Visual Feedback and Motor Imitation In Children

with Autism Spectrum Disorder

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Abstract

Autism Spectrum Disorder is a disorder characterized by social and communicative deficits. Children diagnosed with autism also exhibit problems with imitation and motor skills. Research has shown that the child’s inability to imitate could be a factor in the child’s inability to make mental representations of themselves and their surroundings. Additionally, children are often asked to perform many tasks that involve motor imitation. Some of the tasks that involve motor imitation are cutting, coloring, playing a new game, riding a bike, etc. Many studies looking at motor imitation in children with autism have used visual feedback in an attempt to improve imitation performance.

In the current study I used visual motor feedback in a series of motor imitation tasks in an attempt to improve motor imitation. Children with typical development and those with a diagnosis of autism were participants in this study. Children were randomly selected and placed into two groups, one received visual feedback and the other did not. Multiple repeated-measures analysis of variance (ANOVA) were used to compare the performance of the typical and ASD groups’ on the individual tasks. There was no overall effect on performance of the two groups. We also conducted a between subjects test to compare the group performance of the typical development and ASD group on each individual task. There was a group effect on multiple tasks. Lastly, we examined the ASD and TD group differences of overall rating scores on each of the three categories of motor movements. The meaningfulness and object/gesture category showed significantly lower ratings for the ASD group.
Motor Imitation in Children with Autism Spectrum Disorder

Autism Spectrum Disorder (ASD) is a disorder characterized by impairments in social interaction, communication, and stereotyped patterns of behavior (American Psychiatric Association, 2000). Impairment in social interactions can range from reciprocation with peers on a social and emotional level, nonverbal behaviors such as gestures and eye contact, and peer relationships overall. Impairment in communication can mean delays in or absences of spoken language, initiating communication, or being able to communicate in make believe play or social imitative play. Lastly, repetitive and stereotyped patterns of behavior can include repetitive activities, a preoccupation with an activity or object, repetitive motor gestures, or repeated rituals or routines. In addition to the above three categories another core feature that children with autism exhibit are impairments in motor skills and imitation (Larson, Bastian, Donchin, Shadmehr, & Mostofsky, 2008). Impairments in these areas have a profound effect on the social and communicative areas in a child’s life (Larson et al., 2008).

Social impairment is one of the most easily recognized impairments in persons with autism. The social impairment commonly seen in autism interferes with the child’s ability to play, engage in activities with peers, and restricts the child’s interests (Restall & Magill-Evans, 1994). One theory of social of impairment in ASD is that it is the result of dysfunction of the mirror neuron system in early development (Dapretto et al., 2005). The role of the mirror neuron system is to develop an understanding of other’s actions and intentions. Dapretto et al.’s (2005) study showed that children with ASD had no activity in the mirror area when viewing a video of a person showing facial expressions and asked to imitate those expressions. Even when they were able to imitate the expressions of others, there was absent motor neuron activity, meaning that they possibly did not understand the action or intention. The motor neuron system can
clearly be an underlying factor of the social deficits found in ASD. The inability to understand others actions and intentions, as well as how their own actions and intentions may be perceived may also affect how a child communicates with their peers and caregivers.

Poor communication is often seen in children with ASD. They are commonly referred to as ‘non-social’ and often seen playing alone, unaware of their peers play. Play is important to communication because it serves as a central aspect of development. For instance, children by the age of five usually play make-believe and want to conform to peers during play (Destefanis & Firchow, 2013). An area of communication that is used often in children’s play is social imitative play. The ability to imitate other peers or bring imitations from home (e.g., playing house) is important when playing with peers. Not only does this represent that the child can create mental representations, but also that they can learn from their peers, which often happens without effort or intent (McDuffie, Turner, Stone, Yoder, Wolery, & Ulman, 2006). Restall et al. (1994) evaluated areas of play in children that included motor play, social play, and imaginative play. The results of the study show that when children with deficits in communication are in a familiar environment and receive few communicative demands, they are better able to socialize and, therefore, be successful at play (Restall et al., 1993). Thus, if parents and teachers become more involved in play, even by sitting in on a child’s play, this could further the development of communication skills in play.

ASD is also often associated with impairments in motor skills. A meta-analysis focused on motor impairments in ASD found that motor deficits were clearly present in both upper and lower extremities in children with autism (Fournier, Hass, Nalk, Lodha, & Cauraugh, 2010). Other fine and gross motor skills frequently delayed include balance, manual dexterity, and ball skills (Provost, Lopez, & Heimerl, 2006). Additionally, Provost et al. (2006) found that children
with ASD have a delay with the developments of overall motor skills including object control, manual dexterity, and reach to grasp tasks that facilitate execution and planning. This is problematic for children engaging in play, as they are frequently faced with motor games such as playing ball and riding bikes. To successfully engage in these types of motor tasks a child must be able to form an accurate internal model (Larson, Bastian, Donchin, Shadmehr, & Mostofsky, 2008). Larson et al. (2008) theorized that motor control requires the child to develop an internal model that accurately predicts the consequences of the motor command. If this internal model does not develop properly, then a cascading effect may occur where social, communication, and theory of mind areas become impaired as a result of the internal model development.

In Grush’s (2004) article, according to emulation theory of representation, our brain creates circuits that act as models of our body and environment. It has also been argued that when performing different tasks, usually repetitive, individuals can put their brain on auto-control and are able to perform tasks well without being in conscious thought. To be able to represent the surrounding environment is something that children with autism have difficulty doing. According to Thiemann & Goldstein (2001) children with autism have been shown to be more visual than verbal individuals, especially in a learning context. Erdodi, Lajiness-O’Neil, & Schmitt (2013) reported that there has been much mixed reports on whether children with ASD are really visual learners. Their study showed that there is a greater sensitivity to visual learning but not necessarily making children with ASD visual learners. Results showed that children with ASD had a weaker performance on visual tasks compared to children with ADHD (Erdodi et al, 2013). Recently, research has focused on differences in gesture imitation and object imitation. Ingersoll & Meyer (2011) reported that object imitation may be more closely related to play skills of the child, while gesture imitation may be more closely related to language skills. Object
imitation has been shown to be easier for children with ASD to perform, because the object allows them limited range of motion (Ingersoll & Meyer, 2011). Results showed superior performance for these children on object imitation compared to body imitation.

Additionally, body imitation was shown to predict language development in children with ASD. A positive correlation was found between body imitation and expressive vocabulary (Ingersoll & Meyer, 2011). Research on imitation most always includes a component of meaningfulness. It has been reported that children with autism are more inclined to mimic an action if it is meaningful or provides a reward. Ingersoll, Schreibman, & Tran (2003) reported a positive effect when children were provided with a sensory reward, where children with autism responded better to motivation and rewards. By examining these three areas of motor imitation, we can attempt to identify more closely what factors contribute to imitation performance, and, thusly, language development.

The level of imitation is a good predictor for later communication and social skills in young children with autism (Laine, Rauzy, Tardif, & Gepner, 2010). Imitation is used as a communication device before the child is verbal. If the child fails to develop motor imitation, or has a delay in motor imitation, it can impair them in many areas such as self-development, social development, and learning. When a child engages in motor imitation, it represents the fact that the child is making a mental representation for an object or gesture simply by exhibiting a behavior (McDuffie et al., 2006). Motor imitation is important to develop a representation of the self and be able to distinguish the self from others, engage in reciprocal interactions with peers and caregivers, and being able to learn through peers. From when the child is an infant, motor imitation allows them to be aware of individual and intentional behavior (McDuffie et al., 2006). It is one of the first ways an infant and caregiver engage in reciprocal communication.
Whether imitating peers, caregivers, or teachers, a child who cannot imitate these important figures in life will have a hard time learning any simple behaviors such as facial expressions, play skills such as sharing, or learning the correct way to hold a fork. This is particularly important when the child cannot make a representation of the motor actions and behaviors they are viewing (Munzert, Lorey, & Zentgraf, 2009). When a child can’t engage in theory of mind, or make a representation, their motor skills are affected, which could result in more communication problems and delayed development of social skills (cascading effect).

Imitation also allows the child to make a representation of what that action or behavior means further playing a role in the cascading effect. Munzert et al. (2009) stated that observing an action and executing an action have the same mental representations; furthermore, kinesthetic sensations occur when simply imaging another person’s movement. If the child possesses a deficit in these areas, it would impair their ability to make a representation of body movements of themselves and others. Eventually, the child’s inability to imitate others and make a representation of themselves and others can make the learning process very difficult.

Behavioral interventions have frequently targeted peer modeling to improve imitation in children with autism (McDuffie et al., 2007). Additionally, slowing down the presentation of stimuli wanting to be imitated also improve imitation in children with autism (Laine et al., 2010). Many behavioral studies have showed that children with ASD have difficulty perceiving facial and body movements, especially when these movements are rapid. The difficulty in perceiving facial and body movements slows down the information processing and in turn results in poor cognitive and perceptual task performance. Many studies have showed that slowing down facial and body movements can improve performance in children with ASD. In addition to slowing down movements an effective way of teaching a child imitation is through video modeling.
(Cardon & Wilcox, 2010). Video modeling is having a child watch a video of a person performing a behavior and then the child is given the opportunity to imitate the behavior they just viewed. Video modeling is a time and cost efficient way to teach preschool and school age children imitation. This is effective because it targets for components that are needed for observational learning to occur: attention, retention, production, and motivation. Yet, one drawback from using video feedback, or modeling in general is the impairment in theory of mind in children with ASD. While children may view other’s actions and produce their own actions, it may be difficult for them to understand how their own actions are interpreted by others, and how to incorporate feedback from others into their own behavior.

Albert Bandura first introduced observational learning, or modeling, through his work on social learning theory (as cited in Bellini & Akullian, 2007). When looking at imitation, Bandura concluded that children would be more willing to imitate a model that is similar to them in their qualities and characteristics. Through video modeling we are able to manipulate the sex, gender, age, height, etc. of the actor in the video. Video modeling also allows an intervention in different settings, conditions, and times. According to Bellini & Akullian’s (2007) article, video modeling has been shown to generalize across settings and conditions, therefore giving it an advantage over other interventions. Generalization and manipulation are benefits of the video modeling approach, but the overall goal is to use video modeling to represent desired behaviors that we, in turn, want the child to perform.

Research has found that video feedback is helpful in teaching children with ASD. Thiemann & Goldstein (2001) showed that visual stimuli are a helpful aid in teaching children with autism. More research is needed with regard to teaching children with ASD motor imitation and improving representation through video feedback. The current study aimed to investigate
motor representation across different motor tasks. These different motor tasks also represent different areas that have been correlated with motor problems in children with ASD, such as visual v. verbal learning. Both a typically developing control group and the group of children with ASD performed two trials of motor tasks on different days. Half of each group received video feedback. The control group was expected to perform better than the ASD group, overall. The group of ASD children who received video feedback were expected to make the greatest improvements on their performance, from trial one to trial two. The current study aimed to evaluate the effects of motor feedback, through video of the self, on the representation and imitation of motor tasks.

Methods

Design

The current study employed a mixed design approach to answer the research question. Children with autism and typical development were included in the study as a between-subjects measure of interest. Additionally, motor scores across several components were measured on two occasions, treated as repeated-measures. Additionally, a between-subjects measure was used to look at the effect of visual motor feedback, where one of the two groups received video feedback of their first performance prior to the second test of motor ability.

Participants

Ten children diagnosed with Autism Spectrum Disorder participated in this experiment, as well as ten children with typical development. The ages of these children ranged from five to 12 years of age. Participants were recruited through local elementary schools. Ewing elementary School is a school for children with disabilities, while Williamstown elementary school is a public school. A parental consent form explaining the nature of the study was sent home with
each child. Once the consent forms were signed and returned the child was a potential participant in the study. Participants were randomly assigned to two different groups: one receiving visual motor feedback, one receiving no visual motor feedback from imitation tasks. Children for the ASD group were recruited based on their diagnosis of ASD on file at the elementary school. Typical children were chosen randomly based on a class range of Pre-K to second grade. All children assented to the study before performance of the tasks. During the child’s assent, they were additionally told that they could stop the study at any time. Once the child had completed the video tasks they were allowed to choose a toy out of a toy box, as a reward for participation.

**Measures**

The Cambridge University Behavior and Personality Rating Scale was sent home with parents to assess the level of functioning of each child diagnosed with autism. This rating scale assessed the level of functioning in each child with ASD, as reported by their guardian. In addition to an overall functioning score that is calculated, there are subtests that allow for evaluation of specific areas that the child may excel or have difficulty in. This rating scale allowed for an evaluation of functioning level to become a factor in the study.

**Motor Tasks.** A series of video clips were shown to the child of a person engaging in a behavior. There were six different video clips, each representing six different imitation tasks. The six imitation tasks in the present study were developed from the same notion that different imitation tasks elicit social-communication skills in children with ASD (Ingersoll & Meyer, 2011). By looking at different types of imitation (gesture imitation, object imitation, verbal and visual cues) we can gain further insight into different developmental correlates (McDuffie et. al, 2007). Correlates that were identified as a construct in this study were visual v. verbal stimuli, object manipulation v. gesture, and meaningfulness in imitation. The verbal cue was an actor
saying the word “pencil”, then the child was asked to show what they do with what that object. The visual cue was a picture of a pencil, and the child then had to show me how they use that object. The object manipulation task was a person rolling a ball, the child then had to imitate the rolling of a ball. The gesture task was a facial gesture of an actor sticking out their tongue, the child then had to mimic that action. The meaningful task used in this study was a person taking a drink, the child had to simply imitate this action without the glass. The non-meaningful task was pushing a book across the table, in which the child had a book to push. All of these tasks will be recorded and shown to the child. A television will be used to show the videos to the participants. In one group the children will also be recorded by a video camera while watching the computer screen and responding to the demands of each clip.

Procedure

All research for this study was conducted at Ewing School. An informed consent document was used to ensure the confidentiality of the minors in this study. Letters of consent were sent out to parents of the participants and full consent was obtained from Ewing School where the children attend regular classes. One child participated at a time, and parental consent was obtained prior to the video session. Upon entering the work room, each child was briefed on what they would be asked to do. At that time they were also asked if they still wanted to participate in the experiment. All language was in a format suited for easy understanding about the conditions in the experiment. The child viewed a series of six video clips, each lasting approximately ten seconds. Before each clip begins, the nature of the video was explained and the response expected was explained also. When the video clip ended, the prompt (e.g., “Can you show me what the person in the video did?”) was verbally repeated. The level of imitation or comprehension shown was marked on a rating scale by the researcher. The rating scale used was
taken from Cossu et al. (2012), ranging from 0-3. On the rating scale, a rating of zero meant no movement or incorrect movement, one meant an attempt at correct movement but poor execution, two meant correct movement with minor problems, and three points for a correct execution. Half of the children were randomly assigned to be video recorded during their first trial. Each child went through two sets of trials, each on different days. On the second set of trials the, group that was not videotaped simply performed the demands of the six video clips again. The group that was videotaped watched the tape of themselves before performing the six tasks again. After they performed the task, the researcher debriefed the child. The child was also able to pick a toy out of their toy box, as approved by their aid. After the child was debriefed and had received their reward, they were led back to their classroom.

Results

Multiple repeated-measures analysis of variance (ANOVA) were used to compare the performance of the typical and ASD groups’ on the individual tasks. Counter to the first hypothesis, there was no overall effect on the performance of the two groups (typical and ASD). However, the averages of each task showed a higher average score from trial one to trial two for the ASD group. The verbal and object manipulation tasks showed an average improvement from trial 1 (M 1.67) to trial 2 (M 2.00). The meaningful task, of drinking out of a glass, showed an average score on trial 1 (M 1.83) and trial 2 (M 2.33), making it the greatest performance improvement. The visual cue task shows an average improvement from trial 1 (M 2.00) to trial 2 (M 3.00). Children in the ASD group showed a greater improvement from trial one to trial two on the visual task than the verbal task. The average for the visual cue task (M 2.00) on trial one was also initially higher then the verbal cue task (M 1.67) on trial one. These results indicate
higher scores from trial 1 to trial 2 on children in the ASD group who were given video feedback.

We also conducted a between subjects test to compare the group performance of the typical development and ASD group on each individual task. There was a group effect for the oral-facial gesture ($F(1, 19) = 4.51, p = .05$), object imitation task ($F(1,19) = .023, p = .02$), visual cue task ($F(1, 19) = 6.70, p = .02$), and non-meaningful object imitation ($F(1,19) = 5.88, p = .03$). The visual cue task and object imitation had the strongest group effect as predicted.

We examined the ASD and TD group differences of overall rating scores on each of the three categories of motor movements (shown in Figure 2). In the meaningfulness category, persons with ASD rated significantly lower in their movements, $t(9.1) = 2.46, p = .04$. In the object/gesture category, persons with ASD rated significantly lower in their movements, $t(9.2) = 2.65, p = .03$. In the verbal/visual category, persons with ASD rated significantly lower in their movements, $t(18) = 2.17, p = .04$.

**Discussion**

The purpose of the present study was to investigate an intervention of self-video feedback using different imitation tasks. Results indicated no significant difference of overall imitation tasks between the group that received visual video feedback and the group that did not, in both children with ASD and those of typical development. Additionally, it was found that there was no significant difference between the ASD and typical development group, but this could be due to small sample size. The averages shown above between the ASD and typical development group show average evident average differences between their performances from trial one to trial two.
When comparing means, we can see a higher performance rating on the verbal cue task, object imitation task, meaningful task, and visual: picture cue task. Those that children did not improve in are the non-meaningful task and oral-facial gesture task. We can assume that the meaningful task is a greater improvement then the above tasks because it is a task performed daily and the child has become motivated to perform the task. Being motivated to perform a task (ex. learning to hold your glass so you can get a drink) plays a role in the performance of the task. Improvements in the visual task have also been reported, both in an increase from trial one to trial two and a greater group effect than the other tasks. This supports the second prediction that the children in the ASD group would make the greatest improvement on the tasks, compared to those in the typical group. My results are consistent with those of Thiemann & Goldstein (2001) who reported that children with ASD are more visual learners. Ganz, Earles-Vollrath, & Cook (2011) reported that visual instruction is the most effective instruction to use with children with ASD. This is due to the fact that it is easier to get the students to focus and maintain their attention to the instruction that is given. It also allows them to feel in control when learning unfamiliar lessons. Visual instruction is also easier for the instructor to manipulate the information in a way that condenses it for easy understanding. The feeling of independence and ease of information makes for not only greater motivation to complete the instruction, but also more reinforcement. The greater increase of the average means in the visual cue task over that of verbal cues agrees with this.

Additionally, two out of three of the object imitation tasks had a significant overall group effect between the ASD group and typical development group. Ingersoll & Meyer’s (2011) reported that object imitation was more related to play skills of children while gesture imitation (such as sticking out your tongue) is more related to expressive language. Many of the children
in my study were non-verbal or seeing a speech therapist for troubles with speech. Both of these tasks had a significant group effect with the object manipulation task having \( F(1,19) = .023, p = .02 \) and the oral facial gesture task having \( F(1, 19) = 4.51, p = .05 \). Additionally, the object imitation tasks showed an average increase from trial 1 to trial 2 over body imitation tasks. The play skills of these children have been strengthened through not only school, but also the one on one aid that is provided to the children with ASD. The aid provides more than help with one on one activities and IEP’s given to the child, but they also try to strengthen the child’s play skills and increase their interaction with peers. Selected children that have been referred to a speech therapist do participate in speech therapy at school, but many of these children are non-verbal. My findings in the area of object imitation and oral facial imitation reflect the findings in Ingersoll & Meyer’s (2011) study that gives an explanation of better performance on specific imitation tasks.

This study has several important limitations. For one, this study utilized a small sample size. Ten children with a diagnosis of ASD on file were recruited, and ten children with typical development were used as a control. This small sample size could affect our ability to find differences when they exist when looking at improvements in performance between the two groups. Additionally, it could affect the same issue within the ASD group on the different imitation tasks. Future research needs to include recruitment of more children with a diagnosis of ASD. With the availability of a larger sample size, I would be better able to examine factors such as age and level of functioning.

Another limitation of this study was that not all Cambridge University Behavioral and Personality Assessments were sent back. This limits the evaluation of level of functioning within performance on certain tasks. This would allow me to further explore the relationship between
level of functioning and specific tasks. From this, I could draw further conclusions on object manipulation deficits v. learning deficits. Future research needs to focus on a larger sample size and more factors included such as age level, years of school, functioning level, and grade level.

Overall, it can be concluded that the group of children with ASD made improvements on tasks, specifically object manipulation, visual cue task, and oral facial gesture, than any other task from trial one to trial two. It can be theorized that receiving the visual feedback has allowed the child to critique themselves on ball manipulation and facial gestures and therefore motivate them for improvement in these areas, but that refinement of these feedback videos would be fruitful.
References


Figure 1. Differences between the ASD group and Typical Development groups’ rating score from Trial 1 to Trial 2.
Figure 2. Overall average rating score by the imitation categories.