-CDI

Intervention groups

ImPACT. For the purpose of this research counsellors have attended a two-day workshop and coaching and once they met the implementation fidelity criteria, they were assigned participants, so that reliability was secured. The program is composed of 18 individual sessions of 90 minutes, implemented weekly. If the dyad was from East or West-Flanders, the training took place at home, whilst in the Antwerp and Flemish

Brabant regions, the training took place at the home-based support services. Whenever the dyads were not able to participate for a session, the session was rescheduled as soon as possible. The program was implemented as explained in the first edition of the manual by Ingersoll and and Dvortcsak (2010). Project ImPACT has the main goal of improving social communication skills of toddlers with ASD, with a focus on social engagement, communication, social imitation, and play. For this reason, counsellors were instructed to teach caregivers how to implement appropriate strategies to ameliorate the developmental trajectory of their children. Each session followed the same structure. First, the strategies were discussed and explained, subsequently, the clinician demonstrated the strategies in interaction with the child, and lastly, the caregivers tried out the strategies with the toddler and received feedback from the trainer. At the end of each session, the caregivers were assigned to apply the learned strategies on a daily basis. Now a general overview of what the sessions entailed will follow. The first two sessions served as an outline of the program in which the goals were set and it was discusses how to create a good learning environment at home. The remaining sessions followed a pyramidal structure, with direct teaching techniques building on interactive teaching strategies. Thus, from sessions 3 to 8 interactive strategies were explained, with sessions 3 and 4 focusing on how to stimulate and engage the toddler and provide relevant learning opportunities for language (*follow your child's lead, imitate your child, animation, modelling and expanding language),* whilst session 5 to 7 aimed at improving the child's motivation to communicate (*playful obstruction, balanced turns, communicative temptations).* Session 8 served to review and master the aforementioned strategies. From sessions 9 until 15, direct teaching strategies were thought, which have as their main goal more complex social communication skills which are achieved through prompting and reinforcing, which in turn rely on interactive

teaching strategies. In the last three sessions, sessions 16 until 18, all the techniques were integrated, and the previously established goals were revisited.

Control group. The dyads assigned to the TAU condition served as a control group. This meant that home-based counselling was given twice a month to the families and that the type of intervention could vary based on the needs of the toddlers, so no fixed protocol was foreseen. Thus, some interventions targeted eating and sleeping problems, or toilet training, whilst others focused on adaptive skills and self-reliance.

4. FOURTH CHAPTER: RESULTS OF THE STUDY

4.1 Data preparation and analysis

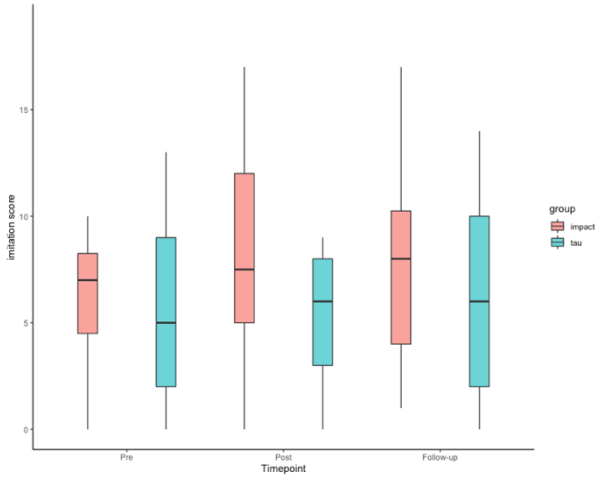
The data analysis was conducted using R (R Core Team, 2020), with the following packages: tidyverse (Wickham et al., 2019), readxl (Wickham et al., 2019), car (Fox & Weisberg, 2019) and ez (Lawrence & Lawrence, 2016). This study has between- and within-subject variables, it is a 2 (intervention: ImPACT or TAU) x 3 (time: pre-test, post-test, follow-up) design.

4.1.1 Data preparation

Winsorizations was used to detect outliers in the imitation scores. It is important to deal with outliers prior to the analysis because they could bias statistical estimates (Kwak & Kim, 2017). More specifically an interquartile range method was applied for detection and correction. No outliers were detected, so no further corrections were necessary (see Figure 1).

Figure 1

Mean scores of imitation task of ImPACT and TAU condition at each time-point and possible outliers.



4.1.2 Data analysis

To make sure the two intervention groups were comparable and balanced, analyses were run to see if there were any significant differences between groups at the baseline (T1). The Welch t-test was used to see if there were any significant differences in age, CSS of ASD , and developmental stage. Chi-Squared test was used to see if there were any significant differences in gender. The analysis showed that there were no significant differences between the ImPACT condition and the TAU condition (see Table 2).

Table 2

Demographics of participants at baseline (T1)

	TAU (*N*=17)		ImPACT (*N*=20)			
	M	*SD*	*M*	*SD*	Welch t-test	Chi-Squared test
Age	35.52	7.02	36.49	8.30	$t(35) = 0.38$; $p = 0.71$	
Gender						$X^2(1) = 0.07$; $p = 0.78$
Male(n)	14.00		19.00			
Female(n)	3.00		1.00			
MSEL	64.53	19.61	64.55	19.46	$t(35) = 0.00$; $p = 1.00$	
CSS ASD	6.29	2.31	7.30	2.56	$t(35) = 1.25$; $p = 0.22$	

Note. *M* = mean; *SD* = standard deviation; *N* = number of participants.

Because of the Central Limit Theorem (CLT) and the sample being size being greater than 30, we regarded the sample as equaling the normal distribution (Kwak & Kim, 2017), and therefore we proceeded to perform the analyses of our dataset.

Parametric analysis were run to check our first hypothesis. More specifically a 3x2 repeated-measures ANOVA was performed to see if by implementing ImPACT an increase in imitation occurred, and if this increase was greater compared to those in the treatment as usual (TAU) condition. Moreover, we performed 2x2 repeated-measures

ANOVAs between each pair of time points to see if there was a significant effect of ImPACT between each time point.

We then proceeded with the exploratory analysis to see if there were any correlations between ASD severity and imitation at pre-test and follow-up regardless of the group condition.With the CLT and the sample being greater than 30 participants, we regarded the sample as normally distributed and proceeded to run a two-tailed Pearson's product moment correlation, at pretest between imitation scores and ASD severity.

4.2 Results

The repeated-measures ANOVA, with *imitation scores* as dependent variable and *intervention* (2 levels: TAU and ImPACT) and *time* (3 levels: pre, post and follow-up) as predictors, showed no statistically significant effects. No significant main effect of *intervention* was seen ($F(35) = .89$, $p > .05$, , $\eta2_p = .02$), nor *time* ($F(70) = 2.38$, , $p > .05$, $\eta2_p = .02$), and also the interaction between *intervention* and *time* was not significant ($F(70) = .61$, , $p > .05$, $\eta2_p = .01$). Mauchly test of sphericity resulted not significant ($p > .05$), therefore the sphericity assumption was not violated. We then performed 2x2 repeated-measures ANOVAs between each pair of time points to see if there was a significant effect of ImPACT between each time point. The repeated-measures ANOVA between pre-test and post-test imitation scores showed no significant main effect of *intervention* ($F(35) = .75$, $p > .05$, $\eta2_p = .01$) and *time* ($F(35) = 3.80$, $p > .05$, $\eta2_p = .03$) and no significant interaction between *intervention* and *time* ($F(35) = 1.04$, $p > .05$, $\eta2_p = .01$) was detected. The same happened with the ANOVA between post-test and follow-up, where the effect of *intervention* ($F(35) = 1.19$, $p > .05$, $\eta2_p = .03$), *time* ($F(35) = .27$, $p > .05$, $\eta2_p = .00$) and interaction between *intervention* and *time* ($F(35) = .19$, $p > .05$,

$\eta 2_p$ = .00), were non-significant. Finally, the results of the repeated-measure ANOVA between pre-test and follow-up didn't differ from the previous ones, with no significant effect on *imitation scores* of *intervention* ($F(35) = .43$, $p > .05$, $\eta 2_p = .01$) or *time* ($F(35) = 2.41$, $p > .05$, $\eta 2_p = .02$), and no statistically significant interaction between *intervention* and *time* ($F(35) = .46$, $p > .05$, $\eta 2_p = .00$). To summarize, results show no significant main effect of neither *time* or *intervention*, no statistically significant interaction effects and very small effect sizes in any of the repeated-measure ANOVAs we ran. A summary of the results can be found in Table 3.

Table 3

Repeated measures ANOVA results

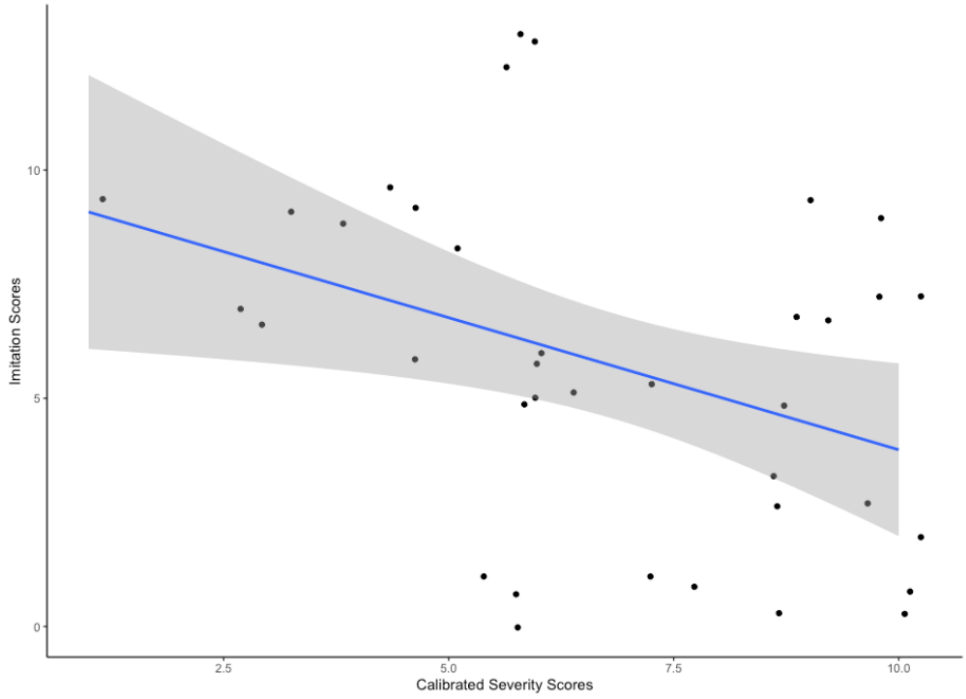
Parameters	*SSn*	*SSd*	*df1*	*df2*	*F*	*p*	$\eta 2_p$
	2 (Intervention: TAU, ImPACT) x 3 (Time: Pre, Post, Follow-up)						
Intervention	35.72	1405.87	1	35	.89	> .05	.02
Time	52.43	771.41	2	70	2.38	> .05	.02
Intervention x Time	13.44	771.41	2	70	.61	> .05	.01
	2 (Intervention: TAU, ImPACT) x 2 (Time: Pre, Post)						
Intervention	20.43	951.95	1	35	.75	> .05	.01
Time	47.48	437.00	1	35	3.80	> .05	.03
Intervention x Time	13.05	437.00	1	35	1.04	> .05	.01
	2 (Intervention: TAU, ImPACT) x 2 (Time: Post, Follow-up)						
Intervention	47.13	1385.22	1	35	1.19	> .05	.03
Time	2.31	300.75	1	35	.27	> .05	.00
Intervention x Time	1.61	300.75	1	35	.19	> .05	.00
	2 (Intervention: TAU, ImPACT) x 2 (Time: Pre, Follow-up)						
Intervention	10.58	860.28	1	35	.43	> .05	.01
Time	28.85	419.36	1	35	2.41	> .05	.02
Intervention x Time	5.50	419.36	1	35	.46	> .05	.00

Note.SSn, SSd = Sum of Squares; df_1, df_2 = degrees of freedom; *F* = F-test; *p* = p-value; $\eta 2_p$ = partial eta squared as effect size.

For our exploratory analysis, we ran a correlational analyses between *CSS* of ASD and *imitation scores* at pre-test, regardless of the group, and after applying the CLT for the normal distribution of the dataset, we ran a two-tailed Pearson's product moment correlation. The results showed a significant negative correlation between *imitation scores* and *CSS* of ASD symptomatology (r = -.45, p < .01; see Figure 3).

Figure 3

Correlation between CSS of ASD and imitation score at pre-test, independently of group condition



5. FIFTH CHAPTER: DISCUSSION AND CONCLUSION OF THE CURRENT STUDY

5.1 Discussion

This study investigated the effect of an evidence based parent-mediated NDBI, namely Project ImPACT, on imitations skills of toddlers with ASD. To do so, a RCT was used, in which caregiver-toddler dyads were randomly assigned to either the intervention condition (ImPACT) or the TAU condition. Toddlers were between 18 months and four years old, and were either diagnosed with ASD, presumed to have ASD, or exhibited a slower development. The study then proceeded longitudinally to see the effect of the ImPACT program. Three measurement moments occurred: pre-test (T1), post-test (T2), follow-up (T3). At the start of the study, it was hypothesized that by implementing ImPACT an increase in imitation would occur, and that this increase would be greater compared to those in the TAU condition. Moreover, we predicted to see a significant negative correlation between ASD severity and imitation scores, which means that with higher imitation scores lower severity of symptomatology was expected, and with lower scores higher severity was expected.

In contrast with our expectations, the results of this study did not support our first hypothesis. ImPACT showed no significant effect on imitation scores across time, which means that the improvements in imitation in the ImPACT condition, if any, were not significantly greater than those in the TAU condition. This result was confirmed also when analysing if there was any effect of the ImPACT program between different time points, but also in this case, results were non-significant. This means that the implemented parent-mediated NDBI has not successfully increased imitation skills more than in the

TAU condition. This is in contrast with the intervention's goal of improving imitation skills (Ingersoll & Dvortcsak, 2010) and also with Yoder's et al. study on the efficacy of ImPACT (2021), which found improvements in motor imitation. Another study by Ingersoll and Lalonde (2010) studied the effect of Reciprocal Imitation Training (RIT), a naturalistic behavioral intervention that teaches imitation to children with autism within a social-communicative context, with the aim of seeing the impact it would have on language use. In this case, the training showed a positive significant effect on generalized object and gesture imitation. As far as this study is concerned, no effect on imitation does not necessarily mean that the intervention was not effective at all, it means that the effect was not significantly greater than the effect shown in the TAU condition, thus further outcomes still have to be investigated, also to gain further understanding on the improvements that can be made. For a better understanding of these results, it is also interesting to do a graphical analysis of Figure 1, which displays the mean scores of imitation of the ImPACT and the TAU condition at each time point. It shows that the ImPACT condition has a slightly higher mean score of imitation at the baseline (T1), and that this difference remains stable across the other time-points. It can be seen though, that after the intervention, even if the slight difference in mean scores across the conditions remains stable, some participants in the ImPACT condition achieve higher scores in imitation, especially at the post-test. This could indicate that for some participants the intervention was indeed effective, and this could be accounted for by the great deal of variability we can see on the spectrum and by every individual having their own developmental trajectory. These results were also found by Van der Paelt et al. (2016), who concluded that there was great individual variability in ASD treatment outcome,

suggesting that it is important to take into account the individual differences of children with ASD when implementing a treatment.

In regard to our second hypothesis, the results show a significant negative correlation between imitation scores and CSS of ASD at pre-test (T1), which confirms our hypothesis. This means that with higher severity of ASD symptomatology lower imitation scores were registered, and that with lower severity of ASD symptomatology higher imitation scores were detected. This is in accordance with previous research results showing that imitation is highly correlated with severity of ASD symptoms (Rogers et al., 2003). Moreover, these results confirm the pivotal role imitation has in ASD symptomatology and the importance of implementing interventions that, as ImPACT, aim at improving imitation skills to ameliorate the developmental trajectory of ASD.

5.2 Limits and future perspectives

We will now take a deeper look at the limits of the current study for the benefit of future studies on the current topic. We previously discussed Ingersoll and Lalonde's study (2010) on imitation. Also in their study the *Unstructured Imitation Assessment - Object and Gesture* (Ingersoll, 2008, 2010; Ingersoll & Meyer, 2011) was used to asses imitation skills, with the difference that both the *Objec*t and the *Gesture Scale* were used. This study implemented RIT, and what resulted was that children exhibited imitation of the verbal marker more often in the *Gesture Scale* than in the *Object Scale*. For the purpose of this research then, it might have been interesting to analyse both scales, to see whether the *Gesture Scale* would have confirmed our hypothesis of increased imitation behaviours after implementing ImPACT, or if it would have confirmed our results which showed no significant effect of the intervention compared to the TAU condition.

Another limitation of the current study is the absence of measurements of parent fidelity of implementation of the current program. Research has shown that higher levels of parent treatment fidelity predicts better outcomes (Strauss et al., 2012). Moreover, Ingersoll and Wainer's (2013) initial study of the efficacy of Project ImPACT, also measured parent fidelity. In the current study, other than the direct feedback of the clinician during the training sessions, we had no further control on the reliability and validity of the intervention when carried out by the caregiver, thus we do not have measures of frequency when it comes to how often the parents implemented the strategy, and we do not know whether the thought strategies were implemented correctly. In future studies, it would be interesting to have this information to better interpret the results, because in some cases, it might be that the program was not effective due to unsuccessful implementation of the intervention by the caregiver. Always in regards of caregiver-related measurements, it would have been relevant to collect further information also about caregiver stress levels, in light of research showing an increased sense of empowerment and reduced stress levels for the parents who feel more capable once they perceive a better PCI (Koegel et al., 2002; Oono et al., 2013). Moreover, studies have demonstrated that parental stress levels have a significant effect on the outcome of the intervention (Strauss et al., 2012). Thus, gathering data on stress levels, would have allowed us to further tackle previous relevant studies results.

Furthermore, the implementation of the intervention took place in different locations depending on the enrollment locations. If the dyad was from East or West-Flanders, the training took place at home, whilst in the Antwerp and Flemish Brabant regions, the training took place at the home-based support services. The current study could not test whether this created any variance due to the lack of data about ImPACT

implementation location. These factors might also be interesting to explore in future research.

It is also relevant that this study did not have a passive control group, with an ASD diagnosis and no intervention administered. This is a common limit to most clinical research studying the effect of a new treatment, due to the clear ethical implications. In turn though, when a study shows no significant main effect compared to the TAU condition, as in this case, it is difficult to understand whether the intervention is non effective or as effective as the treatment usually administered. Knowing that the treatment is as effective as other evidence-based treatments is a great achievement because it would make available an additional intervention which, based on the principle of ASD individual variability, might be more effective for some individuals. For this reason, it would be interesting to investigate the efficacy of this intervention with a sample of infants at elevated likelihood of developing ASD. This would ethically allow the use of a passive control group receiving no intervention, seen that it would not require the participant to forgo treatment they would otherwise receive (Millum & Grady, 2013).

Overall, the current study's results contribute to the current literature on the efficacy of ImPACT on imitation, and due to its fairly new nature (2010), it is necessary to further investigate it. Furthermore, this study confirmed the crucial role imitation has in ASD severity, confirming the importance of investing in new early interventions for the improvement of imitation strategies, with the hope of ameliorating social communication skills of toddlers with ASD.

5.3 Conclusion

To conclude, the study showed no significant effect of Project ImPACT on imitations skills of toddlers with ASD compared to the TAU condition, but it did confirm that imitation skills have a significant negative correlation to ASD severity of symptomatology. This result does validate the main goal of this research, which was to find an effective early intervention for toddlers with ASD in order to ameliorate their atypical developmental trajectory. With imitation skills being negatively correlated with ASD severity, we confirmed that it is of foremost importance to further investigate treatments which efficiently improve imitation, which has a pivotal role in the development of social communication abilities (Bates et al., 1991; Carpenter et al., 1998; Trevarthen et al., 1999; Uzgiris, 1990), one of the main deficiencies of those diagnosed with ASD. Moreover, parent-mediated NDBIs, such as ImPACT, remain a remarkable tool for early intervention in ASD, because they allow to tackle core ASD impairments on a daily basis, in a time and cost-efficient way, other than benefitting also the caregivers themselves with reduced frustration of the child, increased sense of empowerment and reduced stress levels by feeling more capable once they perceive a better PCI (Koegel et al., 2002; Oono et al., 2013). The current study wanted to strengthen the current state of the art, with the goal of contributing to the search of effective individualized interventions for toddlers with ASD and of raising awareness on the importance of early intervention to guarantee the best developmental trajectory possible.

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Acknowledgments

This academic journey has given me the opportunity to grow and to experience fully the field of developmental psychology. This would have not been possible without the support of Professor Mammarella and Professor Roeyers, who made it possible for me to be a part of the Research in Developmental Disorders laboratory of the University of Ghent, which allowed me to grow professionally and to write my thesis on a topic which I am truly passionate about.

A heartfelt thank you to Doctor Arianna Zanatta, who was by my side every step of the way and resolved my every doubt. She pushed me to achieve the best I could, she put trust in me, by making me feel capable and supported. This experience made me even more motivated to pursue a career in the field of developmental psychology, especially in the field of early intervention.

I couldn't have done it without my partner Pietro, who believed in me even when I didn't, and who took this journey with me by taking care of everything around me and by showing me love and support.

Finally, thanks to my mum and dad, without whom I would have not been able to achieve all I have and all I will.