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Over-Imitation in Four-to-Six-Year-Old Children with Autism and Typically Developing
Children

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Abstract

This study is a follow-up based on research conducted by Horner and Whiten in 2005. Nearly identical methods and materials from that study were used to compare the over-imitation behaviors of preschool children with autism to age-matched typically developing (TD) children. Contrary to the hypothesis, the children with autism were found to over-imitate at the same rates as the TD group. However, several limitations were found in this study that may have influenced the results, including small sample size, test location, and previous training.

Keywords: autism spectrum disorders, imitation, over-imitation, emulation

Imitation is a natural part of human development. The ability to mimic is even apparent in newborns (Iacoboni, 2008). Children's ability to learn facial expressions, motor skills, language, appropriate behaviors, and more is facilitated by copying the actions of those around them. Certainly, many positive results arise from this propensity for replication; however, several recent studies have unveiled that humans also have a tendency to over-imitate (Horner & Whiten, 2005; McGuigan, N., Whiten, A., Flynn, E., & Horner, V., 2007; McGuigan, N., Makinson, J., & Whiten, A., 2011). Current research defines over-imitation as any action or series of actions that are imitated even though it is evident that such actions are not relevant to the apparent goal of a task. It appears that when imitation supersedes causal thinking, the copycat mechanism that serves humans so well when learning new skills can also hamper optimal productivity. Despite the apparent negative effects of over-imitation, researchers have also theorized several ways that this facet of imitation may contribute to the acquisition of new skills important to development (Kenward, B., Karlsson, M., & Persson, J., 2011; Lyons, 2008; Lyons, D. E., Young, A. G., & Keil, F. C., 2011).

Thus far, few studies exist that examine the role that over-imitation might play in the development of people with autism spectrum disorders (ASD). Since imitation deficits are known to affect those with ASD (Young, G. S., Rogers, S. J., Hutman, T., Rozga, A., Sigman, M., & Ozonoff, S., 2011; Smith, I. M., & Bryson, S. E., 1994; Rogers, S. J., Bennetto, L., McEvoy, R., & Pennington, B. F., 1996), it is important to determine exactly which aspects of imitation are affected and how these characteristics might shape learning.

Review of the Literature

This review of the literature will define imitation, examine some of the research that has contributed to our understanding of imitation and learning, and provide the basis for the question of this study.

Defining Imitation and Learning

The role that over-imitation plays in learning is not yet clear and several competing theories exist. The phenomenon has been linked to societal norms (Kenward, et al., 2011), culture transmission (Mcguigan et al., 2011), and causation coding (Lyons et al., 2011), but no definitive relationship has been established. A recent over-imitation study by Simpson and Riggs (2011) found that children imitated modeled actions that were both relevant and irrelevant when tested immediately after a display. However, one week after the initial demonstration, these same children reproduced very few irrelevant actions and were much more likely to employ emulation strategies when asked to perform the same task, emulation being opposite to over-imitation wherein only actions pertaining to a goal are copied. The researchers concluded that sensorimotor and conceptual representations likely occur when data is first encoded but that the sensorimotor representations fade over time, leaving only a conceptual image. A conceptual representation provides a clearer sense of which modeled behaviors are and are not relevant to a goal (Simpson & Riggs, 2011), leading to emulation. Though a useful theory of how imitation progresses over time, this research does not address what purpose, if any, a sensorimotor imitative function might serve in the learning process. In fact, this study implies that over-imitation acts serve no purpose, as, over time, they are discarded while only more relevant acts are retained.

Research on Imitation

Chimpanzees and children. The role of imitation in learning has a long history. As tools for performing tasks have changed, researchers developed increasingly intriguing ways to investigate its role in animal learning. The goal of many of these studies was and is to demonstrate that animals learn even complex actions and their consequences via imitation. Since humans are at the top of the learning curve, animal studies typically have included either children or adults as a comparison group. Horner and Whiten (2005) conducted an experiment involving chimpanzees and children between 3 and 4 years of age. Both groups were shown several actions involving a stick and an opaque box with a small door in the front and some sliding pegs attached to a bar on the top. The demonstrator performed several actions without comment. First, a used was stick to tap the top of the box three times. Next, the demonstrator slid a peg on the top of the box, tapped the top as before, and then slid a second peg directly alongside the first, revealing a hole in the top of the box. The stick was then poked into the hole and tapped inside three times. Lastly, a small door on the front of the box was opened, and the stick was inserted to pull out a treat. Both the children and the chimpanzees were able to reproduce all of the actions quite well. Later, another box was brought out that was identical to the first, except that it was transparent. Viewing the second box, it should have been apparent that the box had a false ceiling, making it obvious that no action produced on the top section of the box would contribute to the mission of obtaining the treat. When presented with the clear box, the chimpanzees skipped the initial steps and proceeded immediately to the door with the treat, whereas the human children in the study continued to imitate all of the actions they had previously executed, including those that were clearly irrelevant (Horner & Whiten, 2005).

Children and adults. Researchers McGuigan et al. (2007) later used this experiment to compare 3-year-olds to 5-year-olds, in order to determine whether older children would be better

able to determine causally irrelevant actions. In their study, the exhibition of the experiment was modified to include a videotaped demonstration instead of one conducted by a live human, to control for the potential that a child might imitate to gain positive feedback from a live, adult demonstrator. Once both boxes were presented to the two groups of children, contrary to what the researchers expected, the older children copied the actions even more faithfully than the younger children (Mcguigan et al., 2007). Four years later, Mcguigan et al. (2011) used the same experiment, but they included adults in the study for the first time in order to determine if the tendency to over-imitate extends beyond childhood. Their results showed that the adults were even more likely than the children to imitate actions that serve no causal purpose (Mcguigan et al., 2011). Initially taken aback by these findings, the authors ultimately chalked them up to “the highly adaptive, ‘conformist’, nature of imitation for our species” (Mcguigan et al., 2011, p. 15).

The results of the previous investigations of imitation were confounded by social factors. The authors indicated in their discussions that the role of social expectations could not be separated from the act of imitation. In order to control for social expectations, another research group used this experimental paradigm to determine whether children living in a traditional hunter-gatherer type of society would exhibit the same tendency towards over-imitation as the children raised with the social norms of a modern culture (Nielson & Tomaselli, 2010). Nielson and Tomaselli (2010) tested Kalahari Bushman children between the ages and 2 and 13 and found that, as in previous studies, the degree of precise imitation of actions both causal and irrelevant was enhanced with age. The conclusion of the researchers was that cultural environment does not play a role in this particular imitation mechanism.

Over-imitation: A Second Phase of Imitation Research

As stated earlier, many theories have been tested to determine what causes humans to over-imitate, and what, if any, benefit might be attributed to the behavior. Lyons, Young, and Kiel (2007) conducted a study to test whether over-imitation might be motivated by a social desire to please others, particularly those in authority. They tested children aged 3 and 5 years with several different puzzle boxes, again including both relevant and irrelevant actions in their demonstrations. In the first part of the test, the children were encouraged to identify the unnecessary actions as “silly” and were praised for their discoveries. The children were then left alone to solve the puzzles in a method of their choosing. Overwhelmingly, the children completed the puzzle boxes including the irrelevant actions that they had only moments before identified as such. Even when the children were specifically instructed against copying any unnecessary acts, they replicated every action again, relevant or not (Lyons et al., 2007). This demonstrated that children copy irrelevant actions even when they are confident that those acts do not contribute to the goal. Since the instructions ran counter to the imitative behavior of the children, the study also showed that they were not mimicking in order to satisfy the adult demonstrator.

There was only one instance in the Lyons et al. (2007) study where the children did not over-imitate. In the final test, an object with two equal but connected sections was tested with half of the children, and the rest of the children were presented with the same two equal sections, but, in the second case, they were not connected and appeared as two distinct objects. Both groups were shown actions that were relevant on one section/object and actions that were irrelevant on the opposite section/object. The group that saw the box as one connected item were more prone to imitate the irrelevant actions than the group that had the actions presented between two separate objects (Lyons et al., 2007). That final test appears to indicate that some sort of

causal learning mechanism is involved when humans over-imitate. Otherwise, why would the children cease to imitate irrelevant actions only when presented with an object where the actions performed on it could not lead to any goal associated with the object?

Conversely, researchers Kenward et al. (2011) state that their study shows that the causal belief hypothesis is not valid. They argue that over-imitation fits better with the idea that the children are instead learning a “prescriptive norm.” In their study, children watched a demonstrator perform relevant and irrelevant acts on a novel item, and, before attempting to perform any acts, they were interviewed about what they would copy and why. The children revealed that they understood which acts were relevant to the goal, but the majority of the children stated that they would perform all acts, even the unnecessary ones, without being able to explain why. Kenward et al. (2011) assert that this example is similar to the process of acquiring norms, which only requires following the rules regarding how to act in certain situations without belief in any particular purpose. Indeed, in all cultural traditions, humans are often compelled to comply with the behaviors of peers and superiors, whether or not those acts serve any purpose, make logical sense, or may even inflict harm, so the prescriptive norm idea is tempting. However, the norm hypothesis does not explain why the children in the Lyons et al. study (2007) chose *not* to over-imitate in the instance of the two separate items. In fact, if causal actions were not a factor, and children follow a set of actions simply to adhere to the norm, the children ought to have copied the irrelevant information in that instance as well, but they did not. In light of this fact, it does not seem plausible that children over-imitate actions involving a novel item or tool simply due to an adherence to norms.

Proceeding along causal lines of research, Lyons, et al. (2011) conducted a study to test their “automatic causal encoding (ACE)” theory (p. 1159). In the hypothesis, when a child

witnesses an adult performing actions on an unfamiliar object, those actions will be coded as causally imperative, and the child will thus copy any and all actions whether they appear logical or not. In their study, the theory was determined to be accurate. In all tests where an adult demonstrated intentionality in his or her acts upon a novel artifact, the children were apt to copy both relevant and irrelevant actions. Even when the children were tested in the setting of a competition, wherein copying the irrelevant acts would result in losing said contest, their over-imitation persisted. The only instance in which the irrelevant information was not copied appeared in a test where the demonstrator's actions were presented as if they had occurred by accident. However, when those exact actions were presented as intentional, over-imitation recurred, giving further credence to the ACE hypothesis.

While over-imitation benefits may seem counterintuitive, one can see how children could make use of a mechanism that supersedes logic in order to be able to encode instructions for items that may be more complicated than they appear on the surface. In fact, Lyons (2008) asserts that "...over-imitation is a phenomenon that appears to be quite specific to the domain of artifacts" (p. 99). Lyons argues that the evolution of human tool use has led to our propensity for over-imitation. He explains the distinct differences between tool use in chimpanzees and humans. When chimpanzees encounter a new implement, they may utilize it in several ways, but they do not comprehend it as an item with some specific, constant use. Humans, on the other hand, imagine how a tool could accomplish one or more feats and create an array of uses attached to that particular instrument. Instead of simply reaching for an item to solve a current problem, as chimps do, humans assign certain items for particular uses. This shift from using tools for immediate environmental problem solving to using them toward some future target requires a different type of observational learning (Lyons, 2008). In modern times, the end goal

of an artifact is often not only difficult to determine, it is sometimes far removed from the actions we carry out on it. Consider the actions performed on an iPhone; the seemingly random screen taps give no indication of the communication options that the device is capable of, so to first learn how to use one, a child would be trained quicker by simply copying each and every action presented for the best chance of success. Still, it is not clear why humans continue to over-imitate in the tests where causation is plain and obvious and emulation would seem a more practical choice (Lyons, 2007).

Lyons (2008) agrees that if a child could choose the perfect instance to switch from imitation to emulation, the knowledge gained from combining what one perceives with imitating actions that are only valid to the task would indeed be much greater than simply imitating everything. However, if the child switches from imitation to emulation at the incorrect moment, all potential for learning may be lost (Lyons, 2008). Meaning that it is better for a child to over-imitate in any novel skill acquisition situation rather than lose potentially vital information. While this idea makes sense in regards to children learning how to use novel items, it still does not explain why adults and older children, with sufficient world knowledge and tool use experience to see through something as simple as the opaque versus clear box experiment, over-imitate even more faithfully than young children do (Mcguigan et al., 2011; Nielson & Tomaselli, 2010). However, Lyons' (2008) theory may explain why over-imitation behaviors fade dramatically in as little as a week (Simpson & Riggs, 2011).

Autism and Imitation

Imitation skills can pose a special problem for individuals with autism spectrum disorders (ASD). However, though imitation deficits are a well-established part of ASD (Griffin, 2002), several studies illustrate instances where individuals with autism appear to have many of the

imitation skills that their ability-matched peers without autism possess (Aldridge, Stone, Sweeney & Bower, 2000; Charman & Baron-Cohen, 1994; Nielson & Hudry, 2010; Rogers, Bennetto, McEvoy & Pennington, 1996). Researchers Aldridge et al. (2000) were surprised to discover in their study that preverbal children with autism outperformed cognitively matched children without autism in the area they defined as intentional imitation. The researchers were astounded because the children with autism were not able to perform any of the gestural imitation tasks, which they considered a lower-scale acquisition than the imitation of intentions. In fact, Aldridge et al. (2000) discuss that imitation of intention is indicated as a precursor for theory of mind, which older children with autism have difficulty with, so how is it that these young children with weak language development and poor object comprehension demonstrate imitation of intention as their strongest area of development? They go on to theorize that the children with autism may have failed at the gesture tasks because the gestures were pointless, and so the children may have been busy trying to figure out the intention behind the gesture rather than just acting as puppets. Thus, the researchers could not determine whether the gesture imitations were not carried out due to a disability, or if the children were merely unwilling to participate (Aldridge et al., 2000). Considering that social skill deficits is one of the cornerstones of an ASD diagnosis, it may have been more surprising if these children had copied the meaningless gestures.

Charman and Baron-Cohen (1994) also tested children with ASD in several imitation tasks, and found that they performed as well or better than the control group in all of the tasks except for one: the light box test. In reviewing the imitation tasks presented in their study, they concluded that the light box test was the only undertaking that required true imitation of intentions (another way of describing over-imitation), while all of the other tasks could have

allowed the subjects to utilize emulation to achieve a pass. Griffin (2002) points out that this is likely what occurred in the Aldridge et al. (2000) study, since they did not employ a measure like the light box test wherein the children with autism could not have used emulation to score the points.

In another study, by Nielson and Hudry (2010), researchers sought to determine if children with autism would over-imitate to the same to degree as peers with Down syndrome (DS), who are considered to have good overall imitation skills. Their study found that the children with autism performed all imitation tasks as well as the children with DS, which appears to run contrary to Baron-Cohen's 1994 study that found children with autism lacking in the area of "true" imitation. The data also runs contrary to standard definitions regarding ASD. Nevertheless, it is unclear from their research paper how the tasks in their trials were demonstrated for the children regarding the opening of the boxes. Once again, the case may be that the children with autism were actually utilizing emulation skills, and not what researchers consider "true imitation," to achieve the desired result. More details regarding their methodology would be necessary to make a final determination.

Research by Marsh, Pearson, Ropar, and Hamilton (2013) compared children with ASD with a group of age-matched and a group of verbal mental age-matched TD children in a task involving over-imitation. The children with ASD over-imitated significantly less than either of the typically developing groups. Similar to previous studies (Lyons et al., 2007; Lyons, et al., 2011), this study rated the children in their ability to determine irrelevant actions and instructed the participants to get to the goal of the action as quickly as possible. Despite external motivation for speed and/or accuracy, all groups of TD children were found to over-imitate at a significant rate. However, Marsh et al. (2013) concluded that such actions were socially motivated, whereas

Lyons et al. (2007 & 2011) determined that the causal encoding was responsible. Marsh et al. (2013) argued that since the imitation activities in their study utilized familiar or “causally transparent” artifacts, any over-imitation was not motivated by an attempt to gain knowledge about the object and could thus be viewed as socially motivated. Furthermore, the children with autism scored poorer than TD children when distinguishing the relevant from the irrelevant actions, indicating that the lack of over-imitation in the ASD group was not related to better causal analysis. Also, since an autism diagnosis includes social function deficits, the argument for socially caused over-imitation is compelling. However, in the Simpson and Riggs study (2011) over-imitation in TD children is omitted a week after demonstration, which indicates that any social effects are either short-lived or that a different, nonsocial mechanism is in effect when over-imitation occurs.

Researchers Southgate, Gergely, and Csibra, (2009) reviewed bodies of research that involved studies related to the imitation abilities of children with autism. They cited several areas of research where children with autism were able to infer intention of an uncompleted task and thus complete the task successfully. Again, this seems to indicate particular strength in the area of emulation and not necessarily an aptitude for what Griffin (2002) called “imitation proper.” He stated that children must comprehend both the exact methods and the goal to be performing proper imitation. Emulation allows one to complete a task by completing actions that were not demonstrated or omitting ones there were, which does not adhere to the criteria of following the exact method. Southgate et al. (2009) also found several studies providing evidence of imitative ability in the areas of both voluntary and involuntary imitation areas in individuals with autism. Therefore, in the studies reviewed here, the exact nature of the imitation deficit common in individuals with ASD is unclear.

Summary and Questions of the Study

All groups thus far studied using the opaque versus clear box experiment described earlier have shown that humans have a propensity towards over-imitation that increases with age. Few similar experiments have been conducted with children on the autism spectrum. These studies are particularly interesting because some of the results for children with ASD run counter to expectations from the theory of mind literature and call in to question some widely held assumptions. The goal of this research is to delve into the discontinuity of such assumptions as it pertains to children with ASD and the facets of imitation that this population is able to utilize while learning. One method to investigate this is the opaque versus clear box experiment, which may demonstrate how imitation, specifically over-imitation, is utilized within this population. The specific questions of this study are as follows.

1. Will verbal, 4-to-6-year-old children with ASD over-imitate in the opaque versus clear box study.
2. How will imitation behaviors in these children with ASD compare to typically developing children of the same age?

The hypothesis was that the verbal children with ASD would be able to imitate all of the actions on the opaque box, but would switch to emulation when presented with the clear box and would not over-imitate. The expectation was that the TD children would be found to over-imitate to a much greater degree than the children with ASD.

Purpose of the Study

This study aims to add to the existing pool of knowledge regarding the imitative behavior associated with children who have been diagnosed with autism spectrum disorder (ASD). Thus far, there is much conflicting evidence surrounding which facets of imitation are affected by

ASD (Aldridge et al., 2000; Charman & Baron-Cohen, 1994; Nielson & Hudry, 2010; Rogers, Bennetto, McEvoy & Pennington, 1996; Southgate et al., 2009; Griffin, 2002). Any research that can add to the understanding of the imitative strengths and weaknesses of children affected with ASD will further understanding and may assist practitioners in creating more effective treatment plans for those individuals.

Method

Participants

Six 4-to-6-year-old verbal children with ASD (mean age = 59 months) and six 4-to-6-year-old typically developing (TD) children (mean age = 67 months) participated in the study (See Table 1). One of the TD participants was female. The two groups were gender-matched, and since all of the participants with ASD were male, her results were not included. One of the participants with ASD was unable to complete the imitation tasks on the opaque box and was also disqualified. This left 5 children from each group.

Participating children with ASD met criteria outlined in the Diagnostic and Statistical Manual of Mental Disorders, fourth edition (DSM-IV) for autism spectrum disorder and were identified with ASD by a school service specialist, counselor/clinician, or psychologist. The TD participants were screened via the Social Skills Improvement System (SSIS) (Gresham & Elliot, 2008) to rule out the possibility of any undiagnosed ASD traits. Children with siblings, parents, or grandparents with ASD were disqualified from the TD group, as was any child who had ever received special speech, language, or cognitive skill services.

Participants were recruited via social media and through the University of Arkansas Newswire. The Benton County Sunshine School also took part in the research and several participants were located and tested there. To bolster participation, parents who submitted the

request for consent paperwork within the allotted time were entered into a drawing for a \$100 gas card. One card was awarded to each of the two groups (parents of TD children and parent of children with ASD), for a total of two \$100 gas cards.

Procedures: Methods and Materials

Materials included four boxes of identical eight cubic inch outer dimensions. Two of the boxes were opaque, and two were clear, they were otherwise identical. One 1½ in by 1½ in round hole was on the top of the box and was covered by two bolts able to slide to the left or right, revealing the hole. Another 1½ in by 1½ in round hole was on the front face of the structure. This hole was hidden by a cap with a knob. Pulling the knob removed the cap and revealed the hole. Beyond that hole was a tube, closed on the end opposite the door. The tube was opaque in both the opaque and clear boxes, so what was inside could not be detected. A sticker prize was hidden inside the tube. Between the bottom section with the tube and the top section, where the bolts were, there was a barrier, creating two distinct sections (See Figure 1). A nine-inch sticklike tool was used to perform the tasks and retrieve the prize.

Children were tested in a private room away from distractions. Four of the TD children and one of the children with ASD were tested at the University of Arkansas Speech and Hearing Clinic. The remaining one TD child and four children with ASD were tested at the Benton County Sunshine School. The set-up was identical in both locations. The child sat at a table in a small chair to the right of the demonstrator who kneeled on the floor. The two opaque boxes were on the table, one out of reach of the child, one between the demonstrator and the child. When the child was comfortably seated, he was asked to "watch what happens because I'm going to let you try it in a minute." Five irrelevant actions and one relevant action were then performed on the box by the demonstrator. The first five actions performed were all irrelevant.

To begin, the demonstrator picked up the sticklike tool and tapped three times on the front top bolt on the box. Second, the front top bolt was pushed from the right with the tool, and the bolt was slid to the left. Third, the second top bolt was tapped three times, and then, fourth, the bolt was pushed to the left in the same manner as the first one. The hole on the top of the box was then revealed, and, fifth, the tool was used to tap three times within the hole, onto the false ceiling below. The remaining actions were all relevant. The removable cap on the front of the box was pulled off and the stick was used to drag out the sticker prize, which was then visible at the front of the tube. The demonstrator exclaimed, “There’s a sticker!” when pulling out the prize. The first opaque box was then moved to an out of reach location on the table, and the second opaque box was placed directly in front of the child. At that point, the child was told, “Now it’s your turn,” and the sticklike tool was handed to him. The demonstrator remained quiet while the child interacted with the box. No further instructions were issued, and if a child asked any questions, the demonstrator said, “Do whatever you think.” The first task ended when the child retrieved the prize. When the prize was located, the demonstrator exclaimed, “You got a sticker!”

After the completion of the first task, the demonstrator said, “Let’s do one more.” The two opaque boxes were placed out of view behind a box on the floor and the demonstrator removed the two clear boxes from where they had been concealed up until that point. The two clear boxes were then placed on the table in the same manner as in the first task. The demonstrator performed the exact same actions on the clear box that were executed on the opaque box in front of the child, and moved that box out of reach and placed the second box in front of the child as before. This time, before handing the child the tool, the demonstrator will said, “Now, it’s your turn. I am going to do some paperwork over here, so shout out, ‘I got it!’”

when you find the prize.” The trial ended when the child announced that he located the sticker. All trials were videotaped with a Kodak Playtouch video camera hidden from view, and was activated without the participant’s knowledge.

Results

Data was drawn from the actions the child produced on the clear box only. The chi-square test with a two by two contingency table was used to evaluate the data (See Table 2). Contrary to expectations, 100% of the participants in both groups completed the imitation of both irrelevant and relevant actions on the clear box. The results were identical to expected cell frequencies per null hypothesis. Using Fisher’s exact test, the two-tailed p -value equals 1. The association between rows (groups) and columns (outcomes) is considered to be not statistically significant, as zero difference was found between the two groups.

While the overall over-imitation results were the same for both groups, slight variations were noted between individual irrelevant action productions. Only one of the participants in the TD group omitted any of the irrelevant actions in the clear box condition. Two additional TD children neglected to tap into the top hole before attempting to pull off the cap, but both of them remembered before actually pulling the cap and returned to complete the top hole tapping action before pulling the cap to reveal the prize. When presented with the task of interacting with the two boxes, the TD children were completely absorbed in the task and very enthusiastic during and after the tasks. None of the TD children tested looked to the demonstrator for confirmation or assistance at any time.

The children with ASD displayed less certainty with their actions. Overall, their movements were slower and less precise. Two of the children from this group requested instructions at least once during the tasks, and all but one of them looked toward the

demonstrator more than once while performing the activities. One participant performed the actions in the opposite direction on the opaque box, first pulling the cap to receive the prize and then continuing upward to imitate the irrelevant actions. This was striking, as it was a very clear example of over-imitation since the goal had already been achieved. One of the children with ASD paused before the tapping into the top hole, looked in the direction of the demonstrator, who was faced away from the child, and quickly proceeded to open the cap and get his prize, omitting the top hole action. In his trial with the opaque box, that child paused at the same spot, looked at the demonstrator who was watching his actions, and proceeded to tap in the top hole before pulling the cap.

Discussion

The hypothesis that the children with ASD would not engage in over-imitation, or would be found to over-imitate to a much lesser degree than TD children, proved incorrect in this study. Instead, that group was found to over-imitate at the same rate as the control group (TD children). However, based on subtle differences between how the two groups interacted with the boxes, the motivation behind the actions may have been quite different. While the TD children appeared completely absorbed in the task, most of the children with ASD looked up at the demonstrator at least once and two made verbal requests for assistance. On the surface, this behavior might indicate that the imitative actions of the children with ASD were more socially motivated than those of the TD children. However, since social deficits are one of the cornerstones of an autism diagnosis, this is unlikely. A more plausible reason for the behavior is the fact that all of the children with ASD were receiving special services. Specifically, discrete trial training (DDT) was part of the therapy used with at least four of the five participants (therapy details were unknown for the fifth participant). In his paper, researcher Smith (2001) indicates that DDT can

be used for teaching new behavior structures to children with ASD, including imitation skills. This could explain why the children with ASD in the present study had better over-imitation results than expected. Another facet of DDT is the use of prompts and positive or negative feedback when training the children new tasks (Smith, 2001), which could be why the majority of the children with ASD looked to the demonstrator while interacting with the boxes in both conditions (opaque and clear). This could also be why one child with ASD stopped over-imitating once he saw that he was not being observed. The activity in the present study also resulted in a reward, which could be very similar to any operant conditioning that the children with ASD may have previously experienced in other therapy situations.

This study had several limitations. First, the sample size was small. It proved difficult to locate pre-school-aged children diagnosed with ASD. In future studies, testing school-aged children may provide a larger pool from which to draw, since many children are not diagnosed until they enter the school system. Due to the small sample size, the results may not be indicative of typical over-imitation behavior in children with ASD. Even in the study by Marsh et al. (2013), which concluded that children with autism do not over-imitate, it was found that some of the children with ASD did produce irrelevant actions only that the numbers were far fewer than in the TD group. With a larger sample, this may have proved evident in the present study as well. Secondly the location of the trials may have influenced the results. As noted above, the children with ASD were receiving services and the trials in this study took place in a setting that would be very similar to where treatment would typically occur, so the behaviors could be less spontaneous than what might occur in a more neutral environment. Lastly, an ideal situation would also have the children with ASD interacting with the clear box with no one present, to

control for any conditioned responses the children might have toward a demonstrator due to previous training.

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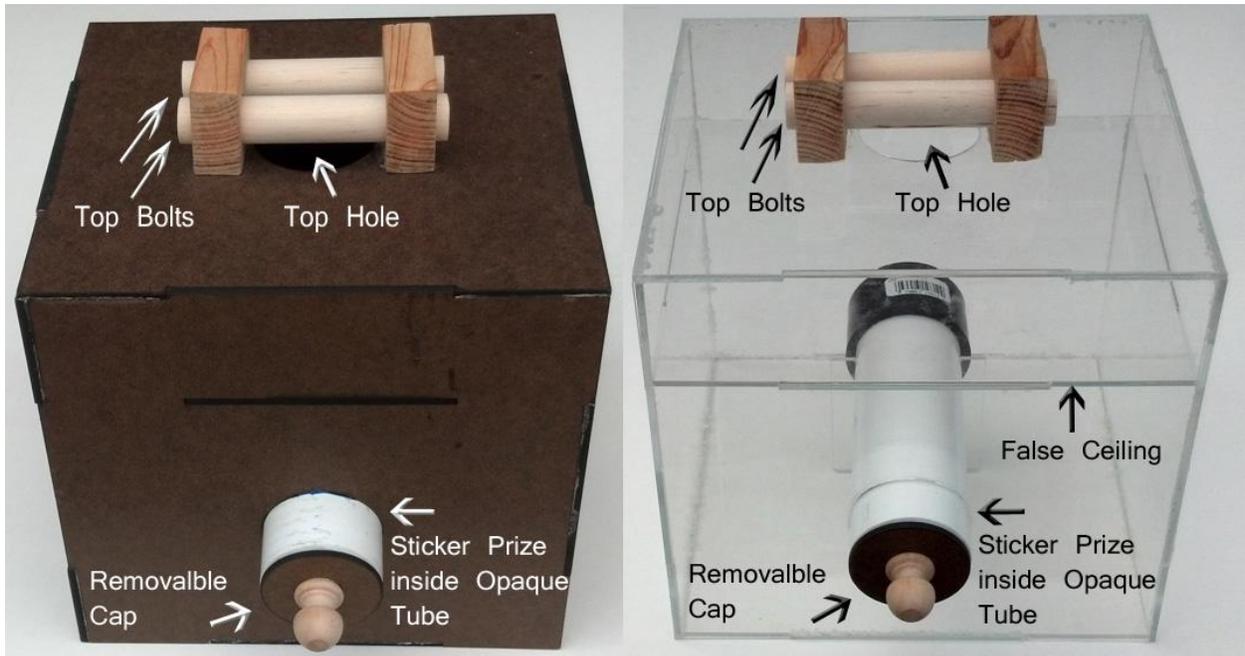
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Appendixes

Figure 1:



Photograph of opaque and clear boxes used in this study.

Table 1

	Age of Participants in Months					Mean age
TD Children	49	58	71	77	80	67
Children with ASD	52	52	52	63	75	59

Table 2

Observations	Imitation of Irrelevant Actions	Imitation of Relevant Actions	Totals
Typically Developing Children	5	5	10
Children with Autism Spectrum Disorders	5	5	10
Totals	10	10	20

Chi-square with 2 by 2 contingency was used to evaluate the data. To calculate, the square of the observed frequencies minus expected frequencies was divided by the expected frequencies for each cell. The sums from the four cells were then added and the resulting number was compared to a table of critical values to establish if the chi-square was significant. For nominal or ordinal variables, such as the comparison between two the types of imitative actions found in this study, the chi-square test is a good gauge to determine if the connection between variables is statistically different from what would occur by chance (Baker, 1999).