# An Exploration of Deferred Imitation in Young Children

# with Autism Spectrum Disorder

by

Jennifer Morgan
B.A., University of British Columbia Okanagan, 2006

A Thesis Submitted in Partial Fulfillment
of the Requirements for the Degree of

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in the Department of Educational Psychology & Leadership Studies

# Supervisory Committee

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Dr. John Anderson, Department of Educational Psychology & Leadership Studies
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## Abstract

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The purpose of this study was to explore imitation in Autism Spectrum Disorder (ASD) by (a) examining the ability of children with ASD to engage in deferred imitation, as compared to typically developing (TD) children; (b) determining the impact of differing time delays on the ability of children with ASD and TD children to imitate simple actions on objects; and (c) examining the role of a verbal prompt on the ability of children with ASD to engage in deferred imitation, as compared to TD controls. Additionally, the role of language in deferred imitation was explored. Participants included 15 children with ASD and 15 TD children. Participants observed object oriented actions and were given the opportunity to imitate spontaneously. Those participants who did not imitate spontaneously were given a verbal prompt and a further opportunity to imitate. Participants with ASD demonstrated fewer spontaneous and total (i.e. spontaneous and prompted) imitations and took more time to do so at a short and a longer time delay, as compared to TD participants. Participants with ASD were given more verbal prompts than TD participants at a short and a longer time delay. Language was related to deferred imitation at a short time delay for participants with ASD but not for TD participants and language was not related to deferred imitation at a longer time delay for either group.

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## Chapter One

## Introduction

When a child imitates, he/she is performing a previously unlearned action he/she has observed another individual performing. Imitation can take place immediately following observation (i.e. immediate imitation) or, after a delay (i.e. deferred imitation). There is evidence that typically developing (TD) newborns can engage in immediate imitation (Meltzoff & Moore, 1977) and TD infants as young as 9 months can engage in deferred imitation (Meltzoff 1988a; 1988b). Some have even gone so far as to argue that imitation is an innate skill that provides the foundation for more complex cognitive skills, such as empathy (Meltzoff & Decety, 2003; Rogers & Pennington, 1991). Imitation is important because it facilitates the acquisition of new skills (Bandura, 1986; Nielsen & Dissanayake, 2003). Sometimes it isn't possible to immediately imitate a model, and if individuals weren't able to imitate after a delay, important learning opportunities would be lost.

Imagine for a minute that you are a young child at preschool. Your playmate rolls playdough between her palms to make a pretend snake. She hands you the playdough and says, “your turn!” Unfortunately, if you are a child diagnosed with an Autism Spectrum Disorder (ASD) you may not be able to imitate (i.e. make your own snake) in the same way your TD peers can. Children with ASD consistently fail to immediately imitate the actions of others (American Psychiatric Association, 2000; Williams, Whiten, & Singh, 2004; Rogers, Hepburn, Stackhouse, & Wehner, 2003). For example, Williams, Whiten, and Singh (2004) conducted a systematic review that demonstrated that children with ASD performed worse on imitative tasks compared to their TD peers. Impairment in imitation, such as that seen in children with ASD, can have a negative impact on the development of more sophisticated social skills (Rogers & Pennington, 1991; Rogers, 1999).

Imagine again that you are that child in preschool and your playmate makes a pretend snake and tells you to copy it. Before you can copy your playmate's snake, the recess bell rings and you run outside. As a child with ASD, what is the effect of this delay on your ability to copy the snake? Recently, researchers (Dawson, Meltzoff, Osterling, & Rinaldi, 1999; Hobson & Hobson, 2008; Hobson & Lee, 1999; McDonough, Stahmer, Schreibman, & Thompson, 1997; Rogers, Young, Cook, Giolzetti, & Ozonoff, 2008; Strid, Heimann, Gillberg, Smith, & Tjus, 2012; Strid, Heimann, & Tjus, 2013; Wu, Chiang, & Hou, 2011) have begun to explore this question, with mixed results.

Given the importance of imitation to learning it is imperative to develop a comprehensive understanding of the ability of individuals with ASD to engage in deferred imitation. This information will contribute to theories of imitation's primacy as a deficit in ASD, will help to resolve conflicting research results, and will aid intervention and teaching efforts.

**Statement of the Problem and Overview of the Study**

Imitation, both immediate and deferred, is an important developmental milestone and provides an important foundation for children's learning. The literature provides clear evidence that children with ASD struggle to engage in immediate imitation, including actions on objects, facial expressions, and gestures (Williams et al., 2004). However, information regarding the deferred imitation abilities of children with ASD is less clear; with some researchers demonstrating an ASD-specific deficit (Dawson, et al., 1998;

Rogers et al., 2008; Strid et al., 2012; Strid et al., 2013) and others reporting no difference in number of accurate imitations performed at differing delays between children with ASD and TD children (Hobson & Hobson, 2008; Hobson & Lee, 1999; McDonough et al., 1997; Wu et al., 2011). The purpose of the present study is to further explore deferred imitation in children with ASD in an attempt to clarify this issue. The study was designed to examine the ability of individuals with ASD to engage in spontaneous and prompted imitation after long and short time delays as compared to their TD counterparts. In order to examine this question, the experimenter demonstrated simple actions on novel objects and participants were given the opportunity to spontaneously imitate after 10 minute (m) and 60 m time delays. These sessions were videotaped for later coding by the experimenter and an independent observer; participants' actions were scored as accurate (i.e. they identically copied the action of the experimenter) or inaccurate (i.e. they did not make any action or their action was not the same as that of the experimenter). The data collected was then analyzed quantitatively using analysis of variance (ANVOA) to compare the number of accurate imitative acts performed at the differing time delays by participants with and without ASD. Data was also analyzed using correlation and analysis of covariance (ANCOVA) to explore the role of language.

**Delimitations**

As with any study, there are methodological restrictions that influence the design and, therefore, the outcomes of the investigation. It is crucial that these delimitations are acknowledged in advance and in an explicit manner so that the consumers of the research have a framework in which to understand and interpret the results. For the current study, the following delimitations were imposed by the researcher:

1) The study sample size was small due to difficulty with recruiting participants from a specialized clinical population (i.e. children diagnosed with ASD).
2) Due to limited sample size and, in an attempt to retain as many participants as possible, participants were not excluded from the sample based on extraneous factors (e.g. gender, cognitive abilities, motor abilities, etc.).
3) In an effort to recruit as many participants as possible, the study employed snowball sampling (i.e. participants' parent/guardian recruited others for the study in a non-random manner), rather than random sampling.
4) Any variables, conditions, or populations not so specified in this study were beyond the scope of the investigator.

**Definition of Terms**

Given that many specialized terms will be used in this study, it is important at this point to offer the working definitions of the following terms in order to ensure shared interpretation of the terminology.

1) Autism Spectrum Disorder (ASD): Individuals diagnosed with ASD are characterized by (a) qualitative impairments in social reciprocity; (b) qualitative impairments in communication (pragmatic communication deficits); and (c) restricted and/or repetitive patterns of interest and/or behaviour (American Psychiatric Association, 2000). For the purposes of this study, a child was determined to have ASD if they have received a formal diagnosis from a licensed psychologist or psychiatrist.

2) Typically developing (TD): for the purposes of this study, a child will be considered TD if they have received no formal diagnosis of any kind. Parents will be asked if their child (a) has any formal diagnosis of a disorder that could interfere with participation (e.g. ADHD could interfere with a child's ability to attend to instructions or action demonstrations); (b) is on the waitlist for assessment for the purposes of diagnosis, or (c) has been referred for assessment for the purposes of diagnosis. TD children were not included in the current study if they met any of these criteria.
3) Actions-on-objects imitation: the deliberate mimicking of actions on objects of another person.
4) Immediate actions-on-objects imitation: motor imitation acts in which an individual watches target actions on objects and is given the opportunity to imitate without delay.
5) Deferred actions-on-objects imitation: motor imitation acts in which an individual watches target actions on objects but is not given an opportunity to imitate until a delay period has elapsed. In the current study, an imitative act is considered to represent deferred imitation if it occurs after a period of 10 m or 60 m has elapsed.

**Summary**

Chapter one presented introductory information regarding the need for future research to explore the deferred imitation skills of children with ASD, as well as the purpose and research questions to be addressed by the proposed research. This will advance knowledge of ASD in general and help to facilitate the work of professionals who are endeavouring to improve their quality of life. In addition, important delimitations and pertinent definitions of terms used throughout the thesis were provided.

Following this section, chapter two will provide a review of the literature that examines imitation and ASD. Key findings in research investigating the relation of imitation skills to the deficits associated with ASD are described. In addition, a possible neural mechanism for imitation, the mirror neuron system (MNS), is described. As well, research investigating the ability of children with ASD to engage in deferred imitation will be reviewed. Finally, the relation of this literature review to the proposed study will be discussed.

# Chapter Two

## Literature Review

The following review of the literature will examine imitation behaviour in children with ASD. Key findings in research investigating the relation of immediate imitation skills to the behavioural and social/communication deficits associated with ASD are described. In addition, a possible neural mechanism for immediate imitation, the mirror neuron system (MNS), is described. As well, research investigating the ability of children with ASD to engage in deferred imitation will be reviewed. Finally, the relation of this literature to the proposed study will be discussed. As such, this chapter will be organized under the following sections: Imitation and Social Cognition; Imitation and ASD: Behavioural Evidence; Imitation and ASD: Neurological Evidence; Imitation and ASD: Deferred Imitation; and Need for Further Research.

### Imitation and Social Cognition

Evidence is accumulating that suggests a primary role of motor imitation in social cognition (i.e. the perception of social stimuli, evaluation of those stimuli, and generation of socially appropriate responses; Sollberg, Rankin, & Miller, 2010). Based on their review of the developmental psychology and cognitive neuroscience literatures focused on imitation, Meltzoff and Decety (2003) propose that imitation (a) is innate in humans; (b) precedes mentalizing and higher-order social skills, such as theory of mind (ToM; i.e. the ability to attribute mental states to others; Baron-Cohen, 1989); and (c) provides the mechanism by which ToM and empathy develop. It has been found that neonates 12 to 21 days of age (Meltzoff & Moore, 1977), and even neonates between 42 m and 72 hours (h) of age (Meltzoff & Moore, 1983), can imitate facial movements without confusing either body parts (i.e. lips versus tongue) or actions (i.e. tongue protrusion, lip protrusion, or mouth opening). Rizzolatti and Craighero (2004) add that the MNS allows for action observation that triggers motor representations that allow an individual to reproduce that observed action (i.e. imitate). Because of this, a concept develops that others have mental states (e.g. intentions) that prompt performance of actions. Therefore, through imitation, infants compare their actions to those of others and begin to build representations of others as "like me" (Meltzoff & Decety, 2003).

As infants develop, they not only imitate others but recognize when they are being imitated. In one experiment it was found that infants looked longer at the adult who was imitating them, smiled more at this adult, and directed more testing behaviour towards this adult (i.e. modulated their acts by performing sudden and unexpected movements to check if the adult was really copying them; Meltzoff, 1990). Meltzoff and Decety (2003) conclude that when infants see someone acting "like me" he/she is learning that others have their own ideas, thoughts, and actions. This knowledge provides the basis for higher social-cognitive tasks, such as ToM.

Through the course of development, TD individuals begin imitating at birth and use imitation to develop an increasingly complex social understanding of the world, such as sameness and differences between individuals. In contrast, individuals with ASD often fail to develop proficiency in imitation, which may have negative consequences for their social development (Rogers, 1999; Rogers & Pennington, 1991). The next section describes a model of ASD in which it is proposed that imitation plays a primary role in the social deficits of these individuals.

**Intersubjectivity model of ASD**

In their intersubjectivity model, Rogers and Pennington (1991) propose that early deficits in imitation, emotion sharing, and ToM negatively impact an infant's ability to form and coordinate social representations of self and other at increasingly complex levels. The end result of deficits in these three core areas for infants and children with ASD is an impaired awareness of others' affective states and subjective minds and impaired ability to represent one's own or others' subjective experiences via pretend play, affective communication, and/or language. Therefore, based on this theoretical perspective, symptoms of ASD lie in impaired capacity to form or manipulate representations of self and others leading to impaired body imitation, affect mirroring and sharing, and awareness of others' subjective mental states.

Stone, Ousley, and Littleford (1997) provided evidence of a predictive link between motor imitation skills and play and language skills. Twenty-six participants with ASD who were evaluated prior to 3 years of age and once again 11 months later were included in the study. The Motor Imitation Scale (MIS) was used to measure motor imitation. The MIS includes 16 items, including imitation of actions on objects and body movements (e.g. clap hands, pat cheek). Half of the actions on objects are meaningful actions and half are non-meaningful actions (e.g. shaking a noisemaker is a meaningful action and banging a spoon on a table is a non-meaningful action). Response accuracy for the MIS is scored on a 3-point scale where 2 represents an accurate imitation, 1 represents an emerging imitation (i.e. a participant attempts to imitate a target action but does not finish it correctly), and 0 represents a failed imitation. Therefore, total imitation scores for the MIS range from 0 to 32. In addition, subscales of the MacArthur

Communicative Development Inventory (CDI) were used to assess expressive language skills as well as pretend play skills. The CDI is a parent-report measure; for the purposes of this study, parents were only asked to estimate how many words their son/daughter says (i.e. expressive language), even though there is also a set of questions for assessing receptive language skills. Two subscales of the CDI were used to assess pretend play: the Play Assessment Scale (PAS) and the "Pretending to be a Parent" Scale. The PAS is an observational assessment of play development that consists of 45 developmentally sequenced items that uses a standard set of toys. Participants receive both prompted and spontaneous scores but only spontaneous scores were used in this study. The "Pretending to be a Parent" subscale consists of a list of 13 pretend actions with dolls or stuffed animals (e.g. put to bed or feed with a spoon); participants' parents reported which actions they had seen their son/daughter engage in. Paired t-tests revealed a significant difference in scores from pre- to post-assessment, with higher scores achieved at Time 2 as opposed to Time 1. This demonstrates that motor imitation skills increase as children with ASD develop. Further, Pearson correlations revealed a significant positive association between the number of total imitations, imitations of actions on objects, and imitations of body movements. The total imitation score was significantly correlated with both play measures at Time 1 (the only time these were collected) and with expressive vocabulary at both Time 1 and Time 2. Scores for imitations of actions on objects were correlated with both play measures at Time 1 and scores for imitations of body movements were correlated with expressive vocabulary at Time 1 and Time 2. These results provide evidence for the assertions of the intersubjectivity model (Rogers & Pennington, 1991); in particular, that motor imitation is strongly correlated with more complex social skills. For this reason, it is important to determine the nature of imitation impairments associated with ASD and to determine if there are any contexts in which children with ASD can imitate accurately.

Thus, there is a strong theoretical argument for a model of ASD in which impaired imitation plays a key role. The next section will provide a selected review of the behavioural evidence of a primary imitation deficit in individuals diagnosed with ASD.

**Imitation and ASD: Behavioural Evidence**

There is ample evidence that imitation is impaired in individuals with ASD (Stone et al., 1997; Williams et al., 2004). According to Rogers (1999, pg. 262), "every methodologically rigorous study so far published [has] found an autism-specific deficit in motor imitation."

Perra, Williams, Whiten, Fraser, Benzie, and Perrett (2008) used discriminant function analysis to explore whether imitative deficits are a specific and important feature of ASD. Participants were asked to complete three types of imitation: (a) hand-gesture imitation (i.e. 31 meaningless gestures completed with one or both hands; (b) adverbial imitation (3 pairs of that varied by force or speed; for example, clapping forcefully or clapping gently); and (c) hand-to-ear imitation (i.e. gestures of one or two hands directed at the ears). Results of initial discriminant function analysis revealed two reliable functions. The first function reliably discriminated TD participants from participants with Developmental Delay (DD) and accounted for 88% of the variance. The second function reliably discriminated participants with ASD from the other two groups and accounted for 12% of the variance. Analysis of the second function revealed that the best discriminators of ASD from the other groups were ToM, followed by imitation scores (including hand-gesture, adverbial, and hand-to-ear imitation). The usefulness of these results was confirmed by comparing the results of the discriminant function analysis to actual group membership. This comparison revealed that, for a total of 43 children, 39 were classified correctly (34 if using a jack-knifed procedure) as having ASD, DD, or as TD. This is substantially higher than chance classification. In order to determine whether imitative performance itself had made a significant contribution to correct classification, a second discriminant function analysis was run that excluded imitation scores. ToM was still able to discriminate participants with ASD from the other groups (TD and DD), but when compared to the original function, which had included imitation scores, it was determined that the inclusion of imitative scores provided improved sensitivity and specificity with respect to ASD classification. Finally, in order to check whether imitative tasks afforded a reliable differentiation between the three groups on their own, Perra and colleagues (2008) ran a discriminant analysis using only the imitation batteries (i.e. hand-gesture, adverbial, and hand-to-ear) as predictors. Importantly, this produced two reliable functions; the first accounted for 66% of the variance and discriminated TD from the two clinical groups (DD and ASD) and the second function discriminated children with DD from children with ASD.  For this second function, it was the set of hand-to-ear tasks in which children were required to copy multiple goals that reliably discriminated between these two groups. Results of this study strongly suggest that imitation skills are impaired in children with autism, as compared to peers with DD and TD peers.

In addition, Rogers et al. (2003) sought to examine the nature and specificity of the imitation deficit associated with ASD. Participants included children with ASD, children with DD, as well as TD children. Participants were asked to complete a number of imitation tasks, including manual (e.g. open and close both hands simultaneously), oral-facial (e.g. extend tongue and wiggle sideways), and actions-on-objects (e.g. pull blocks apart and bang together). Results revealed that participants diagnosed with ASD performed poorest on imitation acts as compared to TD participants and children with DD. Follow-up analyses revealed that participants with ASD were impaired on oral-facial and object imitation tasks, as compared to controls (DD and TD) but not on manual imitation. Next, correlations were conducted to determine the relationship between imitation scores (manual, oral-facial, actions-on-objects, total), expressive language scores (as measured by the Developmental Mullen Scales of Early Learning; MSEL), and play skills (as measured by the Modified Fewell Play Scales). For participants with ASD, no type of imitation was related to expressive language or play. Finally, correlations were conducted to determine the relationship between imitation scores (manual, oral-facial, actions-on-objects, total) and overall severity of symptoms, as established by (a) total scores on the Autism Diagnostic Observation Scale- General (ADOS-G); (b) nonverbal developmental age (using the Merrill-Palmer Scale); (c) frequency of initiating joint attention (as measured by the Revised Early Social and Communication Scales; ESCS); (d) number of correct searches reflecting appropriate set-shifting (from the Spatial Reversal Task of the Vineland Scales of Adaptive Behaviour, Interview Edition; Vineland) and (e) overall adaptive age (from the Vineland). Total, oral-facial and actions-on-objects imitation scores were significantly and negatively correlated with ADOS-G scores as well as significantly and positively related to frequency of initiating joint attention. These results support the conclusion that imitation is impaired in children with ASD and may be directly related to symptom severity.

McIntosh, Reichmann-Decker, Winkielman, and Wilbarger (2006) examined automatic and voluntary imitation of facial expressions in individuals with ASD as compared to TD controls. Since TD individuals automatically imitate the facial expressions of others (i.e. they smile when another smiles and scowl when they see a scowl; McIntosh et al., 2006), the authors wanted to determine whether individuals with ASD do the same (i.e. automatically imitate the expressions of others). Further, the authors sought to explore any differences in voluntary imitation between TD individuals and individuals with ASD. In contrast to automatic imitation of facial expressions, voluntary imitation of facial expressions is more slow and effortful; it is under conscious control, rather than being automatic (McIntosh et al., 2006). Perhaps individuals with ASD would engage in voluntary imitation of facial expressions in the same way that TD individuals do, even though there may be differences between groups in production of automatic imitations. Participants with ASD and TD participants were asked to complete two experimental phases: (i) in the automatic phase, participants were simply instructed to watch facial expressions as they appeared on the screen; and (ii) in the voluntary phase, participants were instructed to make the same expression as the one seen on the screen (either happy or angry). Results revealed no significant difference between groups on voluntary imitation. This provides evidence that the participants with ASD were able to produce the target facial expressions. However, participants with ASD were significantly less likely to automatically imitate facial expressions, as compared to controls, even though they showed the same rate of response to the watched facial expressions (i.e. participants with ASD did produce some facial expressions automatically but they didn't necessarily correspond with the facial expression they were viewing).

It has even been found that even when individuals with ASD are able to imitate the actions of others, they are unable to copy higher-order aspects of imitation, namely, the “style” of an imitative act. Hobson and Hobson (2008) compared the performance of TD children to the performance of children with ASD on two types of imitation acts: goal directed imitation versus “style” imitation (i.e. gentle versus forceful actions). It was hypothesized that copying goal-directed actions would not require engagement with another person whereas copying style requires perceiving, responding to, and identifying with the bodily expressive attitudes of others. Results revealed that participants with and without ASD were able to imitate six, simple, goal-directed actions but that participants with ASD performed significantly poorer, as compared to controls, in imitating the style with which the actions were executed, especially when the style was not critical to achieving the goal.

Moreover, in a review of ASD research (from 1988 to 2002), Williams et al. (2004) found evidence that ASD is characterized by a specific deficit in motor imitation. Taken together, the results of 21 well-controlled studies demonstrated that children and youth diagnosed with ASD are particularly weak when imitating non-meaningful gestures (i.e. novel acts, such as pushing a button with one's forehead), as opposed to familiar, meaningful ones (i.e. pantomime acts, such as pretending to use a comb or waving goodbye). Results revealed that an overwhelming majority of studies found that children with ASD are impaired in their ability to imitate. Those few (4 out of 21) that did not find an impairment were either confounded by ceiling effects, included a very small sample that used much younger children as controls, or used participants with ASD who were much older than controls. Comparisons of participants with ASD to controls on non-meaningful gestures (i.e. body movements only) demonstrated the most difference between groups and comparisons using actions-on-objects revealed the smallest differences. Reviewing their evidence, Whiten and colleagues (2004) conclude that their meta-analysis provides support for the intersubjectivity model, as put forth by Rogers & Pennington (1991).

In sum, current research suggests that individuals with ASD display significant impairments on a variety of different indices of imitation: manual gestures, actions on objects, meaningless gestures, imitating style, and automatic imitation of facial expressions. In addition, neurological research has uncovered a possible neural mechanism, the mirror neuron system (MNS), which underlies automatic imitation ability.  Research suggests that this mechanism may be impaired in individuals diagnosed with ASD, providing a neural explanation for difficulties with imitation in this population. The next section will describe the MNS in TD individuals and individuals with ASD as well as the anticipated behavioural effects of dysfunction within the MNS.

## Imitation and ASD: Neurological Evidence

**MNS discovery.** Gallese, Fadiga, Fogassi, and Rizzolatti (1996) revolutionized the ways in which scientists conceptualized the learning process when they discovered that neurons in the F5 area of macaque monkeys' premotor cortex responded both when the monkeys performed a goal-directed action and when the monkeys observed an experimenter performing an action. These and other researchers have proposed that these so-called “mirror neurons” are the basis of imitative learning (Gallese et al., 1996; Rizzolatti, Fadiga, Fogassi, & Gallese, 1999).

**MNS in Humans.** Brain imaging studies suggest that the human brain has a MNS that is comprised of a complex network formed by occipital, temporal, and parietal visual areas and two other cortical regions whose functions are motor in nature (Buccino et al., 2001; Iacoboni et al., 1999; see Figure 1 below).

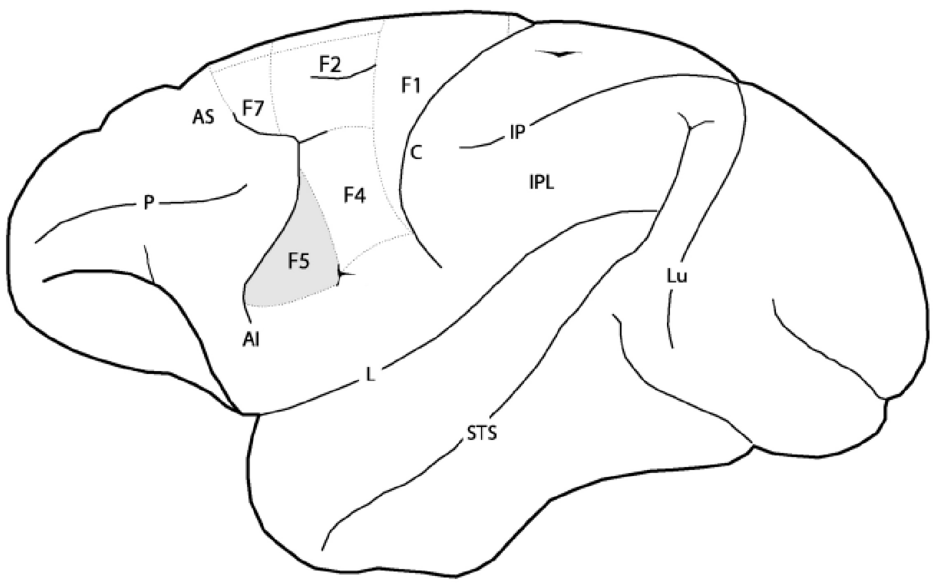


*Figure 1.* Lateral view of the monkey brain showing the parts of the motor cortex. Mirror neurons are located in area F5 and in the inferior parietal lobule (IPL). Abbreviations refer to: inferior arcuate sulcus (AI); superior arcuate sulcus (AS); central sulcus (C); lateral fissure (L); lunate sulcus (Lu); principal sulcus (P); superior temporal sulcus (STS). From Rizzolatti, G., & Luppino, G. (2001). The cortical motor system. *Neuron, 31*, 889-901.

Using *f*MRI scans, Buccino et al. (2001) found clear evidence of the MNS in humans. As they were scanned, participants viewed video clips showing actions performed with different body parts that were both object-oriented and non-object-oriented. Also, action observation was contrasted with observation of static body parts. The authors found clear activation of the MNS during observation of object-oriented actions but not during observation of non-object-oriented actions. As well, it was clear from the results of this study that different areas of the MNS were activated by the use of different body parts.

In addition to the findings of Buccino et al. (2001) that utilized *f*MRI imaging, Gangitano, Mottaghy, and Pascual-Leone (2001) used transcranial magnetic stimulation (TMS) to determine the existence of the MNS in the human brain. TMS involves the application of magnetic stimuli to the motor cortex to induce activity (i.e. a motor-evoked potential; MEP) of the muscle that it innervates. Thus, TMS can be used to determine the effect of watching an action on the size of an MEP. In this study, participants viewed a hand reaching for and grasping a ball on a computer screen, and received a single TMS at different points during the action observation. The results of the study indicated that, while watching the hand reach for and grasp the ball, TMS provoked greater MEPs than when TMS was delivered while participants saw a blank screen.

In sum, it can be seen from the evidence cited in studies such as those carried out by Buccino et al. (2001) and Gangitano et al. (2001) that an intricate MNS system is activated in humans through the observation of actions performed by models.

**MNS and imitation.** To examine how the MNS could be involved in the perception and production of actions, Iacoboni et al. (1999) used *f*MRI imaging to examine brain activity during an imitation task versus one of two instruction tasks. Participants were shown an animated hand in three conditions: (a) the animated hand's index or middle finger moved and participants were asked to imitate the movement; (b) participants saw the same animated hand but this time they were instructed to move the finger that corresponded with a finger presented with a cross on it; and (c) participants were presented with a grey square and were instructed to raise their index finger if a cross appeared on the left side of the square and their middle finger if the cross appeared on the right side of the square. Results revealed that the imitation task produced greater activity levels within the MNS than either instruction condition. Furthermore, the authors established that the MNS worked to describe the motor goal of an observed action and to code the different aspects of that observed movement. These results demonstrate that an important role of the MNS is to stimulate imitative learning.

In order to determine the role the MNS plays in imitative learning of new skills, Buccino et al. (2004) introduced musically naive participants to guitar chords while in an *f*MRI machine. Participants' MNS activity levels were recorded during four phases: (a) observation of guitar chords played by a guitarist; (b) a pause following observation; (c) execution of the guitar chords by the participants; and (d) rest. These were compared to MNS activity levels of participants in three control conditions: (a) an observation only condition; (b) an execution condition in which participants were instructed to produce a guitar chord of their choice; and (c) a condition in which participants performed non-imitative actions following observation of a guitarist playing chords.

It was found that, for participants who imitated the guitar chords, a brain circuit including the MNS was responsible for imitation and that this system became active during observation and continued through the pause following observation. In addition, MNS activation was significantly stronger than activation in the brains of participants in the other conditions, supporting the conclusion that the MNS plays an important role in imitative learning. Buccino et al. (2004) concluded that imitation relies on the MNS and that the system acquires visual information, processed in higher order visual areas, and recombines the motor elements to create a motor pattern in the observer.

The results of the studies discussed here provide evidence of a neurological basis for imitation. The next section will build on this basis and demonstrate differences in MNS function for individuals with ASD. These studies provide neural evidence of a specific imitation deficit in this population.

**MNS and ASD.** The human brain seems to contain a mechanism for automatic imitation of novel motor acts. However, individuals diagnosed with ASD have difficulty imitating the actions of others. Current research is suggesting that these difficulties may be resulting from dysfunction of the MNS (Dapretto et al., 2006; Oberman et al., 2005; Williams, Whiten, Suddendorf, & Perrett, 2001).

Williams and colleagues (2001) were among the first to suggest that lack of imitation in ASD could be the result of dysfunction within the MNS. They conducted a review of the relevant literature and found preliminary evidence to support this hypothesis.

Additionally, Oberman et al. (2005) found abnormal activation of the MNS in children with ASD as compared to TD children. In this experiment, brain waves were recorded as each participant observed an action in one condition and performed an action in the second condition. As expected, TD children showed activation of the MNS during both conditions but children diagnosed with ASD only showed activation during actual performance of an action.

Further, Dapretto et al. (2006) asked TD children and children diagnosed with ASD to both observe and imitate different facial expressions. Similar to the findings of

Oberman et al. (2005), children diagnosed with ASD showed atypical MNS activation during facial imitation activities. Though TD children showed increased rates of activation, as compared to resting rates, for both observation and performance of different facial expressions, children diagnosed with ASD only showed increased rates of activation when an action was actually performed and not when an action was simply observed (Dapretto et al., 2006).

In sum, research suggests that, in TD individuals, the MNS allows for automatic imitation of a variety of behaviours. In contrast, in individuals diagnosed with ASD, research suggests that this MNS functions differently, such that these individuals cannot engage in automatic imitation. Thus there is behavioural and neurological evidence that individuals with ASD show impairments in the ability to automatically and voluntarily immediately imitate the actions of others.

## Deferred Imitation in Typically Developing Children

**Meltzoff's design.** The ability to imitate after a delay (i.e. deferred imitation) can provide an important social learning opportunity. Individuals often do not have the ability to imitate a novel action immediately, so for imitation to fulfill its role in social learning, they must be able to copy an action after a delay (Meltzoff, 1988a, 1988b). Using a methodologically rigorous design, Meltzoff (1988a, 1988b) demonstrated that TD infants as young as 9 months old can accurately imitate simple actions on objects at delays of 24 h or one week. The design of these studies involved 4 phases: baseline, observation, delay, and imitation. In the baseline phase, participants manipulated stimuli without having observed the experimenter. This ensured that any target actions produced in the baseline phase were spontaneous and that target actions produced in the imitation phase were actually imitative, rather than spontaneous. Following this, participants observed the experimenter as he produced target actions on novel objects but were not given the chance to manipulate the stimuli themselves. In this phase, if a participant had spontaneously produced the target action during baseline, a different but equally simple action was substituted. In the delay phase, participants completed activities unrelated to the target actions. Finally, after the delay, participants were given the opportunity to imitate the target actions. Using this design, it was revealed that that 9-month-old infants were accurate in imitating after a 24 h delay (Meltzoff, 1988b) and 14-month-old infants were able to accurately imitate target actions after a delay of one week (Meltzoff, 1988a).

**Replications and extensions.** Meltzoff's (1988a, 1988b) rigorous methodology has been replicated and extended to provide evidence that even very young TD children can engage in accurate deferred imitation. For example, using this design, Barr, Dowden, & Hayne (1996) tested the deferred imitation abilities of infants aged 6-, 12-, 18-, and 24-months old. Results revealed that all age groups produced accurate imitations of target actions and that the 18- and 24-month-olds produced significantly more imitations than 6-month-olds, with 12-month-olds scoring between these two groups.

Similarly, Nielsen & Dissanayake (2003) revealed that 12-24-month old infants engage in accurate deferred imitation after an 8 m delay and that accuracy increases with age, with 12-month-olds producing fewer accurate imitations than 15-month-olds. However, it appears that a plateau in imitation skill is reached as the number of accurate imitations produced by 15-, 18-, and 24-month-olds was equal.

Learmonth, Lamberth, and Rovee-Collier (2005) replicated these studies and showed that 6-, 9-, 12-, 15-, and 18-month-olds were capable of accurate deferred imitation following a 24 h delay and that social context is an important factor in this skill. In this study, participants watched one experimenter produce target actions on an object in the observation phase but a different experimenter provided the object in the imitation phase. For some of the participants, the second experimenter was in the room during the observation phase and the first experimenter was in the room during the imitation phase. For other participants, the second experimenter was absent from the room during the observation phase and the first experimenter was absent from the room during the imitation phase (providing a novel social context for this phase). Results revealed that participants in all age groups engaged in accurate deferred imitation when in a familiar social context but not in the novel social context. However, infants (excluding 6-month-olds) could engage in deferred imitation in a novel situation if they were given the opportunity to practice (i.e. immediately imitate) during the observation phase.

The results of these studies reveal that Meltzoff's (1988a, 1988b) rigorous methodology has been effectively utilized in a variety of studies when documenting the f the presence or absence of deferred imitation, even in young infants. Further, the research demonstrates that TD can produce accurate deferred imitations, even at a young age.

**Deferred Imitation and Children with ASD**

Given the importance of deferred imitation, and overwhelming evidence of difficulties with immediate imitation in children with ASD, this is becoming an increasingly popular area of study within the ASD research literature. However, emerging research on deferred imitation skills in individuals with ASD have provided mixed results; while some studies reveal that children with ASD produce fewer accurate deferred imitations than TD children (Dawson et al., 1999; Rogers et al., 2008; Strid, Heimann, Gillberg, Smith, & Tjus, 2012; Strid, Heimann, & Tjus, 2013), others find no differences in performance between children with ASD and controls (Hobson & Hobson, 2008; Hobson & Lee, 1999; McDonough et al., 1998; Wu, Chiang, & Hou, 2011). An examination of this literature reveals that, while all studies used the Meltzoff (1988a, 1988b) paradigm (i.e. baseline, observation, delay, imitation), there was one major methodological difference that might explain these contradictory findings: whether or not participants' imitation was prompted or spontaneous.

**Spontaneous (unprompted) deferred imitation and ASD.** Dawson and colleagues (1998) used the Meltzoff design (1988a, 1988b) to demonstrate a deferred imitation deficit in children with ASD with a mean age of 64.6 months. The performance of participants with ASD was compared to that of language-matched TD participants (mean age 30.9 months) and language- and age-matched participants with Down Syndrome (mean age 65.3 months). Receptive language mental age was estimated using the Preschool Language Scale- 3 (PLS-3). Participants with ASD scored significantly higher than both TD participants and participants with Down Syndrome on measures of nonverbal ability and this was entered into analyses as a covariate to account for its influence. Target actions were novel actions on objects. Participants were given no verbal cues or prompts during the imitation phase. Participants with ASD performed significantly fewer accurate target actions during the response period than TD participants and participants with Down syndrome.

Rogers and colleagues (2008) also examined deferred imitation in children with early onset (EO) ASD (i.e. symptoms since birth; mean age 35.80 months) and regressive-onset (RO) ASD (i.e. early development typical, followed by loss of language and social skills; mean age 45.98 months) as compared to children with developmental delay (DD; mean age 43.15 months; participants included 10 with language delay, 3 with Down Syndrome, 2 with sensory integration disorder, and 1 with an unknown genetic disorder) and TD children (mean age 23.23). TD participants were significantly younger than all other participant groups. Participants with DD and participants with RO ASD were equivalent in age. Participants with EO ASD were in the middle; they were significantly younger than those with RO ASD and those with DD but older than the TD participants. Verbal Mental Age (MA), nonverbal MA, and overall MA was estimated for each participant. Verbal MA was calculated by averaging scores on the Receptive and Expressive Language subtests of the Developmental Mullen Scales of Early Learning (MSEL). Nonverbal MA was calculated by averaging scores on the Fine Motor and Visual Reception subtests. Overall MA was calculated by averaging the total scores on these four subtests (i.e. Receptive Language, Expressive Language, Fine Motor, and Visual Reception). There was no significant difference in Verbal MA for participants with EO and RO ASD and no significant difference in Verbal MA for participants with DD and TD participants; however, both participants with DD and TD participants had significantly higher MA than children with either type of ASD. Similarly, there was no significant difference in Nonverbal MA between the two groups of participants with ASD (EO and RO). There was no significant difference in Nonverbal MA between participants with ASD (EO and RO) and TD participants. Participants with EO ASD scored significantly lower Nonverbal MA scores than participants with DD but there was no significant different in Nonverbal MA between participants with RO ASD and participants with DD.

Participants were given the opportunity to imitate some items immediately and to imitate other items after a 60 m delay, rather than 10 m (as in Dawson et al., 1998) and target actions were novel actions on objects. Participants were given no verbal cues or prompts during the imitation phase. Results revealed a significant main effect of group, with participants with ASD (EO and RO) performing fewer accurate imitations of simple actions on objects as compared to participants with DD and TD participants. Results also demonstrated a significant main effect of imitation type (immediate vs deferred) such that all participants performed a higher number of accurate immediate than deferred imitations. Since there was a significant difference between groups on Verbal MA, this was entered into a second analysis as a covariate. Results of the analysis removing the effects of language, revealed no group differences in deferred imitation; in other words, participants with ASD performed the same number of accurate deferred imitations as participants with DD and TD participants. There was still a main effect of imitation type such that all participants performed a higher number of accurate immediate than deferred imitations. Both Rogers and colleagues (2008) and Dawson and colleagues (1998) controlled for language abilities in their studies; Rogers and colleagues used statistical means and Dawson and colleagues matched their groups using language skills. Despite this, and the use of the same paradigm (Meltzoff 1988a, 1988b), there results are contradictory. One possible explanation for this is that Dawson and colleagues used a shorter time delay than Rogers and colleagues (10 m vs 60 m); perhaps the relationship between language and deferred imitation ability changes at long and short time delays?

Strid and colleagues (2012) also examined spontaneous deferred imitation using the Meltzoff (1988a, 1988b) paradigm. Participants included those with ASD (mean age

66.8 months) and those who were TD (mean age 34.7 months). Participants with ASD were further divided into those who were nonspeaking (i.e. a participant did not use spoken language during any observations, including free play with the parent, and if a parent indicated that this was typical behaviour for the child; mean age 70.8 months) or speaking (mean age 59.4 months). Participants with ASD and TD participants were matched on vocabulary age and overall mental age. To determine vocabulary age, the Peabody Picture Vocabulary Test- 3rd Edition (PPVT-3) was predominantly used. Seven participants with ASD and 11 TD participants were assessed with this measure. Some participants with ASD were unable or refused to complete the PPVT-3, and for these children, vocabulary age was measured with the Macarthur Communicative Development Inventories- Swedish Version (SECDI), a parent report measure. For 3 participants with ASD and 1 TD participant, the Kaufmann Expressive Vocabulary Subscale was used to determine vocabulary age. The General Cognitive Index of the MacArthy Scales of Children's Abilities was used to estimate mental age. Strid and colleagues (2012) used Meltzoff's (1988a, 1988b) paradigm and a similar procedure to Dawson and colleagues (1998) and Rogers and colleagues (2008), with the exception that participants were given the opportunity to spontaneously imitate after a delay of 2 days (d). One other difference was that participants observed target actions that were either unconventional (i.e. it would be easier to accomplish the goal using a conventional method; e.g. using an elbow (rather than a hand) to push one side of a hinge so that it lay flat, using a pen (rather than a finger) to press a button) or conventional (e.g. shaking an egg, pressing a cup so that it collapsed, putting a string of beads in a cup). Results were analysed using separate Mann-Whitney *U* tests. Overall, participants with ASD performed significantly fewer target actions at the delay than did their TD counterparts, replicating the results of Dawson and colleagues (1998). In addition, participants with ASD who were nonspeaking produced significantly fewer accurate imitations than did participants with ASD who were speaking. Analyses of imitations produced for conventional tasks revealed significant differences such that TD participants produced a higher number of accurate imitations than participants with ASD. However, analyses of imitations produced for unconventional tasks revealed no significant differences between participants with ASD and TD participants. No statistical comparisons were made between the two groups of participants with ASD (nonspeaking vs speaking). This suggests that language ability is important in the ability to imitate after a delay and that task demands may also play a role.

One year later, Strid and colleagues (2013) further expanded their deferred imitation research to examine deferred imitation ability and its relation to pretend play and parent-interaction style. The authors used the Meltzoff (1988a, 1988b) paradigm to measure deferred imitation. In addition, each participant engaged free play with one parent with a standard set of toys. Observers coded the number of instances of pretend play that occurred and the duration of any pretend play that occurred within an 8 m time frame. During this same free play period, parents’ comments were coded as unsynchronized (i.e. concerning toys outside the participant's focus of attention) or synchronized (i.e. concerning toys within the participant's focus of attention). For example, the comment, "that doll has a nice dress" would be coded as synchronized if the child was holding or looking at the doll but it would be coded as unsynchronized if the child was not attending to the doll.  Participants with ASD (mean age 66.8 months) were compared to language-matched TD controls (mean age 34.7 months). The same materials and procedure for estimating language age were used as in Strid and colleagues (2012). Participants were given the opportunity to imitate after a delay of 2 or 3 days (M = 51.09 h). Target actions were novel actions on objects and participants were given no verbal cues or prompts during the imitation phase. Consistent with previous research (Dawson et al., 1998; Strid et al., 2012), participants with ASD were significantly less likely to produce accurate imitations after 2 or 3 days, as compared to language-matched controls. In addition, parents' use of unsynchronized comments was significantly negatively correlated with number of accurate imitations produced. However, the opposite result was found for TD children; in this case, there was a significant and positive correlation between parents' use of unsynchronized comments during free play and number of deferred imitations. For participants with ASD, as the number of unsynchronized comments used by parents decreased, the number of deferred imitations produced by participants with ASD increased but, for TD participants, as the number of unsynchronized comments increased, so did the number of accurate deferred imitations performed. These results suggest a social component to the occurrence of deferred imitation. Results also indicate that language ability is a contributing factor to deferred imitation ability but not the only contributor.

Results of the studies (Dawson et al., 1998; Rogers et al., 2008; Strid et al., 2012; Strid et al., 2013) described here suggests an impairment in spontaneous deferred imitation abilities for children with ASD (see Table 1 for an overview). Further, results suggest a relationship between spontaneous deferred imitation abilities and language skills (Rogers et al., 2008; Strid et al., 2012) as well as a relationship between deferred imitation abilities and social context (Strid et al., 2013). Next, research related to prompted deferred imitation and children with ASD will be outlined.

Table 1

*Similarities and differences of deferred imitation studies*

| Researchers | Control Groups | Matching Measures | CA[6] (months) | Number of Tasks | Imitation Type (S[7]/P[8]) | Results[9] |
|---|---|---|---|---|---|---|
| Dawson et al. (1998) | ASD[1]: 20<br>DS[2]: 19<br>TD[4]: 20 | Vineland Communication Subscale; Preschool Language Scale; Nonverbal MA[5] | ASD: 64.6<br>DS: 65.3<br>TD: 30.9 | 5 | S | TD, DS > ASD |
| Rogers et al. (2008) | ASD: 36<br>DD: 21<br>TD: 20 | Verbal MA; Nonverbal MA; Overall MA | ASD: 35.8/45.98<br>DD: 43.15<br>TD: 23.23 | 6 | S | TD, DD > ASD |
| Strid et al. (2012) | ASD: 20<br>TD: 22 | Vocabulary Age; Overall MA | ASD: 66.80<br>TD: 34.70 | 5 | S | TD > ASD |
| Strid et al. (2013) | ASD: 20<br>TD: 23 | Language Age; Overall MA | ASD: 66.80<br>TD: 34.70 | 5 | S | TD > ASD |
| McDonough et al. (1997) | ASD: 6<br>TD: 12 | Verbal Skills; Nonverbal Skills | ASD: 55 Months<br>TD Verbal: 27<br>TD Nonverbal: 37 | 8 | P | TD = ASD |
| Hobson & Lee (1999) | ASD: 16<br>TD: 16 | Verbal MA | ASD: 171<br>TD: 174 | 4 | P | TD = ASD |
| Hobson & Hobson (2008) | ASD: 16<br>TD: 16 | Verbal MA | ASD: 137<br>TD: 130 | 3 | P | ASD = 84%;<br>TD = 94% |
| Wu et al. (2011) | ASD: 18<br>DD: 18<br>TD: 19 | Nonverbal MA; Fine Motor skills; Verbal MA; Overall MA | ASD: 40.44<br>DD: 38.33<br>TD: 23.26 | 3 | P | TD = ASD |

[1]ASD = Autism Spectrum Disorder; [2]DS = Down's Syndrome; [3]DD = Developmental Delay; [4]TD = Typically Developing;[5]MA= Mental Age; [6]CA = Chronological Age; [7]S = Spontaneous imitation; [8]P= Prompted imitation; [9]Results are summarized using the symbols > (i.e. produced more accurate imitations) and = (i.e. produced an equivalent number of accurate imitations)

**Prompted deferred imitation and ASD.** Several studies have examined deferred imitation using the same general paradigm as those referenced above, except with the addition of a verbal prompt in the imitation phase, rather than requiring spontaneous imitation.

McDonough and colleagues (1997) examined the performance of children with ASD (mean age 55 months) on deferred imitation tasks, using a verbal prompt. Controls included two groups of TD participants, one matched with participants with ASD on verbal ability (mean age 27 months) and the second matched to participants with ASD on nonverbal abilities (mean age 37 months). Participants were verbally directed to imitate familiar (e.g. pick up the phone and say "hello") or novel (e.g. pull apart an L-shaped object and say "wow") simple actions on objects, with appropriate vocalizations, that were defined as either realistic (i.e. explicitly associated with familiar actions; e.g. a plastic telephone), as schematic (i.e. abstract versions of meaningful objects, such as a telephone; e.g. two plastic pipes that could be joined together to form an L-shape and represented a telephone), or as a placeholder (i.e. had no relationship to real objects; e.g. a square wooden block used in place of a telephone). Participants were prompted to engage in deferred imitation after a 1 week delay. In the imitation phase of this study, as each item was presented to a participant, the experimenter prompted them with the phrase, "your turn!" Unlike research on spontaneous deferred imitation (Dawson et al., 1998; Rogers et al., 2008; Strid et al., 2012; Strid et al., 2013), McDonough and colleagues found no group differences in number of accurate deferred imitations produced for any action or object type.

Hobson and Lee (1999) also used a verbal prompt in their study of deferred imitation and ASD. In this study, participants with ASD (mean age 171 months; 14 years, 3 months) were compared to TD participants (mean age 174 months; 14 years, 6 months), matched on Verbal MA (see Table 1). Target actions were goal-directed and were performed on novel objects. For example, participants were given the opportunity to use a pipe-rack (e.g. a specially constructed piece of wood with two ledges, one straight and one with slots, that were placed at right angles to the piece of wood; i.e. a novel object) and the target action was to hold it against the left arm (similar to the way in which one would hold a violin), and, using the right hand, strum the pipe-rack three times with a stick to make a staccato sound (i.e. a goal-directed action). In the imitation phase that occurred 10 m after the observation phase, when participants were presented with the opportunity to imitate, the experimenter prompted with, "use this." If a participant did not copy the target action, the experimenter further prompted, "can you remember exactly how I used it?" After this prompt, participants had the opportunity to interact with the object once more. For each of four objects, an overwhelming majority (either all or all but one participant) of participants with ASD performed the correct action, similar to controls.

Hobson and Hobson (2008) conducted a similar investigation of the ability of children with ASD to engage in prompted deferred imitation. Participants with ASD (mean age 137 months; 11 years, 5 months) were matched with TD participants (mean age 130 months; 10 years, 10 months) using Verbal MA (see Table 1). Participants were presented with three novel objects and were directed to copy one novel, goal-directed action per object after a 5 m time delay. For example, when presented with a specially constructed musical alien doll, participants were expected to squeeze both of the alien's hands simultaneously to produce a song. For each of the three objects, there was a hidden "goal" (e.g. producing a song) that could only be discerned by observation of another performing a certain action (e.g. squeezing two hands simultaneously). When presented with the objects in the imitation phase, participants were instructed to "use this." Statistical analyses of the deferred imitation scores were not conducted, but a visual analysis of the data revealed that participants with ASD performed at least somewhat accurate imitations (rather than coding actions as correct or incorrect, as in other deferred imitation studies, participants were given credit for approximations) 84% of the time. In contrast, participants without ASD performed at least somewhat accurate imitations 94% of the time.

Finally, Wu and colleagues (2011) also used a prompt in their version of the Meltzoff (1988a, 1988b) deferred imitation paradigm. In this study, participants with ASD (mean age 40.44 months) were compared to participants with DD (mean age 38.33 months) and TD (mean age 23.26 months) participants. There was no significant difference in age between participants with ASD and those with DD but TD participants were significantly younger than the two clinical groups. Participants with ASD were matched to participants with DD in terms of Nonverbal MA and fine motor skills, but TD participants scored significantly higher than both of these groups on both measures. Participants with ASD scored similarly to the DD and TD groups on measures of Verbal MA and overall MA (see Table 1). Participants were directed to imitate novel actions on novel objects after a delay of 10 m. When participants were presented with objects in the imitation phase, the experimenter prompted with "your turn." Further, if participants did not produce an action in this first trial, the trial was repeated and could be repeated up to three times before the experimenter went on to the next object. Initial analyses revealed no significant differences between the groups in number of accurate deferred imitation tasks used. When fine motor skills and Nonverbal MA were entered as covariates, participants with ASD and with DD were found to perform a smaller number of accurate imitations when compared with TD participants.

In contrast to deferred imitation studies that do not incorporate a verbal prompt, a large number of studies that do use a prompt fail to find a difference in the number of accurate imitations produced by participants with ASD and control groups (TD and DD), even at different time delays. More research is needed to determine the source of these differences.

**Need for Further Research**

Even though deferred imitation is thought to be a crucial foundation for social skill development (Meltzoff, 1988a, 1988b), it has not received as much attention in the ASD literature as immediate imitation. Further, the results of the studies conducted to date provide a mixed picture of the deferred imitation abilities of children with ASD. While all the deferred imitation studies that have been conducted have used the same general paradigm (Meltzoff, 1988a, 1988b), there are some specific differences in study design that may explain the discrepant results. One major difference is whether a study incorporated a verbal prompt or required participants to respond spontaneously. For example, studies in which imitation was spontaneously elicited (e.g. Dawson et al., 1998; Rogers et al., 2008; Strid et al., 2012; Strid et al., 2013) found that participants with ASD had a deferred imitation deficit. On the other hand, in many studies in which participants were prompted to imitate (Hobson & Lee, 1999; McDonough et al., 1997; Wu et al., 2011), no significant difference was found between participants with ASD and controls.

It is also interesting to consider the relationship between verbal skills and deferred imitation. In some studies, even though participants were matched on measures of verbal ability, a significant difference between groups was found (e.g. Dawson et al., 1998; Strid et al., 2012; Strid et al., 2013) such that participants with ASD performed fewer accurate, spontaneous deferred imitations at differing delays. In contrast, Rogers and colleagues (2008), who required spontaneous imitation and who did not originally match participants based on verbal skills, found that when differences in verbal abilities were controlled for statistically, there were no differences between participants with ASD and controls. Hobson & Hobson (2008) matched their participants on verbal skills and found that 84% of participants with ASD performed accurate, prompted imitations of target actions on objects at a delay of 5 m, whereas TD controls performed at 94% accuracy. These mixed results are interesting and worthy of further study regarding the interaction of language ability and prompted/spontaneous deferred imitation. In fact, Toth, Munson, Meltzoff, and Dawson (2006) found that deferred imitation ability was one important predictor of later language acquisition for children with ASD, further highlighting the importance of exploring the relation between language ability and deferred imitation in ASD.

**The Current Study**

The current research sought to replicate previous research by including both a 10 m and a 60 m time delay in a spontaneous/prompted deferred imitation paradigm. The current study also sought to replicate previous research by including a measure of verbal skills, to explore the link between deferred imitation and language. In order to recruit as many participants as possible within the clinical groups of individuals with ASD, participants were not excluded based on their level of verbal skills. The current study will extend previous research by including a verbal prompt (as in Hobson & Lee, 1999) if participants do not spontaneously imitate.

It is hoped that the results of the current investigation will shed light on the ability of children with ASD to imitate after various delay intervals with and without prompting. Also, the results will expand research on deferred imitation abilities in individuals with ASD and may help resolve some conflicting findings in this area. Finally, the current research could help to facilitate the intervention efforts of professionals.

**Purpose and research questions.** The purpose of this study is to contribute to the existing body of knowledge in the area of imitation and ASD by (a) examining the ability of children with ASD to engage in deferred imitation, as compared to TD controls; (b) determining the impact of differing time delays (10 m versus 60 m) on the ability of children with ASD and TD children to imitate simple actions on objects; and (c) examining the role of a verbal prompt on the ability of children with ASD to engage in deferred imitation, as compared to TD controls. As such, the following research questions and hypotheses were proposed:

1. Do children with ASD demonstrate fewer accurate spontaneous object oriented imitations as TD children, and is this the case both over short and longer time delays?
2. Do children with ASD take longer to display object oriented imitations than TD children, and is this the case both over short and longer time delays?

3. Does the addition of verbal prompting lead to increased object oriented imitations in children with ASD over both short and longer time delays?
4. How does language (as measured through a screening task of verbal reasoning ability) factor in to the above questions?

Spontaneous deferred imitation has been shown to be a challenge for children with ASD (Dawson et al., 1998; Rogers et al., 2008; Strid et al., 2012; Strid et al., 2013); thus, it was hypothesized that participants with ASD would demonstrate fewer accurate spontaneous object oriented imitations than TD participants at both short and longer time delays. In the same respect, it was hypothesized that participants with ASD would take longer than TD participants to display object oriented imitation both at shorter and longer time delays; in other words, response time (RT) would be slower for participants with ASD at both time delays than for TD participants.

Although spontaneous deferred imitation is challenging for children with ASD, research has found that, when imitation is prompted, there is little difference in the number of accurate target actions copied, as compared to control groups (Hobson & Lee, 1999; McDonough et al., 1997; Wu et al., 2011). The current study sought to address this discrepancy in the literature by adding a verbal prompt to the spontaneous imitation paradigm. Participants were given the opportunity to spontaneously imitate object-oriented actions but, if they failed to do so, were given a verbal prompt and another opportunity to imitate. This addition to the typical spontaneous imitation paradigm was intended to determine whether participants with ASD fail to accurately imitate at differing time delays because of an impairment in their ability to copy object oriented gestures or because of an extraneous variable. TD children imitate automatically

(Meltzoff & Moore, 1977; Meltzoff, 1988a, 1988b; Rizzolatti & Destro, 2007) and easily understand the intentions of others (Cattaneo et al., 2007; Rizzolatti & Destro, 2007) and so are likely to imitate without being instructed to. On the other hand, children with ASD, who do not seem to imitate automatically (Williams et al., 2004), may not deduce that this is expected of them. Perhaps the prompt serves to notify children with ASD that they are expected to imitate. Therefore, it was hypothesized that (a) participants with ASD would need a greater number of prompts than TD participants at both short and longer time delays; and (b) when given a verbal prompt, participants with ASD would be as accurate in imitating object oriented actions as TD participants, at both short and longer time delays.

Finally, the role of language in deferred imitation and ASD was explored. It was hypothesized that RV scores would be significantly correlated with number of accurate object oriented imitations demonstrated by participants at both short and longer time delays. It was also hypothesized that RV scores would be significantly correlated with response time (RT) for participants with ASD and TD participants.

**Summary**

Chapter two has provided an examination of the selected literature on imitation and ASD. It has been found that imitation is vital to social development and that many types of imitation are impaired in individuals diagnosed with ASD, possibly due to dysfunction of the MNS. Rogers and Pennington (1991) maintain that this imitation deficit is primary and, along with primary deficits in emotion sharing and ToM, this deficit prevents the development of more complex social skills. There have been few studies examining deferred imitation in individuals with ASD and these have provided mixed results. It is hoped that with continued research, we will extend our understanding of the ability of individuals with ASD to engage in deferred imitation as this is an important index of social skills.

Chapter three will discuss the methodology to be employed in the current study. Participant recruitment procedures, ethical safeguards, materials used, and the procedure for the study will be outlined. In addition, the procedure for determining interrater reliability when coding data will be outlined and results will be presented.

# Chapter Three

# Methods

Chapter three outlines the methodology chosen for this study which explores the research questions: (a) how does the deferred imitation of children with ASD compare to the deferred imitation of TD children; (b) what is the effect of verbal imitation prompts on the deferred imitation abilities of children with ASD who do not spontaneously imitate a target action after a delay? This chapter will provide a description of the research paradigm employed in this investigation to answer these questions and the rationale for its use. Information regarding the research design, procedures, participants, instrumentation, data collection, and data analysis will also be presented.

## Research Design

A quantitative quasi-experimental design was used to examine the deferred imitation abilities of children with and without ASD. Data assessing participants' deferred imitation skills included observations that were coded by two raters; the researcher and an independent observer, a trained graduate student in the department of Educational Psychology. Additional data included results from the Receptive Vocabulary (RV) subtest of the Wechsler Preschool and Primary Scales of Intelligence- 3rd Edition (WPPSI-III; Wechsler, 2002), serving to give an indication of participants’ verbal skills.

## Ethical Approvals and Consent

Ethical approval from the University of Victoria as well as permission from the Central Okanagan Child Development Center, Victoria autism groups, daycares, preschools, and doctor’s offices was received before any advertisement of the study was placed in an office or sent to potential participants. They were also informed of the associated research including (a) purpose of research, (b) data to be collected, and (c) confidentiality and anonymity related to the reporting of research. Participation was voluntary and withdrawal from the study at any time was permitted without penalty (no participants withdrew consent). Full informed consent procedures were utilized and parents of participating children were given information regarding any benefits or risks of participation, videotaping, and data storage procedures. All parents/ guardians of participants gave full informed consent to (a) have their child participate in research as well as (b) have video recordings taken of the experimental sessions for later scoring (see Appendix A for consent form). Participants and guardians were informed that their participation could not be entirely anonymous as an independent rater would have to view videotapes of each experimental session in order to score performance on the imitation tasks. However, during analysis a number was assigned to each case and individual results were not reported, only aggregate results. All video records and test protocols were contained in a locked cabinet and will be destroyed after five years.

**Participants: Sampling Strategy**

**Participants with ASD.** A sample of young children with ASD between the ages of 2.5 and 7 years was recruited in two locations: Victoria and Kelowna, British Columbia. Those in Kelowna were recruited through an Early Intensive Behaviour Intervention (EIBI) program in the Central Okanagan Child Development Association (COCDA). Parents/guardians of children with ASD were recruited by a letter sent via email from a staff member at the COCDA. Those parents/guardians who indicated an interest in participation were contacted by the researcher to set up an appointment. Participants were also recruited using a snowball strategy in which parents of participants contacted other parents of potential participants. Parents recruited through word of mouth contacted the researcher to set up an appointment. A total of 11 participants diagnosed with ASD were recruited in Kelowna.

In the Victoria area, information packages were sent via e-mail to the Victoria Society for Children with Autism (VSCA) and AutismVictoria, local daycares, preschools, and doctor's offices. Packages included a letter describing the study and asking for help in recruiting participants. Professionals were asked to post an advertisement of the study where clientele could see it. The advertisement included a description of the study and contact information of the researcher. As in Kelowna, parents/guardians who indicated an interest in participating were contacted by the researcher to set up an appointment. A total of 4 participants diagnosed with ASD were recruited in Victoria.

**TD Participants.** Samples of TD participants between ages 2.5 and 7 years were recruited in both Kelowna and Victoria, British Columbia. In Kelowna, parents/guardians of participants with ASD were asked to forward the original email recruitment letter from the COCDA staff member to parents/guardians of TD children. Parents/guardians of a TD child who received the email and indicated to the researcher that they would like their child to participate were contacted to set up an experimental session. A total of 10 TD participants were recruited in Kelowna. In Victoria, parents of children with ASD recruited through one of the methods described above, forwarded information about the study and the researcher's contact information to parents of TD children. Any parents recruited in this fashion contacted the researcher if they were willing to have their child participate in the study. A total of 5 TD participants were recruited in Victoria.

## Participants: Inclusion Criteria

**Participants with ASD.** Due to the challenges of recruiting an appropriate clinical sample of children with ASD, the inclusion criteria were fairly broad so as to retain as many participants with ASD as possible. For example, although the ratio of boys with ASD to girls with ASD in the general population is two to one, no gender restrictions were imposed in the current study. Also, ASD can be associated with language impairments (American Psychiatric Association, 2000) and research has demonstrated that language may be related to deferred imitation abilities (Rogers et al., 2008; Strid, Heimann, Gillberg, Smith, & Tjus, 2012; Strid, Heimann, & Tjus, 2013; Toth, Munson, Meltzoff, & Dawson, 2006), however, ASD participants were not excluded due to any existing language impairments. Instead, language ability (as measured by the RV subtest of the WPPSI-III) in relation to deferred imitation was explored as an experimental variable. Information about participant characteristics was provided by parents. Prior to their child's inclusion in the study, parents participated in a brief interview with the researcher. The researcher described the general procedure and materials and asked if that child was able to understand and follow simple verbal directions and to make simple movements with objects.

Inclusion criteria included (a) a diagnosis from a qualified medical practitioner (i.e. psychologist, psychiatrist) using the diagnostic criteria described by the American Psychiatric Association according to the DSM-IV-TR as provided in the practitioner's report (American Psychiatric Association, 2000); (b) sufficient ability to understand and follow verbal directions given by the researcher, as reported by the parent; and (c) parent report of sufficient fine motor ability to reproduce simple actions on objects, such as those demonstrated by the researcher.

Participants in this study who had a diagnosis of ASD were either diagnosed with Autistic Disorder or Pervasive Developmental Disorder- Not Otherwise Specified (PDD-NOS). The DSM-IV-TR (American Psychiatric Association, 2000) criteria for Autistic Disorder include: (1) at least two forms of evidence of a qualitative impairment in social interaction; (2) at least one form of evidence of a qualitative impairment in communication; and (3) at least one form of evidence of restricted, repetitive, and/or stereotyped patterns of behaviour, interest, and activity. In addition, for an individual to be diagnosed with Autistic Disorder they must evidence delays or atypical functioning in at least one of the following areas, with onset prior to 3 years of age: (1) social interaction, (2) language as used in social interaction, and (3) symbolic or imaginative play (American Psychiatric Association, 2000). PDD-NOS is diagnosed when an individual experiences a severe and pervasive impairment in either verbal or nonverbal communication skills or with the presence of stereotyped behaviours, interests, and activities but the criteria for a specific diagnosis on the Autism Spectrum (e.g. Autistic Disorder, Asperger's, Childhood Disintegrative Disorder) are not met. An individual may also be diagnosed with PDD-NOS when (a) he or she does meet the criteria for autism but symptoms appear after the age of 3 years, (b) his or her symptoms are atypical, (c) his or her symptoms are sub-threshold in some areas (i.e. not as severe as in autism), or (d) all of the above (American Psychiatric Association, 2000). To ensure a correct diagnosis, parents/guardians of each participant were asked to provide a copy of their child's diagnostic report to the researcher.

Also, each parent was asked to describe their child's verbal and motor abilities to the researcher prior to participation. Any parent/guardian of a potential participant who described their child as having (a) very limited verbal abilities (e.g. unable to listen to and/or follow verbal directions) or (b) very limited fine motor skills (e.g. difficulty manipulating small objects such as toys or eating utensils) was thanked for their offer of participation but their child was not included in the study. Finally, the researcher also conducted the RV subtests of the WPPSI-III with each participant as a screening measure of verbal skills. One potential participant with ASD was unable to complete this task and therefore was not included in the study.

**TD Participants.** Inclusion criteria for TD participants were children with (a) no formal diagnosis of a disorder that could interfere with participation (e.g. ADHD could interfere with a child’s ability to attend to instructions or action demonstrations); (b) not on the waitlist for assessment for the purposes of diagnosis, or (c) has not been referred for assessment for the purposes of diagnosis. This information was provided by parent report. Further, TD participants were required to have (a) sufficient verbal ability to understand and follow simple directions as well as (b) sufficient fine motor ability to perform simple actions on objects, similar to and assessed as in the same way with the ASD group. No TD participants had any formal diagnoses and no TD participants were excluded.

The final sample consisted of 30 participants, 15 with ASD and 15 who were TD. In total there were 11 girls (3 with ASD, 8 who were TD) and 19 boys (12 with ASD; 7

who were TD). The average age of participants in the study was 55.76 months. The average age of participants with ASD was 60.20 and of TD participants was 51.07 months (see Table 2 for a summary).

Table 2

*Participant Characteristics*

| | Diagnosis | | Age | Age | RV |
|---|---|---|---|---|---|
| | Autism | PDD-NOS[a] | (mean in months) | (range in months) | (mean standard score) |
| ASD (n = 15) | n = 10 | n = 5 | 60.20 | 37.00-73.00 | 6.93* |
| TD (n = 15) | n/a | n/a | 51.07 | 32.00-71.00 | 12.47* |

*$t = -5.37$, df= 28, $p = 0.00$

[a]Pervasive Developmental Disorder-Not Otherwise Specified

**Data Collection: Setting and Researcher**

Each participant was tested in a quiet room of their house, with one exception: one participant's mother indicated that her son was easily distracted at home so he was tested in a quiet room of the UVIC Library. During testing, each participant was seated at a table across from the researcher. The researcher videotaped participants' performance for later scoring. During each of two time delays, most participants chose to watch age-appropriate cartoon television shows (e.g. Dora the Explorer) on the researcher's laptop or on their home television, but a few chose to play simple games (e.g. Simon Says).

The researcher was a graduate student in Special Education, who has experience conducting behavioural interventions with young children with ASD, and who has taken graduate level courses in assessment. All experimental sessions were conducted by this researcher.

**Materials**

**Language measure.** The Receptive Vocabulary (RV) subtest of the WPPSI-III (Wechsler, 2002) was used as one way to explore the verbal skills of participants. The WPPSI-III is an individually administered clinical instrument for assessing the intelligence of children aged 2 years 6 months up to 7 years 3 months. The RV subtest requires a child to look at a group of four pictures and point to the one that the examiner names (e.g. "show me the cup" and the child points to a picture of a cup) or that has the quality the examiner names (e.g. "show me the curly tail" and the child points to a pig with a curly tail). Materials included a stimulus book and scoring protocols.

**Experimental stimuli.** Twelve novel objects were constructed by the researcher (see Appendix B for pictures) and were modelled based on the objects used by Meltzoff and colleagues (1988a, 1988b, Klein & Meltzoff, 1999). These objects included (a) a dumbbell-shaped toy made up of two square wooden blocks, and a round piece of dowling that could be pulled apart and put back together (one block was glued to the piece of dowling and one fit on to the dowling with no glue); (b) an L-shaped platform with one panel attached by a hinge so that it could stand vertical and be pushed flat; (c) a small battery-powered wooden box with a slightly recessed button on the top that could be depressed to produce a loud siren-like noise; (d) a plastic egg filled with three pennies so that it rattled when shaken; (e) a small stuffed monkey with a loop of string attached to its head; (f) a battery-powered circular LED push utility light that, when pushed, lit up (Meltzoff, 1988a, 1988b); (g) plastic cup and a string of beads; (h) two wooden blocks; (i) square plastic container with an open top and a wooden drum stick (Klein & Meltzoff, 1999); (j) toy baby bottle and drum stick; (k) toy car; (l) potato masher (Rogers et al., 2008).

Since it was intended that participants copy novel actions, participants were given an opportunity to manipulate each object in a baseline phase before seeing the target action performed by the researcher. Therefore, some of the stimuli had copies that did not allow participants to perform the target action in the baseline phase. Alternate stimuli included (a) a dumbbell identical to the one used by the experiment, except that neither "dumbbell" section could be detached; (b) the same plastic egg that was not filled with pennies; (c) the same box with a button recessed in the lid with no batteries (when pushed no sound was emitted) and (d) the same circular LED push utility light with no batteries (when pushed no light turned on).

**Other materials.** A stopwatch was used to monitor the amount of time that participants were given to manipulate objects. A timer was used to mark the time for each time delay. A Samsung laptop was used to show videos to participants during the time delay. Videos of participants were recorded using a Samsung video camera and tripod.

**Procedure**

Each experimental session took 2 hours to complete and all activities were completed in one session. Before the start of a session, the researcher provided an informed consent form to the participant's parent/guardian and asked them to read it. Next, the researcher summarized the information in the consent form and asked the parent/guardian to sign the form if they still wished their child to participate. Before starting the experimental activities, the researcher spent a few minutes establishing rapport with the participant (e.g. asked about the participant's hobbies and interests, etc.). Next, the experimenter provided a simple explanation of the procedure to the participant: "I have some activities for us to do. I am going to show you some pictures and some objects. I am going to ask you some questions; some questions will be easy and some will be harder. Don't worry about getting the questions right or wrong- just try your best." At this point the child could provide verbal assent and begin the activities or could decline to participate. A child could explicitly state that they did not wish to participate or could implicitly imply refusal through non-compliance (e.g. refusal to sit at the table, refusal to participate in the RV activities, refusal to interact with the experimental objects). No child declined participation. The first activity completed in the session was the RV subtest of the WPPSI-III. The next activity was the first baseline object exploration phase. Below is a description of the experimental activities that each participant engaged in. Each child saw 12 objects in total, 6 at each time delay. Order of time delay was randomised across participants and presentation order for the 12 objects was also counterbalanced using a Latin-square design.

**First baseline phase.** As in previous deferred imitation studies (Dawson et al. 1998; McDonough et al., 1997; Rogers et al., 2008), participants were given the opportunity to manipulate target objects without having seen any target actions. This was done to ensure that any target actions produced by participants in the imitation phase were, in fact, imitations, and were not produced spontaneously. If a target action was produced in this phase, an alternate but similar action was substituted by the examiner in the observation phase (these alternate actions will be described later). In this first baseline phase, six objects were presented. The order of presentation was randomly determined using a Latin-square design. Stimuli were kept hidden from the view of participants before being brought to the table and were hidden after demonstration of the target action; participants only interacted with objects one at a time. For each object, participants were given 20-s to interact with it.

**First observation phase.** After the first baseline condition, the researcher waited until she had the child's attention (i.e. the child was seated at the table and looking at her) in order to demonstrate a target action on each of the six target objects introduced in the first baseline phase. Demonstrations of target actions took place on the tabletop out of reach of the participant so that he/she could not touch or play with the stimuli during the demonstration. Once the child was attending to the object, the researcher demonstrated a target action three times within a 20-s period. If a participant became distracted or ceased to attend to the demonstration the researcher regained his/her attention by saying something such as, "look over here" or "see what I have" but never used words such as "imitate," or "copy." Participants were not given an opportunity to imitate at this time.

**Target actions.** Target actions were modelled on those of Meltzoff and colleagues (1988a, 1988b, Klein & Meltzoff, 1999). The target action for the dumbbell-shaped toy was to grasp each end and pull outward so that the toy came apart. The action demonstrated on the L-shaped platform was to reach out and push the vertical flap over so that it lay flat. The L-shaped platform was placed in front of participants so that it was oriented with the edge of the vertical piece facing the participant and so that the flap lay flat if pushed from right to left. The target action for the box with the button was to push the button with an elbow. In the observation phase, pushing the button caused a siren-like noise to turn on. In the imitation phase, the box was disabled in order to protect against the possibility that it would start from a touch different than the target action. The target action for the egg was to shake it. In the observation phase, the egg was filled with pennies that rattled when it was shaken but in the imitation phase the pennies were removed so that they would not shake from an accidental touch. For the stuffed bear, the target action was to suspend the bear from the loop of string attached to its head and to jiggle the bear. For the LED push utility light, the target action was to lean forward from the waist to touch the forehead to the orange top (Meltzoff 1988a, 1988b). For the plastic cup and the string of beads, the target action was to pick up the beads and place them in the cup. The target action for the two wooden blocks was to bang the blocks together. The target action for the box and stick was to place the end of the stick in the box and make a "stirring" motion (Klein & Meltzoff, 1999). For the toy baby bottle and stick, the action demonstrated was to invert the bottle and bang it with the stick. Likewise, the action demonstrated on the toy car was to invert it and pat it with the hand. Finally, the target action for the potato masher was to pick it up in one hand and twirl it in the air (see Table 3 for a summary of target actions).

**Alternate target actions.** Alternate target actions were different but equivalent in difficulty (i.e. required an equivalent number of motor actions; see Table 2) to target actions (e.g. Meltzoff, 1988a, 1988b; Rogers et al., 2008). There was no alternate action for the dumbbell-shaped toy since the toy given in the baseline phase could not be pulled apart. The alternate action for the L-shaped platform was turn it over so that it rested on two edges and formed a triangle shape. The alternate action for the box with the button was to push the button with a nose. The alternate action for the egg was to bang it on the table. For the stuffed bear, the alternate action was to suspend the bear from the loop of string attached to its head and to twirl the bear. For the LED push utility light, the alternate action was to push it with the palm of the hand (Meltzoff 1988a, 1988b). For the plastic cup and the string of beads, the alternate action was to pick up the beads and place them around the cup. The alternate action for the two wooden blocks was to bang the blocks on the table. The alternate action for the box and stick was invert the box and bang the bottom with the stick (Klein & Meltzoff, 1999). For the toy baby bottle and stick, the action demonstrated was to turn the bottle sideways and bang the side with the stick. Likewise, the alternate action demonstrated on the toy car was to and pat the top with palm of the hand. Finally, the target action for the potato masher was to pick it up in one hand, point it to the ground, and twirl it (see Table 3).

Table 3
*Target and Alternate Actions for Each Experimental Object*

| Object | Target Action | Alternate Action |
| --- | --- | --- |
| LED utility light | Push light with forehead | Push light with hand |
| Small stuffed bear (string attached to its head) | Dangle bear by string so it appears to dance | Twirl the bear with the string |
| Small egg (filled with pennies) | Shake to rattle pennies | Bang egg on the table to rattle pennies |
| Square Tupperware container and drum stick | Put stick into container and make a "stirring" motion | Invert the container and bang with the stick |
| Two wooden blocks | Bang blocks together | Bang both blocks on the table |
| Wooden dumbbell-shaped toy | Pick up and pull apart | N/A |
| Plastic cup and string of beads | Pick up the beads and place in the cup | Place the beads around the cup |
| Toy baby bottle and drum stick | Invert the bottle and bang with the stick | Bang the stick on the side of the bottle |
| L-shaped platform | Push the vertical board so that it rests on the horizontal board | Invert the platform to create a triangle |
| Potato masher | Point in the air and twirl above the head | Point toward the ground and twirl |
| Toy car | Invert and pat the car | Pat the top of the car |
| Box with a button in the lid | Push the button with elbow | Push the button with thumb |

**First time delay.** In order to determine the effect of differing delays on the deferred imitation abilities of participants, two time delays (10 m versus 60 m) occurred between the observation phase and the imitation phase. The order of time delays was randomized across participants. During the time delay, participants watched an age-appropriate video presented on the researcher's laptop computer.

**First imitation phase.** After the time delay, each of the six objects presented in the first baseline and first imitation phases was placed on the table, one at a time, within reach of the participant. Once an object was placed on the table in front of a participant, he or she had 20-s in which to spontaneously imitate the target action for that object. If the participant produced the target action, that object was returned to the box and the next object was placed on the table. However, if at this time, the participant did not produce the target action, he or she received a verbal prompt from the researcher. In this case, the researcher told the participant, “copy what I did.” Another 20-s response period followed the prompt before the target object was removed from the table and replaced with another. This procedure was repeated until all objects in each time delay condition have been presented to the participant.

**Second baseline phase.** At this time, participants were given the opportunity to play with the six experimental objects that were not presented earlier. Otherwise the procedure was the same as for the first observation phase.

**Second observation phase.** Following the first baseline phase, participants watched the experimenter perform a target action for each of the six target objects presented in the second baseline phase. The procedure was the same as for the first observation phase.

**Second time delay.** Participants watched an age-appropriate video or played simple games with the researcher as in the first time delay.

**Second imitation phase**. As in the first imitation phase, participants were given the opportunity to imitate the target action that had been demonstrated by the researcher and were prompted to imitate if they did not do this spontaneously. The procedure was the same as for the first imitation phase.

**Finishing the session.** Once the experimental session was concluded, the researcher presented participants with a t-shirt with the logo “I was a university student for a day” as a thank-you for participation.

This section provided an overview of necessary materials for the proposed investigation as well as planned procedures. The next section will detail the ways in which data was coded from videos.

**Data Coding**

Videos of each experimental session were used to record and subsequently code participants' responses. An independent rater was recruited in order to help code the video data. This rater was a graduate student in the department of Educational Psychology & Leadership Studies at the University of Victoria (UVIC), and she was trained by the researcher. She was told that she would be watching videos of children who would be performing actions on objects, that the target action would be specified for each object, and that she would be asked to judge whether each child performed the specific action per object. The rater was asked to do this for data from both the baseline phases and imitation phases for all participants. She was not told whether a participant had ASD or was TD, whether each item had been presented after a 10 m or a 60 m time delay, or whether the action was spontaneous or prompted. In order to help ensure the rater would not know a participant's group affiliation (ASD or TD), what time delay had occurred (10 m or 60 m), or whether the action produced by a participant was spontaneous or prompted, videos were muted. A passing score for each item was operationally defined (e.g. a participant correctly imitated if he/she turned the car over and patted the bottom with the palm of his/her hand) and a list of each action and its associated object was provided. This list also included the alternative actions that were substituted if a child was judged to have spontaneously produced the target action in the baseline phase.

Participants' responses in the two baseline phases were coded as a target action or not a target action for each object. Target actions were defined as actions that were the same as those the researcher would demonstrate for that object. For example, if a participant was manipulating the toy car in the baseline phase and turned the car upside down and patted its underside, this was coded as the same as the target action. Actions deemed not to be target actions were defined as those that were different than actions that would be demonstrated by the researcher (e.g. driving the car across the tabletop), actions that would be demonstrated by the researcher for a different object (e.g. shaking the car), or no interaction with the object (e.g. the participant looks at the car with his/her hands in his/her lap). A total baseline inter-rater reliability kappa score was calculated by entering the raters' and the researchers' responses in SPSS Version 20. Inter-rater reliability was strong and significant (kappa = 0.91, $p$ = 0.00).

Participants' responses in the two imitation phases were coded as accurate imitations or inaccurate imitations. Accurate imitations were defined as actions that were the same as those demonstrated by the researcher. For example, as above, if a participant was presented with the toy car and turned it upside down and patted its underside, this was coded as an accurate imitation. Inaccurate imitations were defined as those that were different than actions demonstrated by the researcher (e.g. driving the car across the tabletop), actions demonstrated by the researcher for a different object (e.g. shaking the car), or no interaction with the object (e.g. the participant looks at the car with his/her hands in his/her lap). Actions that approximated an accurate action (e.g. pointing the potato masher forward, rather than above the head, and twirling it) were counted as inaccurate. Each participant received a total imitation score for 10 min and 60 min, consisting of the number of actions accurately imitated (spontaneous and prompted) divided by the total number of actions demonstrated (6 at 10 min and 6 at 60 min; Rogers et al., 2008). Total correct imitations were divided by the total number of actions demonstrated to yield the proportion of correct imitations. Each participant also received a spontaneous imitation score consisting of the total number of actions imitated accurately without a prompt divided by the total number of actions demonstrated. Finally, each participant received a prompted imitation score consisting of the total number of actions accurately imitated with a prompt divided by the total number of actions observed. For example, a participant who accurately imitated a total of 5 out of 6 actions at 10 minutes would receive a total imitation score of 0.83. If 3 of those 5 accurate imitations were spontaneous (i.e. not prompted), this would result in a spontaneous imitation score of 0.6. In this example, the same participant would receive a prompted imitation score of 2 divided by 6, or 0.33. Inter-rater reliability calculated for imitation scores was strong and significant (kappa = 0.80, $p = 0.00$).

**Summary**

Chapter three provided an overview of the methodology of the proposed research, including participants, materials, procedure, and data coding. Chapter four will describe the data analysis and results.

# Chapter 4

## Results

Chapter three described the ways in which data was collected, including a description of the participants and how they were recruited, the materials used in the study, and the tasks participants were asked to complete. This chapter will provide an analysis of the results of the study.

Analyses and results are presented separately for each of the research questions. First presented are analyses of the number of accurate spontaneous object oriented imitations demonstrated by participants with ASD and TD participants. It was hypothesized that participants with ASD would demonstrate fewer accurate spontaneous object oriented imitations than TD participants at both short and longer time delays. In the same respect, it was hypothesized that participants with ASD would take longer than TD participants to display object oriented imitation both at short and longer time delays.

Next, the effect of verbal prompting on the number of accurate object oriented imitations demonstrated by participants with ASD was analysed. It was hypothesized that participants with ASD would need a greater number of prompts than TD participants at both short and longer time delays. Further, it was hypothesized that the addition of a verbal prompt would lead to more accurate object oriented imitation for participants with ASD, such that there would be no difference in the total (spontaneous + prompted) number of object oriented imitations produced by participants with ASD and TD participants either at short or longer time delays.

Finally, the effects of language, as screened using the Receptive Vocabulary (RV) subtest of the WPPSI-III, on the accuracy of object oriented imitation of participants with

ASD and TD participants was investigated. It was hypothesized that RV scores would be significantly correlated with number of accurate object oriented imitations demonstrated by participants at both short and longer time delays. It was also hypothesized that RV scores would be significantly correlated with response time (RT) and number of prompts for participants with ASD and TD participants.

**Preliminary Analyses**

Prior to analysis, number of accurate spontaneous imitations, number of total accurate imitations (spontaneous + prompted), spontaneous RT, accurate spontaneous RT, and number of prompts were examined for accuracy of data entry, missing values, and fit between their distributions and the assumptions of Analysis of Variance (ANOVA). The variables were examined separately for participants with ASD and TD participants. All data was entered accurately. There were no missing values for number of accurate spontaneous imitations, number of total accurate imitations (spontaneous + prompted), spontaneous RT, and number of prompts. Two participants were missing values for accurate spontaneous RT since they did not respond accurately to any items at either 10 min or 60 min. For analyses involving this variable, these two participants were not included. Examination of descriptive statistics and histograms for each of the variables indicated no severe deviations from normality. Bivariate scatterplots between each pair of variables indicated roughly linear relations.

A 2 X 2 (Group [ASD, TD] and Time Delay [10 min, 60 min]) ANOVA was conducted to explore the amount of time that participants manipulated objects in the baseline condition. This was a mixed ANOVA with Group serving as a between factor and Time Delay serving as a within factor. Number of seconds that objects were manipulated served as the dependent variable. Results revealed no significant main effects or interactions; participants with ASD spent as much time as TD participants manipulating objects and there was no difference in amount of time spent manipulating objects before a short or a longer time delay.

**Spontaneous Deferred Imitation**

**Accuracy.** A 2 X 2 (Group [ASD, TD] and Time Delay [10 min, 60 min]) ANOVA was conducted to determine if a group difference in accurate spontaneous object-oriented imitation existed at both the short and longer time delays. This was a mixed ANOVA with Group serving as a between factor and Time Delay serving as a within factor. Proportion of correct items imitated spontaneously served as the dependent variable. Results (presented in Figure 2) revealed a significant main effect of group ($F(1, 28) = 19.24$, $p = 0.00$, $\eta 2 = 0.41$) but no significant effect of time delay and no significant interaction. Visual inspection of means revealed that participants with ASD demonstrated fewer accurate spontaneous object oriented imitations at both short ($M = 0.47$) and long ($M = 0.44$) time delays than TD participants ($M = 0.77$; $M = 0.68$). This result supports the first hypothesis that participants with ASD would demonstrate fewer accurate spontaneous imitations than TD participants.

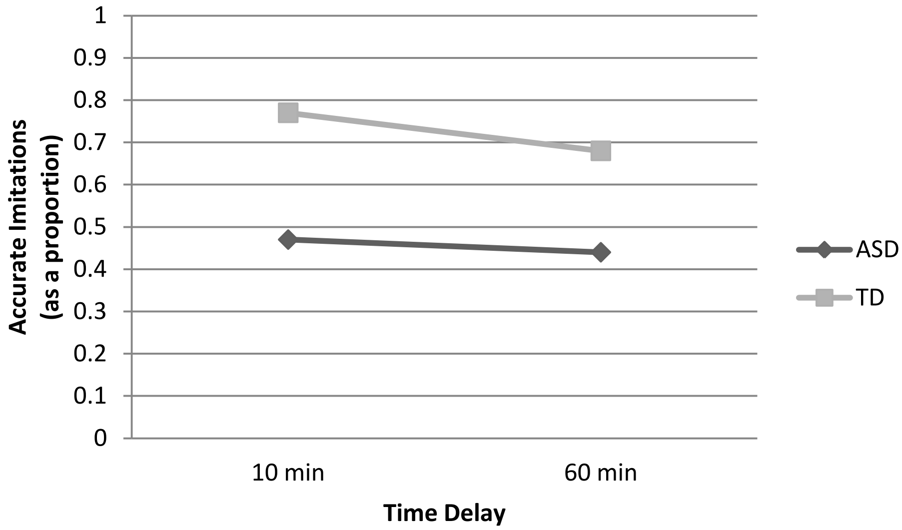


*Figure 2.* Proportion of accurate spontaneous imitations demonstrated by participants with ASD and TD participants at 10 m and 60 m.

**Spontaneous response time.** Recall that participants were given 20 seconds (s) to spontaneously display object-oriented imitation for each of 6 items at each of 2 time delays. Subsequently they were given a further 20 s to display prompted object-oriented imitation if they failed to display spontaneous object-oriented imitation. Response time (RT) was operationalized as the time elapsed between presentation of an object to a participant and the time at which that participant produced the correct target action for that object. For each object, a participant could have a maximum RT of 40 s indicating that he/she did not correctly imitate the target action for that object when given the opportunity to do so spontaneously or when prompted. Therefore, for this analysis, participants could receive a maximum RT of 240 s (i.e. the participant made no move to imitate any object-oriented action). Table 4 provides an example. This participant's total RT score is 120.1 s (20 + 1.5 + 3.2 + 20 + 11.2 +20 + 4.2 + 20 + 20). A spontaneous RT score was also calculated for each participant at each time delay in which prompted scores were not included in the calculation. For the same participant presented in Table 4, his/her spontaneous RT score is 75.9.

Table 4

*Sample Participant RTs and Calculations*

| Imitation Type | Number of seconds | | | | | |
|---|---|---|---|---|---|---|
| Spontaneous | 20 | 1.5 | 3.2 | 20 | 11.2 | 20 |
| Prompted | 4.2 | n/a | n/a | 20 | n/a | 20 |

A 2 X 2 (Group [ASD, TD] by Time Delay [10 min, 60 min]) ANOVA was conducted to determine if this group difference for spontaneous object-oriented imitation existed at both the short and longer time delays. Spontaneous RT served as the dependent variable for the ANOVA. Results (presented in Figure 3) revealed a significant main effect of group ($F(1, 28) = 6.14$, $p < 0.05$, $\eta^2 = 0.18$). Visual inspection of means revealed that participants with ASD took longer to display spontaneous object-oriented imitations at both short (*M* = 68.49) and longer (*M* = 68.83) time delays than TD participants did at both short (*M* = 42.70) and longer (*M* = 57.95) time delays. This result supports the second hypothesis that participants with ASD would take longer than TD participants to demonstrate object oriented imitations at different time delays, even when they are actually engaging in imitation. There was no significant effect of time delay and no significant interaction. However, it should be noted that the power to detect such a difference was low (0.29) for the interaction and inspection of Figure 3 reveals a trend toward significance for the interaction. At 10 min there appears to be a sizeable difference in the time that participants with ASD and TD participants took to display object oriented imitation, with participants with ASD requiring much more time than TD participants. However, at 60 min there appears to be a much smaller difference in the time that participants in the two groups took to display object oriented imitations. Visual inspection of this trend suggests that participants with ASD took approximately the same amount of time at 10 min and 60 min to produce the object oriented imitations, whereas TD participants appeared to take longer at 60 min than at 10 min, thus narrowing the gap between the imitation production times of both groups. Further investigation with a larger sample size may find this interaction to be significant.

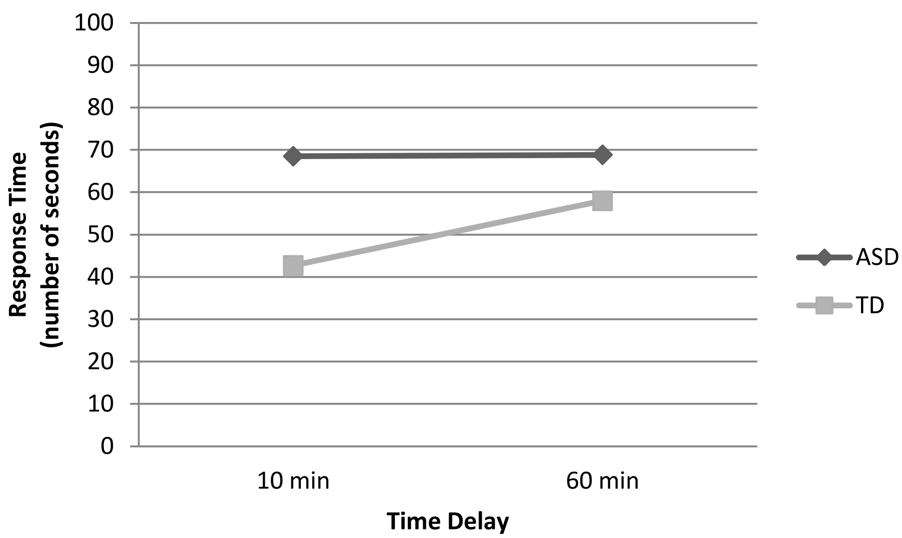


*Figure 3.* RTs (number of seconds taken to imitate) at 10 m and 60 m for participants with ASD and TD participants.

**Accurate response time.** The amount of time that participants with ASD and TD participants took to display accurate spontaneous object-oriented imitations was also explored. For this analysis, the spontaneous score was calculated by determining average RTs for accurate spontaneous imitations (e.g. 1.5 + 3.2 + 11.2 = 15.9/3 = 5.3). Thus, each participant received an accurate spontaneous score at 10 min and an accurate spontaneous score at 60 min.

A 2 X 2 (Group [ASD, TD] and Time Delay [10 min, 60 min]) ANOVA was conducted using average accurate spontaneous RT as the dependent variable. Results (presented in Figure 4) revealed no significant main effects of Group or Time Delay and no significant interaction. However, inspection of Figure 5 reveals a trend toward significance for the interaction; while there is no difference in RT for participants with ASD (*M* = 2.90) and TD participants (*M* = 2.90) at the short time delay, there is a difference at the longer time delay such that TD participants responded faster (*M* = 3.00) than participants with ASD (*M* = 4.20). These findings are in contrast to those found for RT for both accurate and inaccurate trials in which participants with ASD were took significantly longer to demonstrate object oriented imitation than did TD participants.

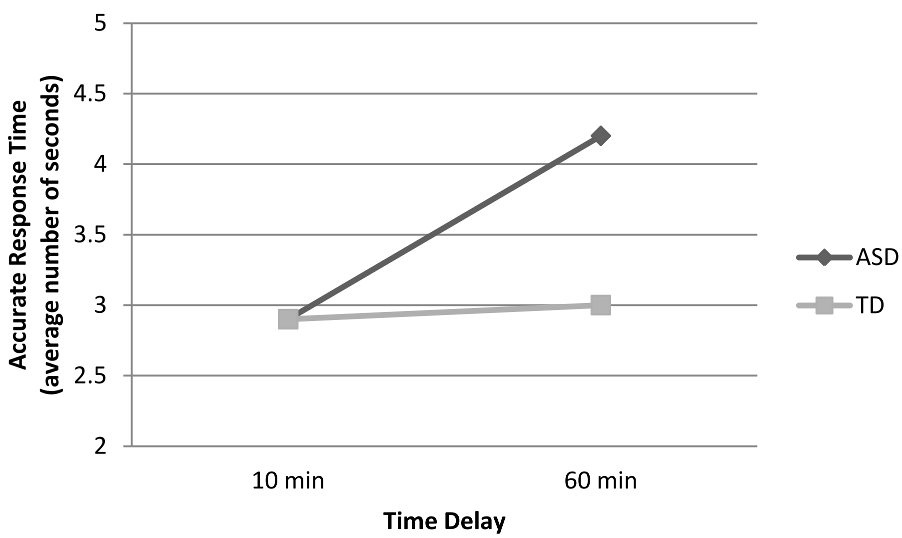


*Figure 4.* Accurate RTs (average number of seconds taken to imitate for accurate trials only) at 10 m and 60 m for participants with ASD and TD participants.

**Prompted Deferred Imitation**

Although spontaneous deferred imitation is challenging for children with ASD, research has found that, when imitation is prompted, there is little difference in the number of accurate target actions copied, as compared to control groups (Hobson & Lee, 1999; McDonough et al., 1997; Wu et al., 2011). Participants in the current study received a verbal prompt if they did not spontaneously produce object oriented imitations. This addition to the typical spontaneous imitation paradigm was intended to determine whether participants with ASD fail to accurately imitate at differing time delays due to a misunderstanding of task demands (i.e. an impairment in spontaneous imitation), rather than an inability to imitate. Number of prompts given and comparisons of accuracy for total (i.e. spontaneous + prompted) object oriented imitations of participants with ASD and TD participants were used to examine this issue. It was hypothesized that participants with ASD would need significantly more prompts than TD participants at short and longer time delays.

**Number of prompts.** A 2 X 2 (Group [ASD, TD] and Time Delay [10 min, 60 min]) ANOVA was conducted to determine if participants with ASD required more prompts than TD participants at both short and longer time delays. This was a mixed ANOVA with Group serving as a between factor and Time Delay serving as a within factor. Total number of prompts given served as the dependent variable. Results (presented in Figure 5) revealed a significant main effect of Group ($F(1, 28) = 11.13$, $p < 0.01$, $\eta^2 = 0.28$) and inspection of means revealed that participants with ASD received more prompts at both short (*M* = 3.20) and longer (*M* = 3.23) time delays than TD participants received at both short (M = 1.53) and longer (*M* = 2.27) time delays. These results support the third hypothesis. There was no significant effect of Time Delay and no significant interaction.

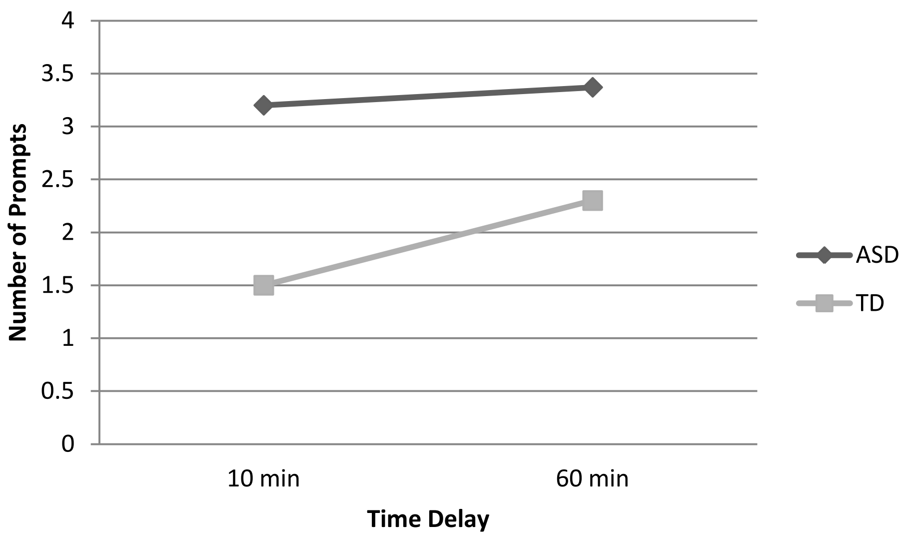


*Figure 5.* Number of prompts given to participants with ASD and TD participants at 10 m and 60 m.

**Accuracy of deferred imitation with prompts.** A 2 X 2 (Group [ASD, TD] and Time Delay [10 min, 60 min]) ANOVA was conducted to determine if this difference existed at both short and longer time delays. This was a mixed ANOVA with Group serving as a between factor and Time Delay serving as a within factor. Total (i.e. spontaneous and prompted) proportion of items imitated correctly served as the dependent variable. Results (presented in Figure 6) revealed a significant main effect of Group ($F(1, 28) = 19.33$, $p = 0.00$, $\eta^2 = 0.41$). Visual inspection of means revealed that participants with ASD displayed significantly fewer accurate object oriented imitations at both short ($M = 0.53$) and longer ($M = 0.49$) time delays than did TD participants at both short ($M = 0.81$) and longer ($M = 0.72$) time delays. This result does not support the hypothesis that a verbal prompt would erase the difference in the number of accurate object oriented imitations demonstrated by participants with ASD and TD participants at short and longer time delays. No significant main effect of Time Delay was revealed and no significant interaction was revealed.

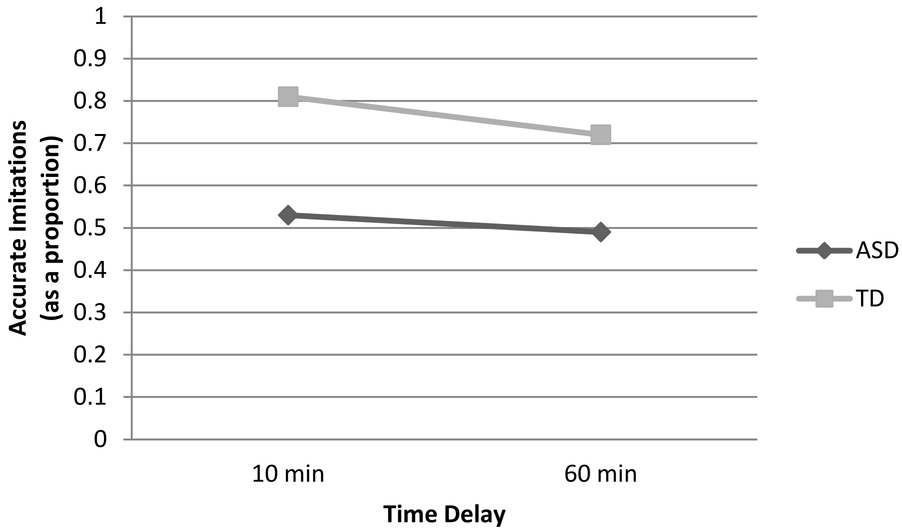


*Figure 6.* Proportion of total (spontaneous + prompted) accurate imitations demonstrated by participants with ASD and TD participants at 10 m and 60 m.

## Language and Deferred Imitation

**Accuracy.** Participants with ASD (*M* = 6.93) scored significantly lower on an index of language (Receptive Vocabulary) than TD participants (*M* = 12.47; $t(28) = -5.37$, $p = 0.00$). It was hypothesized that scores on an index of language would be significantly related to accuracy of deferred imitation for participants with ASD and TD participants at both short and long time delays. To determine whether this was true for the current sample, correlations were conducted. There was a significant positive correlation between RV scores and number of spontaneous imitations at the short ($r = 0.63$, $p < 0.01$, one-tailed) time delay for participants with ASD (see Figure 7). Results (presented in Figure 7) for TD participants failed to show a significant correlation at a short time delay ($r = 0.43$, $p > 0.05$, one-tailed). There was no significant correlation between number of spontaneous object oriented imitations demonstrated at a longer time delay for participants with ASD ($r$ = -0.10, $p$ > 0.05, one-tailed) or TD participants($r$ = -0.22, $p$ > 0.05, one-tailed; see Figure 8).

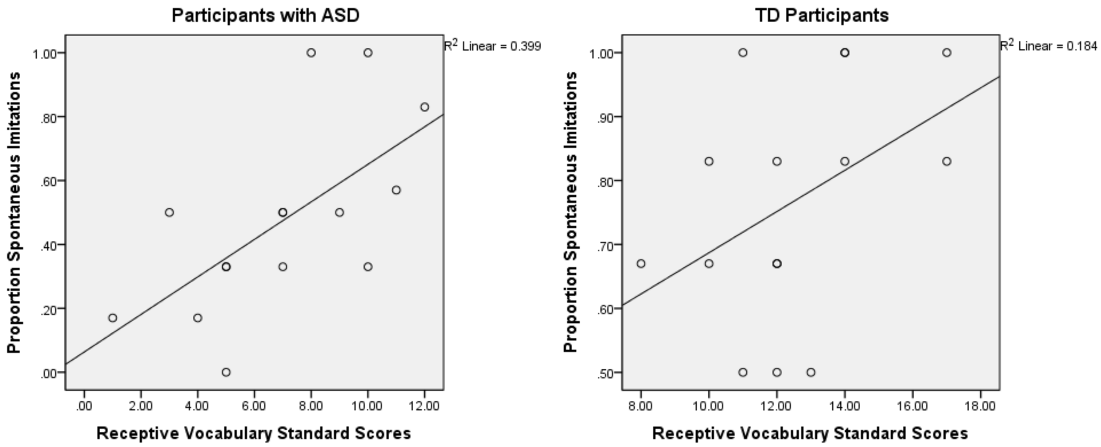


*Figure 7.* Receptive Vocabulary standard scores plotted against spontaneous imitations demonstrated at 10 m.

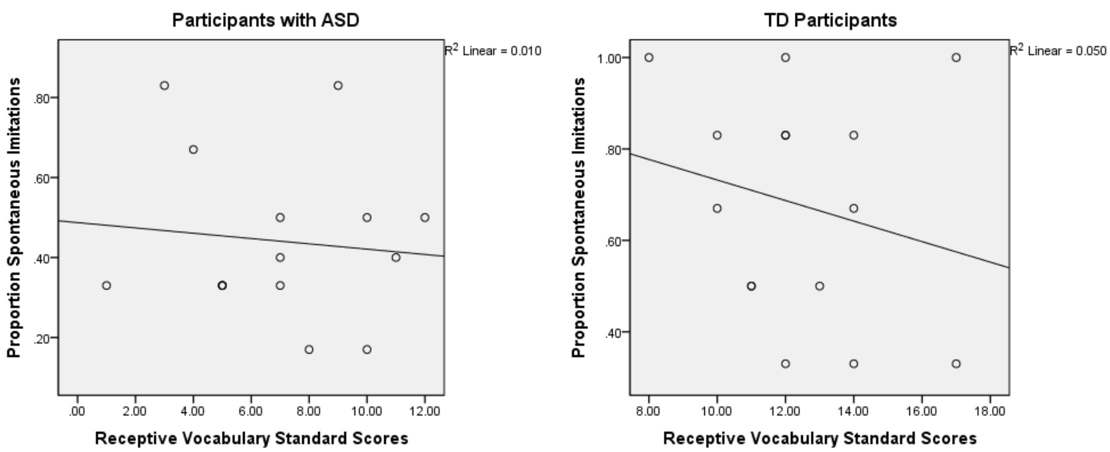


*Figure 8.* Receptive Vocabulary standard scores plotted against spontaneous imitations demonstrated at 60 m.

There was also a significant positive correlation between RV scores and number of total (i.e. spontaneous + prompted) imitations at the short ($r$ = 0.70, $p$ < 0.01, one-tailed) time delay for participants with ASD (see Figure 9). There was no significant correlation for TD participants ($r$ = 0.38, $p$ > 0.05, one-tailed; see Figure 9). However, similar to the findings with spontaneous imitations, there was no significant correlation between RV scores and total number of imitations at the longer time delay for participants with ASD (*r* = -0.00, *p* > 0.05, one-tailed) or TD participants (*r* = -0.28, *p* > 0.05, one-tailed; see Figure 10).

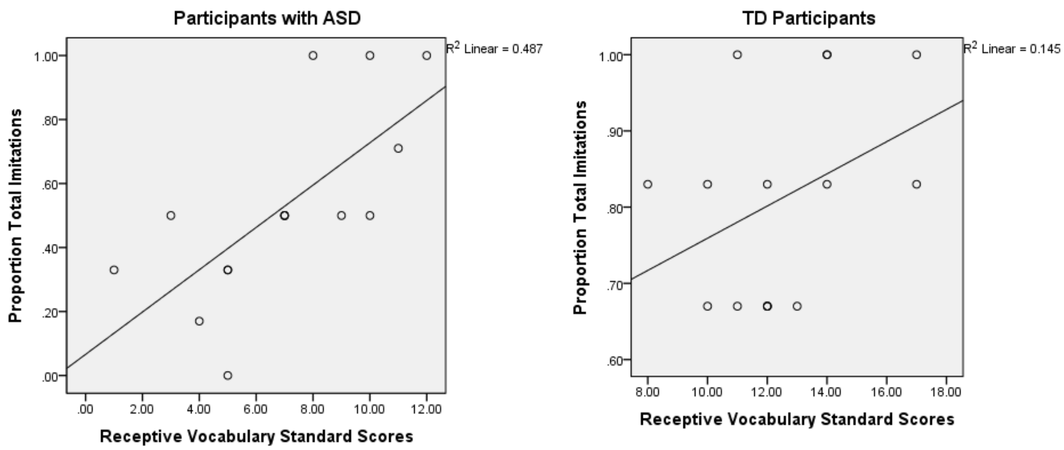


*Figure 9.* Receptive Vocabulary standard scores plotted against total (spontaneous + prompted) imitations demonstrated at 10 m.

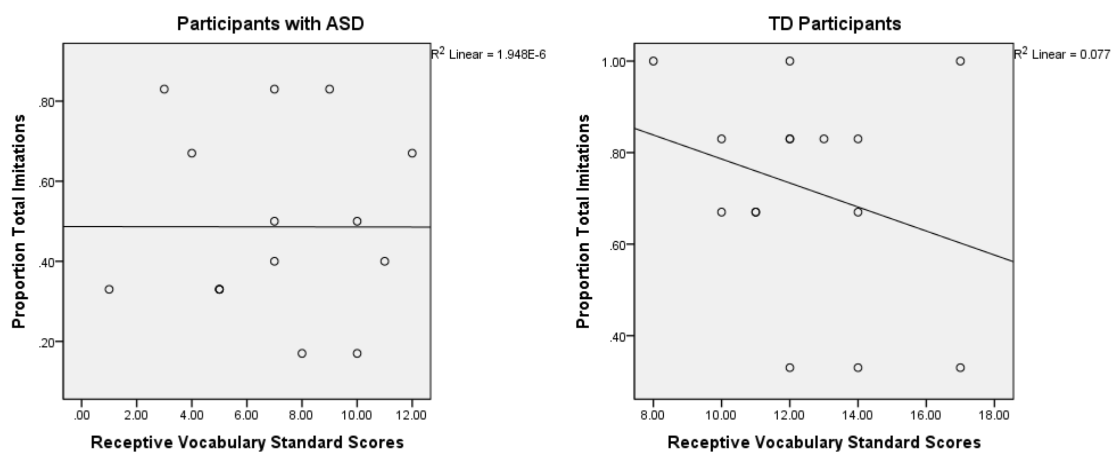


*Figure 10.* Receptive Vocabulary standard scores plotted against total (spontaneous + prompted) imitations demonstrated at 60 m.

**Response time.** Similarly, a significant negative correlation was found between RV scores and the length of time it took for participants with ASD to produce spontaneous imitations at the short ($r$ = -0.51, $p < 0.05$, one-tailed) time delay (see Figure 11). Results (presented in Figure 11) demonstrate similar results for TD participants at a short time delay; there was a significant negative correlation between RV scores and the amount of time taken to produce spontaneous imitations ($r$ = -0.54, $p < 0.05$, one-tailed). In other words, participants with ASD and TD participants who had better language scores took less time to perform spontaneous imitations at short time delays. However, there was no significant correlation between RV scores and the length of time it took for participants with ASD ($r$ = -0.31, $p > 0.05$, one-tailed) or TD participants ($r$ = 0.10, $p > 0.05$, one-tailed) to produce spontaneous imitations at the longer time delay (see Figure 12).

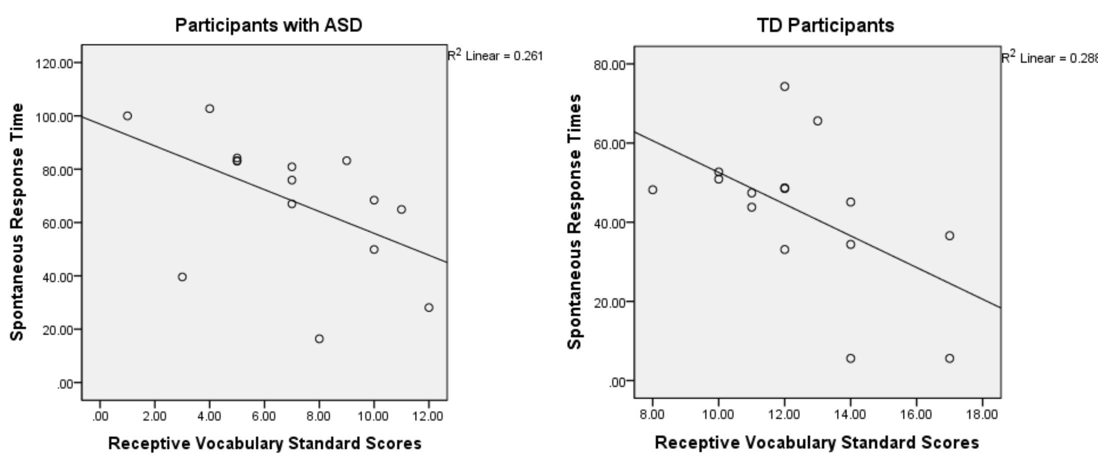


*Figure 11.* Receptive Vocabulary standard scores plotted against spontaneous response times at 10 m.

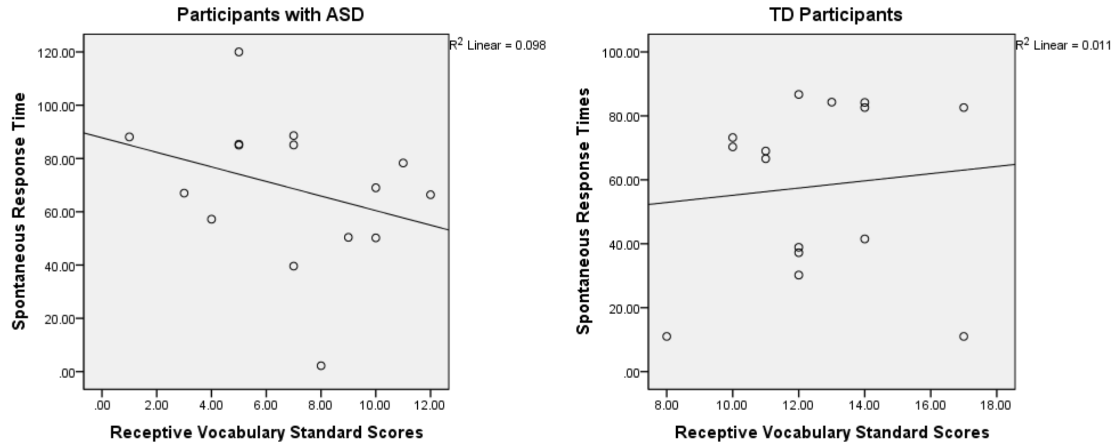


*Figure 12.* Receptive Vocabulary standard scores plotted against spontaneous response times at 60 m.

There was no significant correlation between RV scores and the length of time it took for participants with ASD ($r$ = -0.28, $p$ > 0.05, one-tailed) or TD participants ($r$ = -0.31, $p$ > 0.05, one-tailed) to produce accurate spontaneous imitations at the short time delay (see in Figure 13). Similarly, there was no significant correlation between RV scores and RT for accurate spontaneous imitations for participants with ASD ($r$ = 0.11, $p$ > 0.05, one-tailed) or TD participants ($r$ = -0.31, $p$ > 0.05, one-tailed) at a longer time delay (see Figure 14).

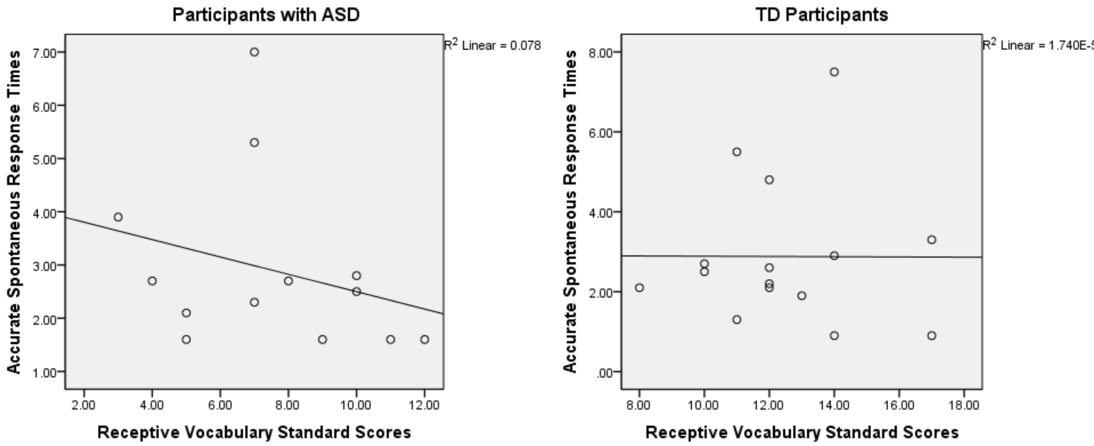


*Figure 13.* Receptive Vocabulary standard scores plotted against response times (accurate trials only) at 10 m.

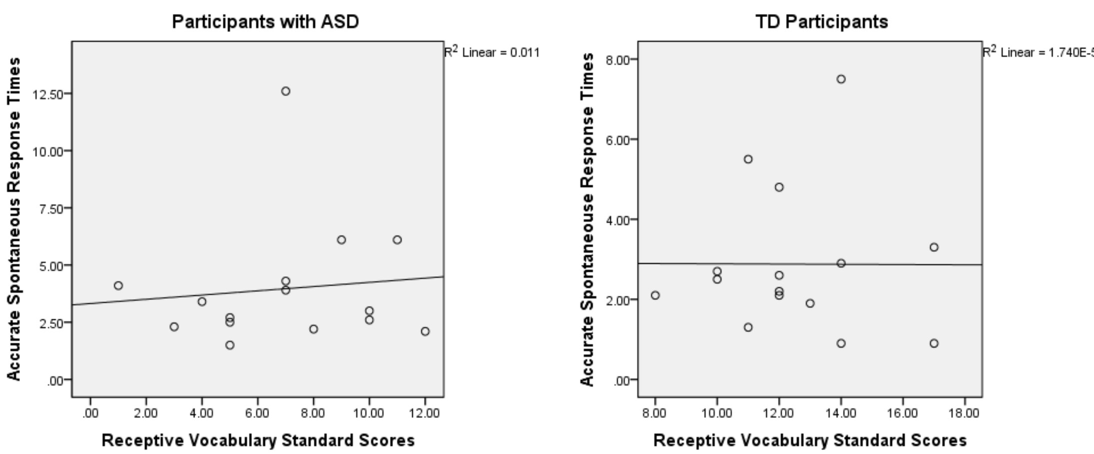


*Figure 14.* Receptive Vocabulary standard scores plotted against response times (accurate trials only) at 60 m.

**Prompts.** There was a significant negative correlation between RV scores and number of prompts given at the short time delay for participants with ASD ($r$ = -0.68, $p$ > 0.01, one-tailed; see Figure 15). Similarly, there was a significant negative correlation between RV scores and number of prompts given to TD participants at a short time delay ($r$ = -0.57, $p$ < 0.05, one-tailed; see Figure 15). There was no significant correlation between number of prompts at a longer time delay for participants with ASD ($r = 0.06$, $p > 0.05$, one-tailed) or TD participants($r = 0.08$, $p > 0.05$, one-tailed; see Figure 16).

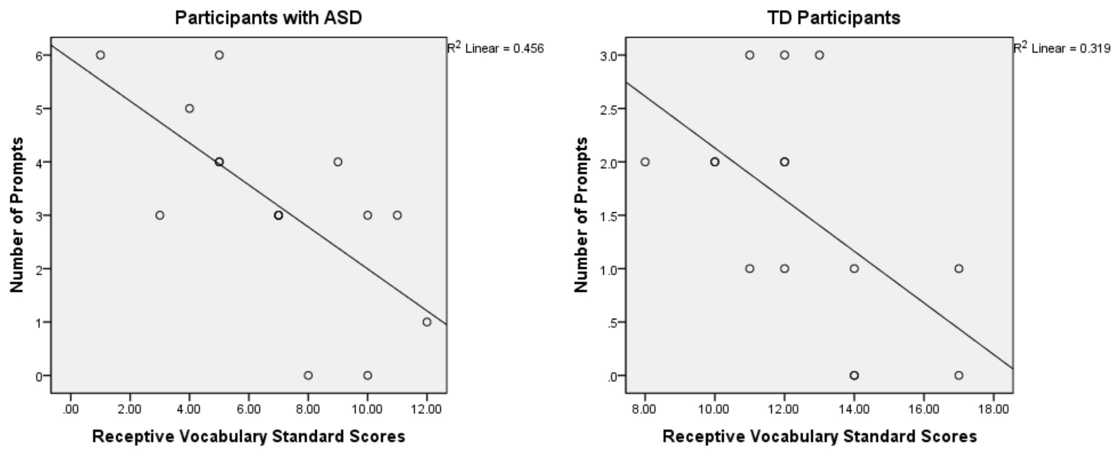


*Figure 15.* Receptive Vocabulary standard scores plotted against number of prompts given at 10 m.

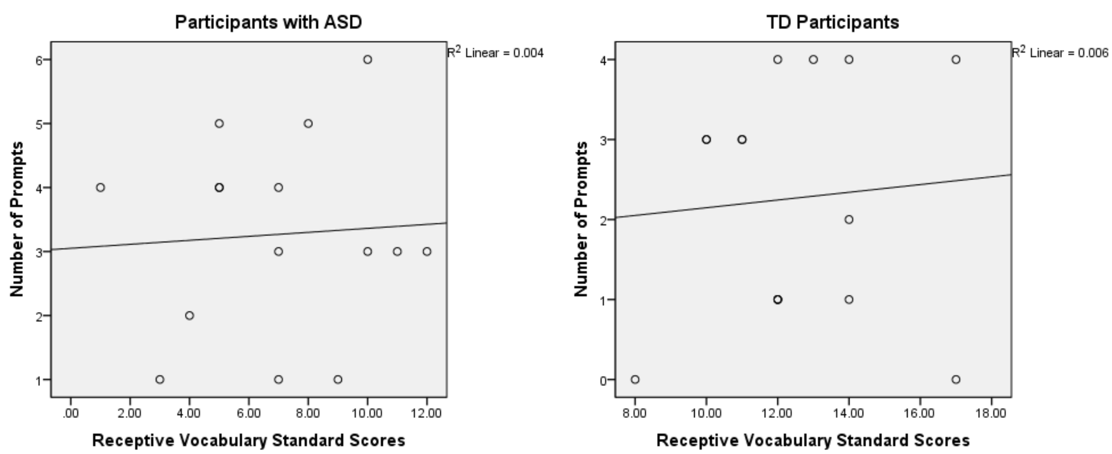


*Figure 16.* Receptive Vocabulary standard scores plotted against number of prompts given at 60 m.

**Language and imitation accuracy.** Because RV scores were significantly related to accuracy at short time delays, an Analysis of Covariance (ANCOVA) was conducted. A 2 X 2 (Group [ASD, TD] and Time Delay [10 min, 60 min]) ANCOVA was conducted to explore group differences in spontaneous imitation accuracy at both the short and longer time delays when RV standard scores were held constant. This was a mixed ANOVA with Group serving as a between factor and Time Delay serving as a within factor. Proportion of items imitated spontaneously and correctly served as the dependent variable. The covariate (RV) was significantly related to Time Delay ($F(1,27) = 9.81$, $p < 0.01$, $\eta^2 = 0.21$) but not to Group ($F(1, 27) = 2.75$, $p = 0.11$, $\eta^2 = 0.09$). Results (presented in Figure 17) revealed a significant main effect of Time Delay ($F(1, 27) = 7.36$, $p < 0.01$) but no significant effect of Group and no significant interaction. Visual inspection of means revealed that participants in both groups produced more accurate independent imitations at a short time delay ($M = 0.62$) than at a longer time delay ($M = 0.56$). Therefore, it is possible that differences in number of accurate spontaneous imitations demonstrated are, at least partly, influenced by language. Further investigations are needed to determine other factors (such as memory) that may play a role at longer time delays. It should be noted that inspection of means also suggested a trend toward significance for the interaction; in other words, participants with ASD appeared to be more accurate at a short ($M = 0.61$) than a longer ($M = 0.41$) time delay whereas TD participants appeared to be less accurate at the short ($M = 0.63$) than the longer ($M = 0.71$) time delay.

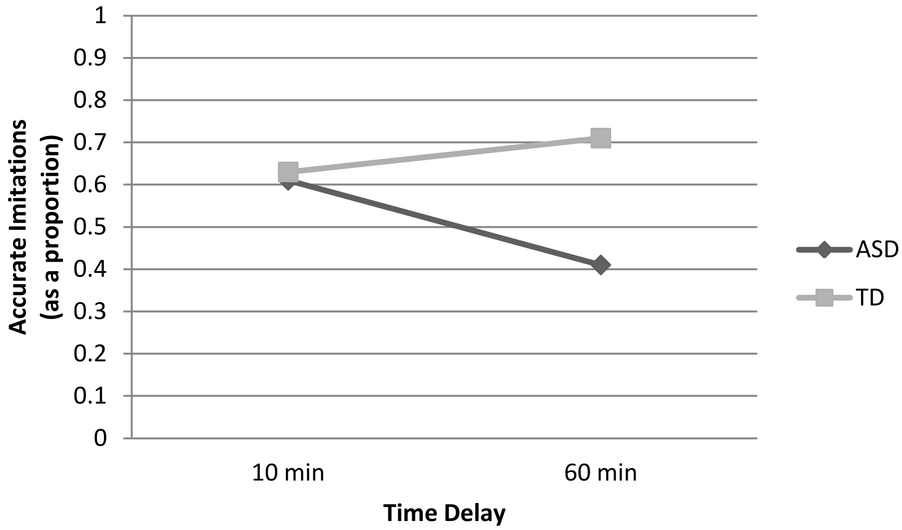


*Figure 17.* Proportion of accurate spontaneous imitations demonstrated by participants with ASD and TD participants at 10 m and 60 m with Receptive Vocabulary scores held constant.

Similarly, a 2 X 2 (Group [ASD, TD] and Time Delay [10 min, 60 min]) ANCOVA was conducted to determine if a group differences in total (i.e. spontaneous + prompted) accuracy existed at both the short and longer time delay when RV standard scores were held constant. This was a mixed ANCOVA with Group serving as a between factor and Time Delay serving as a within factor. Proportion of items imitated correctly served as the dependent variable. The covariate (RV) was significantly related to Time Delay ($F(1,27) = 9.30$, $p < 0.01$, $\eta^2 = 0.26$) but not to Group ($F(1, 27) = 3.41$, $p > 0.05$, $\eta^2 = 0.26$). Similar to the results for spontaneous imitations above, the results (presented in Figure 18) revealed a significant main effect of Time Delay ($F(1, 27) = 6.79$, $p < 0.05$, $\eta^2 = 0.20$) but no significant effect of Group and no significant interaction. Visual inspection of means revealed that participants produced more accurate total imitations at a short time delay ($M = 0.67$) than at a longer time delay ($M = 0.60$). The same ANOVA calculated without RV as covariate demonstrated a significant effect of group affiliation (participants with ASD demonstrated fewer accurate imitations than TD participants at both time delays). This supports language as a contributing factor in deferred imitation ability. Once again, a visual inspection of means suggests a trend toward significance for the interaction in that participants with ASD were more accurate at a short (*M* = 0.66) than a longer (*M* = 0.46) time delay but TD participants were less accurate at the short (*M* = 0.68) than the longer (*M* = 0.75) time delay.

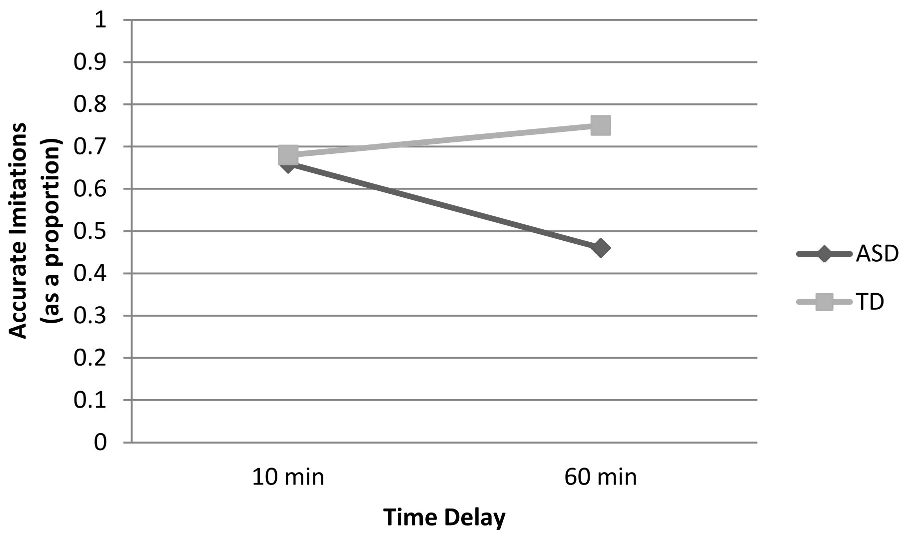


*Figure 18.* Proportion of accurate total (spontaneous + prompted) imitations demonstrated by participants with ASD and TD participants at 10 m and 60 m with Receptive Vocabulary scores held constant.

**Language and imitation response time.** A 2 X 2 (Group [ASD, TD] and Time Delay [10 min, 60 min]) ANCOVA was conducted to determine if group differences in RT for spontaneous imitations existed at both the short and longer time delays when RV standard scores were held constant. This was a mixed ANCOVA with Group serving as a between factor and Time Delay serving as a within factor. Average time (in seconds) to respond spontaneously served as the dependent variable for the ANCOVA. The covariate (RV) was not significantly related to Time Delay but it was significantly related to Group ($F(1,27) = 4.26$, $p < 0.05$). Results (presented in Figure 19) revealed no significant main effect of Group and no significant main effect of Time Delay and no significant interaction.

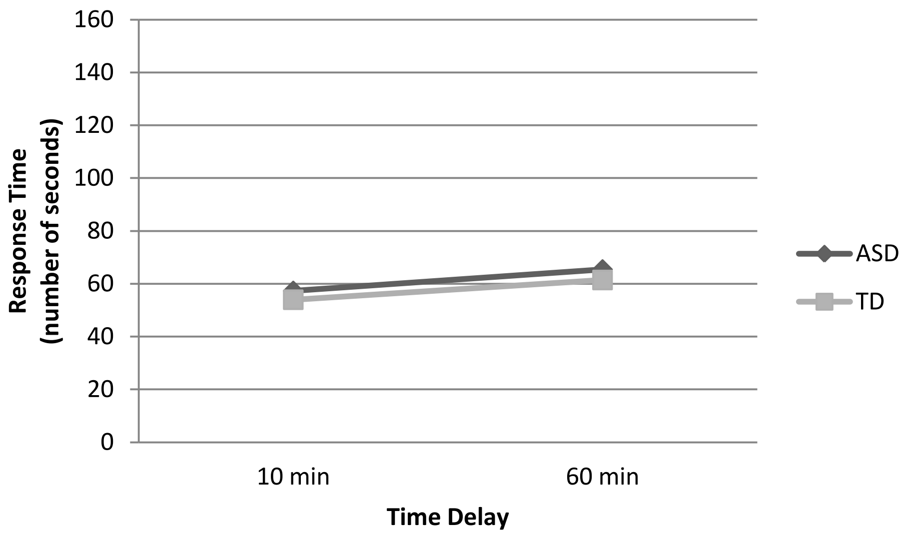


*Figure 19.* RTs (number of seconds taken to imitate) at 10 m and 60 m for participants with ASD and TD participants with Receptive Vocabulary scores held constant.

A 2 X 2 (Group [ASD, TD] and Time Delay [10 min, 60 min]) ANCOVA was conducted to determine if group differences in RT for accurate spontaneous imitations existed at both the short and longer time delays when RV standard scores were held constant. This was a mixed ANCOVA with Group serving as a between factor and Time Delay serving as a within factor. Average time (in seconds) to respond accurately and spontaneously served as the dependent variable for the ANCOVA. The covariate was not significantly related to Time Delay or Group. Results revealed no main effects of Time Delay or Group and no significant interaction. However, it should be noted that the power to detect a difference was low for Group (0.05), Time Delay (0.07), and any interaction (0.15) and visual inspection of means suggests a possible interaction such that accurate spontaneous RT for TD participants was similar at short ($M$ = 3.08) and longer ($M$ = 3.21) time delays whereas accurate spontaneous RT for participants with ASD increased between short ($M$ = 2.67) and longer ($M$ = 3.90) time delays.

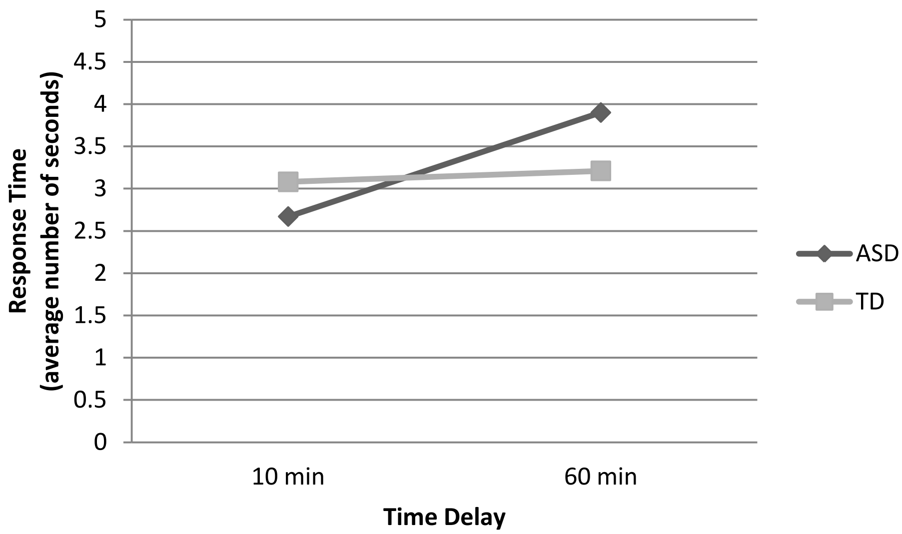


*Figure 20.* Accurate RTs (average number of seconds taken to imitate for accurate trials only) at 10 m and 60 m for participants with ASD and TD participants with Receptive Vocabulary scores held constant.

**Language and prompts.** A 2 X 2 (Group [ASD, TD] and Time Delay [10 min, 60 min]) ANCOVA was conducted to determine if participants with ASD required more prompts than TD participants at both short and longer time delays. This was a mixed ANCOVA with Group serving as a between factor, Time Delay serving as a within factor, and RV standard scores serving as covariate. Total number of prompts given served as the dependent variable. RV scores were significantly related to both Time Delay ($F(1, 27) = 9.59$, $p < 0.01$, $\eta^2 = 0.26$) and Group ($F(1, 27) = 4.63$, $p < 0.05$, $\eta^2$ =

0.15). Results (presented in Figure 21) revealed a significant main effect of Time Delay ($F(1, 27) = 7.03$, $p < 0.05$, $\eta^2 = 0.21$) but no significant main effect of Group and no significant interaction. These results contrast with the finding that, when RV is not entered as a covariate, number of prompts given varies by group affiliation, with participants with ASD receiving more prompts than TD participants. The current findings suggest that language skills, through their association with group affiliation (with ASD students having lower language scores) play a role in deferred imitation. Visual inspection of means reveals that participants in both groups required fewer prompts at the short ($M = 2.37$) time delay than at the long ($M = 2.67$) time delay. Further inspection of means suggests a trend toward a significant interaction such that participants with ASD required fewer prompts at the short time delay ($M = 2.27$) than at the longer time delay ($M = 3.37$), but TD participants required more prompts at the short time delay ($M = 2.46$) than at the longer time delay ($M = 2.16$). This may suggest that, similar to the correlations above, language may play a greater role in imitation at a short versus a longer time delay.

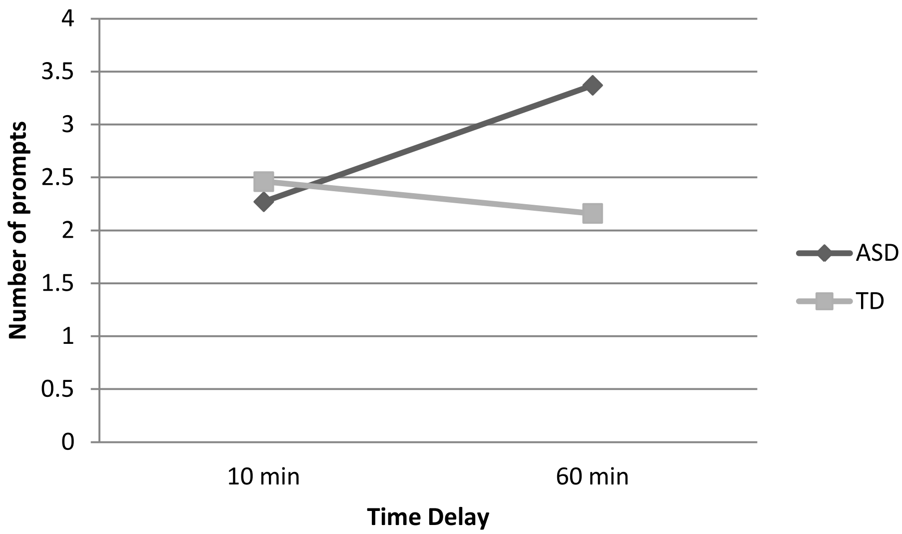


*Figure 21.* Number of prompts given to participants with ASD and TD participants at 10 m and 60 m with Receptive Vocabulary scores held constant.

## Summary

Chapter four has provided an analysis of the results of the current study, including group differences in accuracy, RT, the effect of prompts, and the relation of language to these factors. Chapter five will present an interpretation of these results with respect to the extant literature on deferred object oriented imitation as well as implications to theory, research, and practice, and an overview of the limitations of the study.

# Chapter Five

## Discussion

Chapter four provided an analysis of the results of the study for each of the research questions. This chapter will examine the findings in relation to the extant literature, along with a discussion of the limitations of this research, and suggested directions for future research.

Imitation is an important skill that facilitates the acquisition of new skills (Bandura, 1986; Nielsen & Dissanayake, 2003). Developmentally, imitation helps infants and young children develop increasingly more complex social skills that are crucial for day-to-day living (Meltzoff & Decety, 2003; Rogers & Pennington, 1991). The capacity to imitate after a delay is an important foundation for learning, in that often individuals do not have the opportunity to immediately imitate the actions of others. The developmental literature in TD children suggests that they are able to engage in imitation after varying time delays (ranging from 24 hours to 1 week) starting in infancy (Meltzoff, 1988a, 1988b); however, the picture is much less clear for individuals with ASD. In fact, Rogers & Pennington (1991) suggest that an imitation impairment may be one important cause of impairment in higher-level social skills seen in individuals with ASD.

The current research was designed to examine the imitation capabilities of children with ASD across several different conditions. Imitation performance of children with ASD was investigated on both spontaneous and prompted deferred imitation tasks, in order to explore spontaneous imitation and imitation capabilities when given prompts. In addition, imitation was examined at both short and long time delays, and compared to foundational language abilities. Overall, the aim of this study was to provide more understanding of imitation in children with ASD, particularly as, clinically, this has been noted as an area of concern (Williams et al., 2004).

This study attempted to replicate previous research, by including spontaneous and prompted imitation conditions both at short (10 m) and longer (60 m) time delays. As in previous research, a measure of verbal skills was included to explore the link between deferred imitation and language. Research stimuli and procedures were modelled based on Meltzoff's (1988a, 1988b) research paradigm. The inclusion of a verbal prompt built on previous research (Hobson & Lee, 1999) and was included to determine whether failures to imitate in children with ASD are due to a misunderstanding of task demands in experimental paradigms (i.e., lack of awareness that they are supposed to imitate the examiner) or true differences in imitation capabilities.

The performance of children with ASD was compared to that of their same-age TD peers in terms of accuracy and response time (RT). Accuracy was defined as number of correct object oriented target actions copied correctly whereas response time was defined as length of time from presentation of an object to start of the spontaneous imitation. These variables were explored in order to (a) examine the ability of children with ASD to engage in deferred imitation, as compared to TD controls; (b) determine the impact of differing time intervals (10 m versus 60 m) on the ability of children with ASD and TD children to engaged in deferred imitation; and (c) examine the role of a verbal prompt on the ability of children with ASD to engage in deferred imitation, as compared to TD controls. The results of the current investigation were intended to shed light on the ability of children with ASD to imitate after various delay intervals with and without prompting. Understanding the factors that influence whether children with ASD engage in deferred imitation and how they do so is important due to the role that deferred imitation is purported to play in the development of social and communication skills (Rogers & Pennington, 1991; Rogers, 1999; Toth et al., 2006).

**Spontaneous Deferred Imitation**

Our first research hypothesis explored whether children with ASD demonstrated fewer accurate deferred imitations (spontaneous object oriented imitations) than TD children, whether it took them longer to engage in spontaneous deferred imitation, and whether this was the case over short and longer time delays. It was hypothesized that participants with ASD would demonstrate fewer accurate spontaneous object oriented imitations than TD participants at both short and longer time delays and that participants with ASD would take longer to display object oriented imitation both at short and longer time delays. Results supported these hypotheses, in that children with ASD performed fewer accurate spontaneous imitations and took longer to do so than their TD counterparts at short and longer time delays. These group differences did not appear to be simply due to lack of interest in manipulating the objects in children with ASD, because during the baseline phases both children with ASD and TD children showed equal interest in manipulating the objects. These results are consistent with previous research demonstrating that individuals with ASD perform fewer accurate deferred imitations than typically developing individuals (Dawson et al., 1998; Rogers et al., 2008; Strid et al., 2012; Strid et al., 2013).

In looking more closely at the response time data for spontaneous imitations, it appeared that children with ASD were slower to engage in spontaneous imitations at both time delays than TD children, and that children with ASD took a similar amount of time to engage in spontaneous imitation across both shorter and longer time delays. In contrast, the response times for TD children were faster at the short versus longer time delays. The interaction was not statistically significant, likely due to lack of statistical power, but this trend is worthy of further explanation. A possible explanation for this trend could be short-term memory difficulties in children with ASD. In other words, it may be that children with ASD are unable to remember what action to perform or how to perform the action at both short and longer time delays. On the other hand, while TD children are able to initially remember actions, there is some degree of forgetting that occurs over time. Indeed, Klein and Meltzoff (1999) found a similar result in TD children who were asked to imitate object oriented actions after varying delays from 3 min up to 4 weeks: children were able to produce accurate imitations at all time delays, but the number of accurately performed imitations decreased over time.

Response times were also examined for trials in which children with ASD and TD children demonstrated accurate spontaneous deferred imitations. When only considering accurate spontaneous imitations, results revealed no differences in response time between children with ASD and TD children across either time delay. Upon further examination, there appeared to be an interaction that, while not significant, likely due to lack of statistical power, is worthy of consideration. It appeared that at the short time delay, children with ASD and TD children took a similar and quick amount of time to imitate accurately but, at a longer time delay, while TD children still were quick to imitate accurately, children with ASD appeared to take more time. One possible explanation for this finding is that, even when children with ASD are able to perform accurate deferred imitations, this is still an onerous task that requires more effort than it does for TD children.

**Prompted Deferred Imitation**

In addition to spontaneous deferred imitation, prompted deferred imitation was explored in this study. Our research question explored whether the addition of verbal prompt would lead to increased accuracy of deferred imitations in children with ASD over both short and longer time delays. Previous research (Hobson & Lee, 1999; McDonough et al., 1997; Wu et al., 2011) has demonstrated that when individuals with ASD receive a verbal cue, they are as accurate as TD individuals. In the current investigation, participants were given the opportunity to spontaneously imitate and then were only given a verbal prompt if they did not accurately imitate the target action. This addition to the typical spontaneous imitation paradigm was intended to explore whether participants with ASD fail to accurately imitate at differing time delays due to a misunderstanding of task demands (i.e. lack of awareness that the examiner wants them to imitate), rather than an inability to imitate. It was hypothesized that participants with ASD would require a greater number of verbal prompts than TD participants. It was also hypothesized that the addition of the verbal prompt would lead participants with ASD to produce as many accurate target actions as their typically developing counterparts. Results confirmed that participants with ASD did need a greater number of prompts than TD participants in order to engage in deferred imitation; however, surprisingly and unexpectedly so (based on our hypotheses), even when receiving verbal prompts, participants with ASD were still not as accurate as TD participants. These results contradict the findings of (Hobson & Lee, 1999; McDonough et al., 1997; Wu et al.,

2011) that children with ASD can perform as many accurate deferred imitations as their typically developing counterparts when they are given a verbal cue. On the other hand, these results do support research (Dawson et al., 1998; Rogers et al., 2008; Strid et al., 2012; Strid et al., 2013) that provides evidence of an impairment experienced by children with ASD in spontaneous deferred imitation. Taken together, these studies provide support for the intersubjectivity model of Rogers and Pennington (1991) that posits a primary role of imitation in the social development of children with ASD. This theory suggests that children with ASD should experience an imitation impairment in any paradigm, even when prompted to imitate, as was the result in the current study. Although beyond the scope of the current investigation, future investigations should address whether children with ASD simply cannot remember the target action (i.e. they have memory impairment) and therefore, even with a verbal prompt, would not be expected to accurately perform the actions.  In addition, it would be interesting to explore whether use of a different type of prompt, rather than the standard verbal prompt as is typically used in such research, would be more helpful for children with ASD. For example, perhaps a motor prompt, such as moving children's' hands to the object, may have increased the number of accurate actions performed. These investigations may shed more light on the abilities of children with ASD to engage in deferred imitation and in what paradigm they may do so.

**Language and Deferred Imitation**

Research has found that language may play a role in spontaneous and prompted deferred imitation (Dawson et al., 1998; Hobson & Hobson, 2008; Strid et al., 2012; Strid et al., 2013). Some studies (e.g. Dawson et al., 1998; Strid et al., 2012; Strid et al., 2013) found that, even though participants with ASD were matched to other participants on measures of verbal ability, participants with ASD performed fewer accurate, spontaneous deferred imitations at differing delays. According to Strid and colleagues (2012 and 2013), these results point to a specific imitation impairment for children with ASD as compared to TD children. Rogers and colleagues (2008), whose paradigm required spontaneous imitation and who did not originally match participants based on verbal skills, found that participants with ASD performed fewer deferred imitations as compared to TD children and children with developmental delay. However, when differences in verbal abilities were controlled for statistically, there were no significant differences between participants with ASD and controls. According to Rogers and colleagues (2008), language and imitation skills are highly related in children with ASD and, thus, controlling for language ability removes some of the variability associated with imitation skills, thereby reducing any group differences on deferred imitations. Therefore, any impairment in deferred imitation for individuals with ASD is likely related to language impairments and not due to a specific imitation impairment.

Along similar lines, Toth and colleagues (2006) found that deferred imitation abilities, along with toy play, significantly predicted later language abilities. These authors found that immediate imitation and joint attention skills were related to initial language development and they speculated that these skills set the stage for social and communicative exchanges in which language can develop. Deferred imitation on the other hand involves not only shared attention by representational thought (forming and storing a mental representation), intact recall memory (calling up that representation at a later time), and cognitive and motor planning skills that allow an individual to execute that represented act. Therefore, any impairment in language and/or deferred imitation may be the result of impairments in these common and core skills.

At the moment it is unclear whether deferred imitation difficulties seen in individuals with ASD are related to an autism-specific imitation impairment or are associated with a more general language difficulty. We hypothesized that language would be significantly related to (a) number of accurate spontaneous and accurate total object oriented imitations demonstrated, (b) length of time to taken to demonstrate spontaneous object oriented imitations, and (c) number of prompts given at a short and a longer time delay. As expected, children with ASD scored significantly lower on an index of language (Receptive Vocabulary) as compared to TD children. At the short time delay, language was significantly related to number of spontaneous and total (i.e. spontaneous and prompted) accurate deferred imitations, length of time taken to demonstrate spontaneous deferred imitations, and number of prompts given for children with ASD. These results partially support our hypotheses and may support the link between language and deferred imitation posited by Toth and colleagues (2006). Perhaps children with ASD with low language scores struggle to form mental representations (essential to language and deferred imitation) and so also struggle to perform accurate deferred imitations. At a short time delay, the language index was related to spontaneous response times and number of prompts but not to number of spontaneous or total (i.e. spontaneous and prompted) accurate deferred imitations for TD children. In other words, TD children were able to perform accurate deferred imitations regardless of their language scores, but those with lower language scores took longer and required more prompts to do so. Maybe TD children are able to form mental representations but find it more difficult to access these representations (i.e. have difficulties with recall memory that is essential to both language and deferred imitation) and therefore, take longer to do so and require more prompts to cue them to the correct target actions.

At a longer time delay, language was not significantly related to any measure for either group of children. It may be that at a longer time delay, memory becomes a more important factor. It is possible that, at a longer time delay, participants simply do not remember the target action to be performed. These results make sense if, as hypothesized above, memory plays a role in deferred imitation. It may be the case that memory is more strongly related to deferred imitation at a longer time delay, since it can be assumed that it is more difficult to remember target actions over increasing amounts of time, just as Klein and Meltzoff (1999) found in their study. It is interesting to note that language was strongly related to most measures for participants with ASD, but not for TD participants. These results seem to suggest that language may be a more important factor in deferred imitation for individuals with ASD than for TD individuals and this is confirmed by the findings of Toth and colleauges (2006). These contrasting results for children with ASD and TD children are interesting and warrant further examination with more sophisticated language measures.

Because language was significantly related to accuracy at short time delays, Analyses of Covariance (ANCOVAs) were conducted to explore deferred imitation with the effect of language held constant. When language was not held constant, children with ASD were significantly less accurate than TD children. However, when language was held constant, results for spontaneous and total accuracy of deferred imitations revealed that all children, regardless of group affiliation, performed similarly and were more accurate at short versus longer time delays. Additionally, when language was held constant, all participants performed similarly and received significantly fewer prompts at a shorter time delay than at a longer time delay. An examination of length of time taken to spontaneously imitate after short or longer time delays revealed that, when language was held constant, there was no difference across groups (ASD, TD) or at differing time delays. In other words, both children with ASD and TD children took the same amount of time to engage in deferred imitation at a short and at a longer time delay. The same result was found for trials in which participants successfully engaged in accurate deferred imitation was examined. These results lend support to the suggestion that language, rather than a specific imitation impairment, is the reason for deferred imitation impairments seen in children with ASD.

However, further examination of the ANCOVA results revealed some non-significant trends that warrant comment. Examination of one trend revealed that, while TD children's accuracy was more or less the same at a short than a longer time delay, children with ASD were as accurate as TD children at a short time delay but appeared to be less accurate at a longer time delay. Also, although TD children received about the same number of prompts across time delays, children with ASD appeared to receive more prompts at a longer time delay. Finally, while TD children took the same amount of time to demonstrate accurate deferred imitations across time delays, children with ASD took longer than TD children to demonstrate accurate deferred imitations at a longer time delay, even though they took about the same amount of time as TD children at a short time delay. Further investigation of these trends with a larger sample size is warranted and may provide evidence of a more global impairment in imitation for individuals with autism.

**Limitations and Directions for Future Research**

The present study provides a new examination of deferred imitation ability in individuals with ASD as compared to TD controls. This study builds on previous research by examining the deferred imitation of children with ASD, as compared to TD children, at varying time delays and by cuing children with a verbal prompt when they did not spontaneously engage in deferred imitation. The role of language in deferred imitation was also explored. However, as with most research, limitations exist that must be addressed. First, the sample size was limited due to the difficulty of recruiting participants with ASD. It would be beneficial to replicate the current results with a larger sample. In addition, many statistical tests were conducted, increasing the chance of a Type I error (i.e. the chance of finding a significant effect when one does not, in reality, exist; Howell, 2008). This should be taken into consideration when interpreting the current results. Further, a convenience method of sampling was used to recruit participants, rather than random sampling. As a result, it is hard to determine how closely the current sample reflects the general population of young children with ASD and, therefore, generalizing the current results should be done with caution. Future research with a representative sample would be valuable.

When comparing children with ASD to others on any task, it is preferable to match these groups of participants on more than just age, as was the case in this study. It was beyond the scope of this study to include multiple control groups that matched participants with ASD on important skills and characteristics, such as IQ, developmental age, nonverbal skills, as well as gender balance. Replication of the current study with multiple comparison groups would enhance the utility of the findings. Further, in the current study, parents provided a copy of the diagnostic report for children with ASD and this served to determine who would be included in the group of children with ASD. In future, results of the current study should be replicated with more rigorous screening procedures conducted by a trained clinician.

Language is an important factor in deferred imitation research. The current study utilized the Receptive Vocabulary subtest of the WPPSI-III as a measure of language. However, vocabulary is not the only measure of language and the current study should be replicated with more comprehensive language measures.

The current study did not include a measure of memory. Future research could extend the current results by directly testing memory to determine its possible role in deferred imitation and children with ASD. Is it the case that children with ASD have more difficulty than TD children in remembering target actions at longer time delays and, thus, produce fewer deferred imitations? The current study used only one kind of prompt: a verbal prompt. The current results could be extended to include motor prompts, as well. Similarly, it would be interesting to examine the role of motivation in deferred imitation and children with ASD. Are children with ASD more likely to engage in deferred imitation if they receive a verbal or physical reward?

Finally, the current study used simple, means-end tasks that children with ASD typically have less difficulty imitating (Rogers et al., 2008). Future research should explore the abilities of children with ASD to engage in different kinds of imitation including imitation of hand gestures or facial expressions.

**Implications of the Findings**

Despite these limitations, the present study makes an important contribution to ASD research, especially to the children themselves, their families, and professionals working in intervention settings. This study adds to current knowledge of deferred imitation abilities in young children with ASD by examining both spontaneous and prompted deferred imitation in the same paradigm. It adds to existing research by investigating the effect of a verbal prompt for children who do not spontaneously imitate at different time delays. Current results suggest that children with ASD demonstrate fewer accurate deferred imitations, take longer to demonstrate deferred imitations, and require more prompts to demonstrate accurate deferred imitations. Taken together, results suggest that children with ASD truly struggle to engage in deferred imitation and do not simply misunderstand task demands. The current results point to a role for language in deferred imitation for children with ASD, similar to the findings of Rogers and colleagues (2008) and Toth and colleagues (2006).

Practically, these results provide important knowledge for professionals working in intervention settings. It is important for professionals to know that children with ASD may not automatically imitate others, even after a time delay. Also, language skills may be a predictor of deferred imitation abilities, and professionals need to be aware of this. It is likely that children with ASD need explicit instruction in deferred imitation. Children with ASD may need help remembering actions to be imitated. Further, verbal prompting may not be an effective teaching practice and others must be explored.

**Final Summary**

Imitation is an important skill that facilitates the acquisition of new skills (Bandura, 1986; Nielsen & Dissanayake, 2003). Sometimes it isn't possible to immediately imitate a model, and if individuals weren't able to imitate after a delay, important learning opportunities would be lost.

Imitation is an important developmental skill that helps infants and young children develop more complex social skills required in day-to-day living (Meltzoff & Decety, 2003; Rogers & Pennington, 1991). Results of the current study suggest that children with ASD struggle to engage in deferred imitation more than TD children. The current study provides another piece of information in the growing body of literature concerning the different abilities of children with ASD.

**References**

American Psychiatric Association. (2000). *Diagnostic and statistical manual of mental disorders, 4th ed. (DSM-IV-TR).* American Psychiatric Association, Washington, DC.

Baron-Cohen, S. (1989). The autistic child's theory of mind: A case of specific developmental delay. *Journal of Child Psychology and Psychiatry, 30(2)*, 285-297.

Baird, G., Simonoff, E., Pickles, A., Chandler, S., Loucas, T., Meldrum, T., et al. (2006). Prevalence of disorders in the autism spectrum in a population cohort of children in South Thames: The Special Needs and Autism Project (SNAP). *Lancet, 368*, 210-215.

Bandura, A. (1977). *Social learning theory.* Englewood Cliffs, New Jersey, U.S.A.: Prentice-Hall, Inc.

Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory.* Englewood Cliffs, New Jersey, U.S.A.: Prentice-Hall, Inc.

Barr, R., Dowden, A., & Hayne, H. (1996). Developmental changes in deferred imitation by 6- to 24-month-old infants. *Infant behaviour and development, 19*, 159-170.

Bertrand, J., Mars, A., Boyle, C., Bove, F., Yeargin-Allsop, M., & Decoufle, P. (2001). Prevalence of autism in a United States population: The Brick Township, New Jersey, investigation. *Pediatrics, 108,* 1155-1161.

Bryson, S.E., & Smith, I.M. (1998). Epidemiology of autism: Prevalence, associated characteristics, and implications for research and service delivery. *Mental Retardation and Developmental Disabilities Research Reviews, 4,* 97-103.

Buccino, G., Binkofski, F., Fink, G.R., Fadiga, L., Fogassi, L., & Freund, H.J. (2001). Action observation activates premotor and parietal areas in a somatotopic area. *European Review of Neuroscience, 13,* 400-404.

Buccino, G., Vogt, S., Ritzl, A., Fink, G.R., Zilles, K., Freund, H.J., et al. (2004). Neural circuits underlying imitation learning of hand actions: An event-related *f*MRI study. *Neuron, 42,* 323-334.

Cattaneo, L., Fabbri-Destro, M., Boria, S., Pieraccini, C., Monti, A., Cossu, G., & Rizzolatti, G. (2007). Impairment of action chains in autism and its possible role in intention understanding. *Proceedings of the National Academy of Sciences, 104(45)*, 17825-17830. doi: 10.1073/pnas.0706273104

Colombi, C., Liebal, K., Tomasello, M., Young, G., Warneken, F., & Rogers, S.J. (2009). Examining correlates of cooperation in autism. *Autism, 13(2),* 143-163.

Conners, C.K. (1997). *Conners' Parent Rating Scale- Revised.* New York: Multi-Health Systems, Inc.

Dapretto, M., Davies, M.S., Pfiefer, J.H., Scott, A.A., Sigman, M., Bookheimer, S., Y., et al. (2006). Understanding emotions in others: Mirror neuron dysfunction in children with autism spectrum disorders. *Nature Neuroscience, 9,* 28-30.

Dawson, G., Meltzoff, A.N., Osterling, J., & Rinaldi, J. Neuropsychological correlates of early symptoms of autism. *Child Development*, *69(5)*, 1276-1285.

Gallese, V., Fadiga, L., Fogassi, L., & Rizzolatti, G. (1996). Action recognition in the premotor cortex. *Brain, 19,* 593-609.

Gangitano, M., Mottaghy, F.M., & Pascual-Leone, A. (2001). Phase-specific modulation of cortical motor output during movement observation. *Neuroreport, 12*, 1489-1492.

Hobson, R.P. & Hobson, J.A. (2008). Dissociable aspects of imitation: A study in autism. *Journal of Experimental Child Psychology, 101*, 170-185.

Howell, D.C. (2008). *Fundamental statistics for the behavioral sciences* (6th Ed.). Thomson Wadsworth: Belmont, CA.

Iacaboni, M., Woods, R.P., Brass, M., Beckering, H., Mazziotta, J.C., & Rizzolatti, G. (1999). Cortical mechanisms of human imitation. *Science, 286*, 2526-2528.

Learmonth, A.E., Lamberth, R., & Rovee-Collier, C. (2005). The social context of imitation in infancy. *Journal of Experimental Child Psychology*, *91*, 297-314. doi: 10.1016/j.jecp.2005.02.001

McDonough, L., Stahmer, A., Schreibman, L., & Thompson, S.J. (1997). Deficits, delays, and distractions: An evaluation of symbolic play and memory in children with autism. *Development and Psychopathology, 9*, 17-41.

Meltzoff, A.N. (1988a). Infant imitation after a 1-week delay: Long-term memory for novel acts and multiple stimuli. *Developmental Psychology, 24(4)*, 470-476.

Meltzoff, A.N. (1988b). Infant imitation and memory: Nine-month-olds in immediate and deferred tests. *Child Development, 59*, 217-225.

Meltzoff, A.N. (1990). Foundations for developing a concept of self: The role of imitation in relating self to other and the value of social mirroring, social modelling, and self practice in infancy. In D Cicchetti and M. Beeghly (Eds.). *The Self in Transition: Infancy to Childhood*. Chicago: University of Chicago Press.

Meltzoff, A.N. & Decety, J. (2003). What imitation tells us about social cognition: A rapprochement between developmental psychology and cognitive neuroscience. *Philosophical Transactions of the Royal Society of London, 358,* 491-500.

Meltzoff, A.N. & Moore, M.K. (1977). Imitation of facial and manual gestures by human neonates. *Science, 198,* 75-78.

Meltzoff, A.N. & Moore, M.K. (1983). Newborn infants imitate adult gestures. *Child Development, 54*, 702-709.

Newschaffer, C.J., Falb, M.D., Gurney, J.G. (2005). National autism prevalence from United States special education data. *Pediatrics*, *115,* e277-e282.

Nielsen, M. & Dissanayake, C. (2003). A longitudinal study of immediate, deferred and synchronic imitation through the second year. *The Interdisciplinary Journal of Artificial Intelligence and the Simulation of Behaviour, 1(4),* 305-318.

Oberman, L.M., Hubbard, E.M., McCleery, J.P., Altschuler, E.L., Ramachandran, V.S., & Pineda, J.A. (2005). EEG evidence for mirror neuron dysfunction in autism spectrum disorder. *Cognitive Brain Research, 24,* 190-198.

Ouellette-Kuntz, H., Coo, H., Lloyd, J.E.V., Kamara, L., Holden, J.J.A., & Lewis, M.E.S. (2007). Trends in special education code assignment for autism: Implication for prevalence estimates. *Journal of Autism & Developmental Disorders*, *37,* 1941-1948.

Perra, O., Williams, J.H.G., Whiten, A., Fraser, L., Benzie, H., & Perrett, D.I. (2008). Imitation and "theory of mind" competencies in the discrimination of autism from other neurodevelopmental disorders. *Research in Autism Spectrum Disorders, 2*, 456-468.

Rizzolatti, G. & Craighero, L. (2004). The mirror-neuron system. *Anuual Review of Neuroscience, 27*, 169-192. doi: 10.1146/annurev.neuro.27.070203.144230

Rizzolatti, G., & Destro, M. (2007). Understanding actions and the intentions of others: The basic neural mechanism. *European Review, 15(2)*, 209-222.

Rizzolatti, G., Fadiga, L., Fogassi, L., & Gallese, V. (1999). Resonance behaviours and mirror neurons. *Archives Italiennes de Biologie, 137,* 85-100.

Rizzolatti, G., & Luppino, G. (2001). The cortical motor system. *Neuron, 31*, 889-901.

Rogers, S.J. (1999). An examination of the imitation deficit in autism. In J. Nadel & G Butterworth (Eds.). *Imitation in Infancy*. Cambridge, U.K.: Cambridge University Press.

Rogers, S.J. & Pennington, B.F. (1991). A theoretical approach to infantile autism. *Development and Psychopathology, 3,* 137-162.

Rogers, S.J., Hepburn, S.L., Stackhouse, T., & Wehner, E. (2003). Imitation performance in toddlers with autism and other developmental disorders. *Journal of Child Psychology and Psychiatry, 44,* 763-781.

Rogers, S.J., Young, G.S., Cook, I., Giolzetti, A., & Ozonoff, S. (2008). Deferred and immediate imitation in regressive and early onset autism. *The Journal of Child Psychology and Psychiatry, 49(4)*, 449-457.

Sollberg, M., Rankin, K.P., & Miller, B.L. (2010). Social cognition. *Continuum: Lifelong Learning in Neurology, 16(4)*, 69-85.

Stone, W.L., Ousley, O.Y., & Littleford, C.D. (1997). Motor imitation in young children with autism: What's the object? *Journal of Abnormal Child Psychology, 25(6),* 475-485.

Strid, K., Heimann, M., Gillberg, C., Smith, L., & Tjus, T. (2012). Deferred imitation and social communication in speaking and non-speaking children with autism. *Focus on Autism and Other Developmental Disabilities, 20(10),* 1-11. doi: 10.1177/1088357612468030.

Strid, K., Heimann, M., & Tjus, T. (2013). Pretend play, deferred imitation, and parent-child interaction in speaking and non-speaking children with autism. *Scandinavian Journal of Psychology, 54*, 26-32. doi: 10.1111/sjop.12003.

Théoret, H., Halligan, E., Kobayashi, M., Fregni, F., Tager-Flusberg, H., & Pascual-Leone, A. (2005). Impaired motor facilitation during action observation in individuals with autism spectrum disorder. *Current Biology, 15,* R84-85.

Toth, K., Munson, J., Meltzoff, A.N., & Dawson, G. (2006). Early predictors of communication development in young children with autism: Joint attention, imitation, and play. *Journal of Autism and Developmental Disorders*, *36*, 993-1005. doi: 10.1007/s10803-006-0137-7

Wechsler, D. (2002). *Wechsler Preschool and Primary Scales of Intelligence*. (3rd Ed.). San Antonio, TX: The Psychological Corporation.

Williams, J.H.G., Whiten, A., & Singh, T. (2004). A systematic review of action imitation in autism spectrum disorder. *Journal of Autism and Developmental Disorders, 34,* 285-299.

Williams, J.H.G., Whiten, A., Suddendorf, T., & Perrett, D.I. (2001). Imitation, mirror neurons, and autism. *Neuroscience and Biobehaviour Review, 25,* 287-295.

Wu, C., Chiang, C., & Hou, Y. (2011). A two point time study of imitative abilities in children with autism spectrum disorders. *Journal of Applied Research in Intellectual Disabilities, 24,* 39-49. doi: 10.1111/j.1468-3148.2010.00595.x.

Yeargin-Allsop, M., Rice, C., Karapurkar, T., Doernberg, N., Boyle, C., & Murphy, C. (2003). Prevalence of autism in a US metropolitan area. *Journal of the American Medical Association, 289*, 49-55.

**Appendix A**

**Participant Consent Form**

University of Victoria
British Columbia • Canada

# *Participant Consent Form*

Your child is invited to participate in a study entitled **An Exploration of Deferred Imitation in Children with Autism Spectrum Disorder** that is being conducted by Jennifer Morgan.

Jennifer Morgan is a graduate student in the department of Educational Psychology and Leadership Studies at the University of Victoria and you may contact her if you have further questions by phone at (250) 507-7218 or e-mail at morganj@uvic.ca.

Conducting research is an important part of the requirements for a graduate degree in Educational Psychology. This research is being conducted under the supervision of Dr. Jillian Roberts. You may contact her at (250) 721-7759 of you have any questions. This research is being funded by the Canadian Institutes of Health Research (Frederick Banting and Charles Best Canada Graduate Scholarships- Master's Award).

**Purpose and Objectives**

In everyday life, we often learn and develop new skills by copying, or imitating, others. For example, a child may see his or her parent wave to a friend and copy the action. Our lives are busy, however, and we often do not have the ability to imitate a novel action immediately, so we must be able to imitate that action after a delay. This is referred to as deferred imitation. There is evidence that, even when not given the opportunity to imitate an action immediately, typically developing infants as young as 9 months can imitate after a 24 hour delay (Meltzoff, 1988b). Unfortunately, it is often the case that individuals with Autism Spectrum Disorder (ASD) struggle to imitate others (American Psychiatric Association, 1994), although research findings regarding deferred imitation have been mixed (Dawson et al., 1998; Rogers et al., 2008). Therefore, given the developmental importance of deferred imitation in learning new skills, the purpose of this research project is to untangle these mixed results and provide a clear picture of the ability of individuals with ASD to engage in deferred imitation.

**Importance of this Research**

It is hoped that the proposed research project will inform research, theory, and practice. It is hoped that the results will help to shed light on current research findings in the area of deferred imitation and ASD. Importantly, research of this type can provide important information for professionals working with children with ASD and their families.

**Participants Selection**

Your child is being asked to participate in this study because he or she has been diagnosed with ASD and his or her performance can shed light on the deferred imitation ability of children with this diagnosis *or* your child is typically developing and will provide an important contrast to the performance of the participants with ASD.

**What is involved?**
If you agree for your child to voluntarily participate in this research, your child's participation will involve 1.5 to 2 hours of participation. Participation will take place in a quiet room in your home, depending on your preference. With your permission, the experimental session will be videotaped for later analysis. During the experimental session, your child will be seated at a table across from the experimenter. The experimenter will present 12 objects to your child, one at a time, so that your child can play with each object for a brief period of time. Next, the experimenter will present each of the 12 objects one at a time and perform a simple action on the object (e.g. flick a switch). After a delay (10 minutes for each of 6 objects; 60 minutes for each of 6 objects), each object will be re-presented to your child one at a time. In doing this, I will be waiting to see if your child will imitate the same action on the object that was presented earlier. If your child performs an action on the object the next object will be presented. If, on the other hand, your child does not produce an action on the object, the experimenter will prompt your child to imitate the action (e.g. "copy what I did"). During the delay between observing actions and performing actions on objects, your child will watch a video on the experimenter's laptop computer.

**Risks**
There are no known or anticipated risks to your child by participating in this research.

**Benefits**
The potential benefits of your participation in this research include: (a) contributing to existing theoretical knowledge by providing a clearer empirical picture of the deferred imitation ability of individuals with ASD; (b) adding to theoretical views of the primacy of imitation abilities in the development of ASD (e.g. intersubjectivity model; Rogers & Pennington, 1991); and (c) providing additional information that can be of use to professionals working with individuals with ASD and their families.

**Compensation**
As a thank-you for your child's participation, he or she will be given a t-shirt with the logo, "I was a university student for a day." If you agree to participate in this study, this form of compensation to you must not be coercive; it is unethical to provide undue compensation or inducements to research participants. If you would not participate if the compensation was not offered, then you should decline.

**Voluntary Participation**
Your child's participation in this research must be completely voluntary. If you do decide that your child will participate, you or your child may withdraw at any time without any consequences or any explanation. If you, or your child, do withdraw from the study your child's data will not be included in the final analysis and will be destroyed.

**Anonymity**
In terms of protecting your anonymity, complete anonymity cannot be ensured during data collection and analysis, as data will be collected in the form of personal observation. Also, please be aware that the number of children with ASD in Victoria, BC is a fairly small group and this increases the possibility that any information provided could be linked back to individual participants in the current study. However, your child's real names will never be published and data will only be reported in group form; individual data will never be released and these steps should help to ensure your child's confidentiality. Further, when the data is stored, all names will

be removed and in their place a code number will be used. Confidentiality of your child and of his or her data will be protected as his or her names will never be revealed and coded data will be kept in a locked file cabinet and on a password protected USB drive at all times.

**Confidentiality**

Your confidentiality and the confidentiality of the data will be protected by storing electronic data on password protected USB drives. Hard copy and video cassettes will be stored in a locked filing cabinet. All data will be destroyed five years after completion of the study.

**Dissemination of Results**

It is anticipated that the results of this study will be shared with others in the following ways: (a) reported at an oral thesis defense; (b) presentations at scholarly meetings; (c) communicated with staff members at CAFCA; and/or (d) published in a scholarly journal.

**Disposal of Data**

Data from this study will be disposed of after five years. Electronic data will be deleted and video-cassettes will be burned, and paper documents will be shredded.

**Contacts**

Individuals that may be contacted regarding this study include: (a) the experimenter, Jennifer Morgan, at (250) 507-7218 or morganj@uvic.ca; or (b) thesis supervisor, Dr. Jillian Roberts, at (250) 721-7759.

In addition, you may verify the ethical approval of this study, or raise any concerns you might have, by contacting the Human Research Ethics Office at the University of Victoria (250-472-4545 or ethics@uvic.ca).

Your signature below indicates that you understand the above conditions of participation in this study and that you have had the opportunity to have your questions answered by the researchers.

**Visually Recorded Images/Data**

- Videos may be taken of my child for: Analysis _______

**Consent for my child to participate:**

| ______________________ | ______________________ | ____________ |
|---|---|---|
| *Name of Participant* | *Signature of parent/guardian* | *Date* |

***A copy of this consent will be left with you, and a copy will be taken by the researcher.***

# Appendix B

## Experimental Objects