Generalized Event Representation in Pre-School Children with Mild- to High-Functioning Autism Spectrum Disorder (ASD) and Children with Cognitive and Linguistic Delays (CLD)

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GENERALIZED EVENT REPRESENTATION IN PRE-SCHOOL CHILDREN WITH MILD- TO HIGH-FUNCTIONING AUTISM SPECTRUM DISORDER (ASD) AND CHILDREN WITH COGNITIVE AND LINGUISTIC DELAYS (CLD)

by

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A dissertation submitted to the Graduate Faculty in Psychology in partial fulfillment of the requirements for the degree of Doctor of Philosophy, The City University of New York

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Abstract

GENERALIZED EVENT REPRESENTATION IN PRE-SCHOOL CHILDREN 
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Tashana S. Samuel

Advisor: Dr. Laraine McDonough

Children with autism spectrum disorder (ASD) frequently establish rigid routines and have difficulties flexibly applying what they have learned. Three experiments were conducted to examine generalized event representation in 34 pre-school children. In Experiment 1, children diagnosed with varying kinds of cognitive and language delays (CLD: n = 14) were tested with the generalized imitation paradigm, a reliable measure of representational capacity. Two sets of perceptually dissimilar objects with similar functions were used to perform the same task: one set consisted of modeling props and the other set was the generalization props. At the generalization assessment, children observed actions modeled by the experimenter, after which they were given different sets of objects (varying in size, shape, color and texture, but have the same function as the modeled props) that they could use to generalize the events. At the imitation assessment, children again observed actions modeled by the experimenter, but were given the same set of objects that the experimenter had used. The order in which the individual actions were modeled was causal (the actions must be produced in a particular order to achieve a goal), arbitrary (the actions can be produced in any order with the same resulting outcome), or conventional (e.g.,
bedtime stories are typically read after the child is in bed). This procedure was administered for eight tasks (4 novel events, 4 familiar events). The dependent measures were the mean proportion of actions and the mean proportion of correctly ordered sequences in which the actions were produced. Experiment 2 was conducted on adults to empirically confirm that the objects used for modeling and generalization were indeed perceptually dissimilar, but similar in function. Experiment 3 was a replication of Experiment 1, and was conducted on children diagnosed with autism spectrum disorder (ASD: $n = 10$) and typically developing controls (TD: $n = 10$). Comparative data revealed that all groups were able to generalize and imitate actions and sequences compared to their baseline assessments. Although all three groups generalized fewer causal actions than arbitrary and conventional ones, ASD children performed as well as TD children. However, it was the CLD children that showed more differences, generalizing substantially fewer causal actions than the other groups. Furthermore, productive language obtained from verbal IQ data was also related to generalization ability: CLD children with higher verbal IQ generalized better on these tasks than those with lower IQ. There were no diagnostic differences found for sequences, indicating that although participants found generalizing some actions to be problematic, their sequential understanding of events remained intact. The null result of the ASD group compared to the TD group in this sample provides evidence that children with ASD demonstrate certain cognitive strengths. Although in real world contexts, insistence on sameness can hinder learning and generalized event representation in children with ASD, the current results reflect the heterogeneity of this cognitive function.
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TABLE OF CONTENTS:

Copyright page…………………………………………………………………………………….ii
Approval page…………………………………………………………………………………….iii
Abstract…………………………………………………………………………………………...iv
Acknowledgments………………………………………………………………………………..vi
Table of Contents………………………………………………………………………………viii
List of Tables……………………………………………………………………………………x
List of Figures……………………………………………………………………………………xi
I. INTRODUCTION
Dissertation Introduction and Overview………………………………………………………1
Historical Explanations for the Causes of Autism…………………………………………5
Current Diagnostic Criteria of Autism Spectrum Disorder (ASD)………………………14
Perseveration of Sameness Symptomology………………………………………………21
Event Representation: An Introduction……………………………………………………………25
Category Development: Early Foundations for Generalization Skills……………………27
Early Generalized Knowledge Based on Object Function…………………………………36
Object Function within Everyday Events, and the Importance of Sequential Understanding….40
Event Representation in Individuals with Autism Spectrum Disorder (ASD)………………..45
Purpose of Dissertation and Research Hypotheses…………………………………………48

II. DISSERTATION STUDY
Experiment 1: Generalization in Children with Cognitive and Linguistic Disabilities………58
  Procedure………………………………………………………………………………………62
  Results and Discussion……………………………………………………………………….66
Experiment 2: Adult Similarity Judgment of Objects…………………………………………73
  Procedure………………………………………………………………………………………73
  Results and Discussion……………………………………………………………………….78
Experiment 3: Replication of Generalization Experiment in ASD and TD Children………..80
  Procedure………………………………………………………………………………………86
  Results and Discussion……………………………………………………………………….87
Comparison between Experiment 1 and 3 (CLD, ASD, and TD Groups)………………….93

III. GENERAL DISCUSSION
Performance of CLD, ASD and TD Groups………………………………………………..99
Limitations and Future Research……………………………………………………………106
Summary and Conclusions…………………………………………………………………..110
APPENDICES

A. Description of Stimuli, Prompts, and Max Values for Novel and Familiar Tasks…116
B. Stimuli Used in Experiments 1, Experiment 2, and Experiment 3…………………..120

BIBLIOGRAPHY
LIST OF TABLES

Table 1: Demographic Information and IQ Scores……………………………………………………………60
Table 2: Modeling (Set A) and Generalization (Set B) Stimuli Object Pairs……………………………74
Table 3: Demographic Information, CARS-2, and PPVT-IV Assessment Scores…………………..84
LIST OF FIGURES

Figure 1: Mean Proportion of Target Actions by CLD Children in Experiment 1….................69
Figure 2: Mean Proportion of Target Sequences by CLD Children in Experiment 1.............70
Figure 3: Mean Proportion of Target Actions by ASD and TD Children in Experiment 3........89
Figure 4: Mean Proportion of Target Sequences by ASD and TD Children in Experiment 3....91
Figure 5: Comparison of Target Actions by TD, ASD, and CLD Children........................95
Figure 6: Comparison of Target Sequences by TD, ASD, and CLD Children......................101
CHAPTER I. INTRODUCTION

Typically developing children compose, systematize, and make representations of everyday events as they encounter them. Routines such as getting dressed in the morning, having breakfast, bathing, going to the supermarket, and preparing for bedtime occur on a regular basis. Each of these activities includes actors, related objects, and actions performed in a particular sequence. Children learn these routines early in life, and can use them to form expectations about novel events (e.g., eating dinner at a friend’s house). This kind of memory is called generalized event representation.

Research on how infants and young children remember events composed of organized action sequences has shown that event knowledge takes place from a very early age and temporal orders governed by causal connections are recalled more often than those with arbitrary orders. Children around 3-6-months of age can also learn a task using one set of objects and can carry it out on a different set of objects (Barnat, Klein & Meltzoff, 1996; Bauer & Dow, 1994; McDonough & Mandler, 1998). This kind of generalization is not attributable to forgetting (as found in research with younger infants using conditioning paradigms; see Borovsky & Rovee-Collier, 1990) because these older infants can also remember which objects they saw the activities modeled on before. Regarding the types connecting relations (causal, arbitrary, conventional), typically developing children tend to imitate higher proportions of causal actions and sequences than arbitrary actions and sequences in novel tasks (Bauer, 1992; Bauer & Thal, 1990). Causal sequences require that all actions must be performed in a particular order to
achieve the end result (one must open a juice carton before pouring its contents). With arbitrary sequences, there is more than one way to achieve the end result (e.g. the order in which we put clothes on). Conventional, or familiar sequences may include causal and arbitrary actions, but are typically done in one particular way based on social norms (breakfast is typically eaten in the morning but could be made and eaten anytime during the day). There have also been instances, however, in which actions and sequences that are arbitrarily ordered are readily generalized, while those that are causally ordered are difficult for young children to generalize (Bauer & Dow, 1994). A reason for why causally ordered actions are difficult to order has not been offered.

Previous research has provided insight about the extent to which typically developing infants and young children are able to abstract what they know and apply this knowledge to novel situations. To date, little to no research has been conducted on generalization and everyday event representations of children with intellectual disabilities (but see Cheatham, Bauer & Georgieff, 2006). This is important because if researchers are interested in designing training programs for individuals with intellectual disabilities, it is not only important to know that these children are capable of retaining information, but also that they are able to apply this knowledge to different contexts. Autism, in particular, is a complex neurodevelopmental disorder that presents with difficulties in communication and social interaction as well as engagement in restricted and repetitive behaviors (RRBs). Perseveration of sameness, an RRB subtype, refers to restricted interests, and engagement in rigid routines and rituals, which hinders cognitive flexibility.
In order to address inadequacies of recognition and appropriate reactions to emotional and social cues by individuals with autism, there has been extensive focus on teaching behavioral scripts. Behavioral scripts are designed to teach appropriate behavior by providing guidelines that prompt awareness to social norms (Bock, 2007; Wang & Spillane, 2009). However, there is limited research investigating whether or not individuals with autism spontaneously acquire cognitive scripts about everyday event knowledge, and if they do, the extent to which they can generalize this knowledge to other novel events.

The current experiments are the first to investigate generalized event representation as a function of action and sequence relations (causal, arbitrary, conventional) in pre-school children with mild- to high-functioning autism spectrum disorder and children with other cognitive and language delays. The method employed is the generalized imitation paradigm (Bauer, 2002; Mandler & McDonough, 1996; 1998), which is an appropriate measure of representational capacity. Each task consists of several props, in which imitation in a particular sequential order is necessary for task completion. For each test event, the stimuli that the children receive for generalization were perceptually dissimilar to the modeling props, yet retained their functional similarity. One goal of the current study was to increase ecological validity in an effort to reflect real world settings, which is especially important for children with ASD. With this measure, actions are modeled with miniature, realistic-looking objects in a particular sequence that is naturalistic and not awkward. Generalization with other realistic objects
is assessed. Event representation is assessed by the extent to which children are able to use the substitution props to the original while recalling the sequences in the correct order in which they were modeled.

**Overview of the Dissertation Sections**

The introduction is a literature review on previous research in event representation and generalization abilities in typically developing children, children with cognitive and language delays (CLD), and children diagnosed with autism spectrum disorder (ASD). Section 1 defines autism and provides a historical account of its causes. Section 2 outlines the rationale for the current diagnostic classification of autism spectrum disorder (ASD) according to the Diagnostic Statistical Manual of Mental Disorders (5th ed.; DSM-5; American Psychiatric Association [APA], 2013), and provides information about ASD symptomatology. Perseveration on sameness, one of the core characteristics of ASD that affects generalization ability, is defined thoroughly in Section 3. Section 4 briefly defines event representation and describes why generalization is an essential cognitive skill. Categorization, which serves as a foundation for generalization skills, is defined in Section 5. This section also recounts extensive research on categorical development in typically developing children. Section 6 discusses previous research on young children’s ability to generalize the function of objects. Section 7 explains how objects are related to everyday events and the importance of sequential understanding. Section 8 is a review of previous research on event representation in
children with ASD. Section 9 summarizes the purpose of the current research proposes various hypotheses.

The dissertation research is presented in Chapter II, which is subdivided into three experiments. Experiment 1 investigates generalized event representation in children with various cognitive and language delays (CLD). Experiment 2 is an internal validity check to ascertain whether the two sets of stimuli used in Experiment 1 were indeed different from each other with respect to perceptual between-category similarity. Experiment 3 is a replication of Experiment 1 conducted on children with mild- to high- autism spectrum disorder and on typically developing controls.

Chapter III (General Discussion) provides a detailed explanation of the results of the performance of the TD, ASD, and CLD groups in the current experiments compared to previous research discussed in Section 1. Sections 2 and 3 discuss limitations of the experiments, summarize the dissertation, and offer recommendations for future research.

1.1 Historical Explanations for the Causes of Autism

Autism, one of most common intellectual disabilities in the United States, is a neurodevelopmental disorder characterized by deficiencies in social interaction and reciprocity, challenges in communication, and repetitive, stereotyped behavior occurring before the age of three (Greenspan & Weider, 2006; Lord, 2011). The term *autism* was originally coined by Bleuler in 1911 (Wing, 1997) to characterize the symptom associated with detached reality found in patients with schizophrenia. However, Leo Kanner (1943) popularizes the label *autism* to describe the distinct pattern of social,
communicative, and repetitive behaviors based on detailed case studies he observed in a small group of children, diagnosing them with “early infantile autism.” His vivid descriptions of behaviors that emphasized a lack of emotional responses in social situations, accompanied by eccentricities such as engagement in repetitive and/or stereotypic behaviors clearly distinguished these children from typically developing children. Children with early infantile autism, he noted, were very resistant to change, had speech difficulties, and were socially aloof, yet they also displayed proficiency in rote memory and visual-spatial tasks. The juxtaposition of social deficiency with components of normal cognitive intelligence was what Kanner believed made autism unique compared to other childhood disorders. In 1944 Hans Asperger described his own observations of another set of behaviors, displayed by older children and adolescents that resembled early infantile autism, but was quite distinct. Like autistic children, these older individuals also had restricted interests, deficits in social interaction and nonverbal communication; however, their linguistic production was intact and many had above average intelligence.

It is important to note that although Kanner and Asperger were considered pioneers for defining the symptomatology of autism, autistic-like symptoms have been chronicled as early as 1801 (Wing, 1997). Victor, the “feral” child, who was found in his teenage years living in the woods of Averyron, France, is one such example (Bettelheim, 1959). He had no speech production despite many intervention attempts by French physician J.M.C. Itard. According to Wing, whose article (1997) recounts the legend and
history of autism, J.M.C. Itard’s detailed account of Victor’s behavior described autistic tendencies. Amala and Kamala, feral girls from Midnapore, exhibited extremely similar behavior to children as observed by Bruno Bettelheim at the Sonia Shankman Orthogenic School at the University of Chicago (Bettelheim, 1959).

The classification of childhood disorders was first recommended by Henry Maudsley (1867; in Wing, 1997) and was slowly implemented thereafter. Subtypes of childhood disorders began to emerge at the beginning of the twentieth century, which included children who, after developing normally, regressed in language ability, social skills, and cognitive functioning.

A few antiquated explanations for the cause of autism have been controversial. The most contentious, that autism was caused by a lack of maternal warmth and attention, was introduced by Kanner (1943; 1949). Influenced by psychoanalytic theorists, Kanner proposed that the behaviors of autistic children resulted from parents who were also socially and emotionally detached and displayed aloof behavior towards their children. He concluded that the symptoms of autism emerged in children who were “kept neatly in refrigerators which did not defrost” (Kanner, 1973, p. 61). Since the majority of children that he observed at the time had moderate intelligence and came from parents who were well educated, Kanner contended that the parents caused autistic behaviors by disrupting their children’s emotional well-being. This theory quickly gained approval in the scientific community. Bruno Bettelheim, a staunch supporter of the refrigerator mother theory, propagandized this idea in a series of articles and books throughout the 1950’s
and 1960’s. After witnessing the lack of affect and withdrawal exhibited by prisoners in German concentration camps that reminded him of autistic children, Bruno Bettelheim proposed that autistic symptoms were actually a coping mechanism to deal with the horrible emotional pain children endured at their parents’ hands (Seifert, 1990). According to Bettelheim (1967), “autism has essentially to do with everything that happens from birth on” (p. 393). Despite evidence suggesting otherwise, he argued that the autistic child is born with normal intelligence and the ability to communicate but chooses not to in order to defend him or herself from future trauma (Seifert, 1990). Although Kanner’s explanation, and Bettelheim’s promotion of the refrigerator mother theory, were responsible for feelings of intense guilt and blame in many parents of children with autism, these theories also led to the emergence of autism advocacy groups and organizations such as The National Autistic Society (Wing, 1997). However, Bernard Rimland, a prominent psychologist, and founder of the Autism Research Institute and Autism Society of America, was also the parent of a son with autism, and strongly opposed the refrigerator mother hypothesis. Although Rimland’s (1964) research on the neural implications of autism eventually convinced Kanner that autism was perhaps a neurological disorder, Bettelheim remained unmoved.

In hindsight, what Kanner may have observed was a possible correlation (and not a causal link) between lack of maternal affection and autistic behaviors in children. However, since we now know that lack of communication is a core symptom of autism, specifically, the failure to engage in social interaction, a plausible explanation is that
naturally, this lack of engagement of the child would also diminish social reciprocity by mothers over time. Nevertheless, what Kanner and Bettelheim failed to investigate (and never addressed) was whether this pattern was evident in the same mothers toward their non-autistic children.

Later research has explored the relationship between child-rearing methods and autistic symptoms in children. The Strange Situation Procedure was a scenario developed by Ainsworth, Blehar, Waters, & Wall (1978), which initially investigated attachment profiles of typically developing children with their caregivers. In the procedure, the child experiences brief separation and reunion episodes with his or her caregiver in a laboratory setting. Based on the emotional and behavioral responses displayed by infants during separation and reunion episodes, Ainsworth and colleagues determined that there are two discrete attachment patterns: secure and insecure. The securely attached child tends to seek comfort from his/her caregiver. By using the caregiver as a secure base, the child will independently explore the surrounding environment in the caregiver’s presence. The child will naturally display behaviors of distress when separated from the caregiver, but is delighted when reunited. Insecure attachment is subcategorized in three ways: resistant, avoidant, and disorganized. Insecure-resistant children are extremely distressed when parents leave them, and upon return, show conflicting behaviors of both contact seeking, and anger/resistance. Although the child is happy to be reunited with the caregiver, he or she displays anger for being left alone, and does not use the caregiver’s comfort to ease the distress. Insecure-
avoidant children show little distress when caregivers leave or return, essentially responding to the parent as they would a stranger. The insecure-disorganized profile is typically found in children who have been abused or have sustained other unresolved trauma. The child is thus faced with the dilemma of whether to flee to safety to the same person who is the source of the distress (the caregiver). Because the parent’s behavior pattern is unpredictable, the child has no organized strategy from which to benefit. Therefore, these children respond by displaying bizarre or inhibited behavior upon the parent’s return. In an attempt to seek comfort, the child may run to approach the parent, but then fearing to be in close proximity to the parent, the child may then hit the parent, or freeze, and run away.

Research using the Strange Situation Procedure has revealed that some children with autism do foster secure attachments with their parents (Rutgers, Bakermans-Kranenburg, van IJzendoorn, & van Berckelaer-Onnes, 2004). The degree of security, however, is correlated with the level of functioning of the child. For instance, children with autism who are low functioning tend to display more insecure and disorganized attachment relationships with their parents than their typically developing counterparts (van IJzendoorn, et al. 2007). Findings by Haltigan, Ekas, Seifer & Messinger (2011) also revealed no differences in attachment security (secure, insecure, avoidant) of infant siblings of older children with autism (at least one sibling diagnosed) compared to infant siblings of typically developing older children. A closer look within the secure attachment category revealed that the only difference between the groups was how
behaviors were expressed—autistic siblings tended to be “rarely distressed during separation” from parents; moreover, evidence of their secure attachment was revealed by highly indifferent, restrained demeanor. On the other hand, securely attached, non-autistic siblings showed more behaviors of frustration and distress upon separation; upon reunion, they maintained close contact with the parent. Although both groups were classified as having secure attachment with their caregiver, variation emerged in terms of their emotional reactions towards their caregiver in the strange situation scenario.

Although the initial explanations of causes of autism have since been dispelled, the growing literature on autism has not determined any salient origin. Instead, research suggests that although there is no single genetic marker (Abrahams & Geschwind, 2008), the etiology for autism includes genetic variations with possible influences from the environment (Lord & Bishop, 2010). Evidence in support of a genetic basis for autism is found in sibling concordance rates and behavioral similarities of parents. Furthermore, research has revealed higher prevalence rates of autism in intermarriage among first cousins in isolated areas of the world, specifically the Middle East (Kamer, Zohar, Youngmann, Diamond, Inbar & Senecky, 2004). Because many children with genetic disorders such as tuberous sclerosis and Fragile X syndrome have shown expressions of autistic-like behavior (although these symptoms were not sufficient for official diagnosis; Lord & Bishop, 2010), some researchers have argued that the biological components of these disorders could also be genetically linked to autism (Cohen, Pichard, Tordjman, Baumann, Burglen, et al, 2005; Jensen & Spannagel, 2011).
Formerly considered as a variant of schizophrenia in childhood, autism is currently recognized as a separate disorder. Two features that distinguish schizophrenia from autism are the symptomatology and age of onset (Ghaziuddin, 2005).

Schizophrenia is a psychotic disorder with symptoms of hallucinations, delusions, and disorganized thoughts. The onset of schizophrenia typically emerges during late adolescence/early adulthood, and is rarely found in children (about 1 in 100 adults with schizophrenia showed symptoms in childhood; Reaven, Hepburn & Ross, 2008). By contrast, symptoms of autism are marked by impairments in social interaction, communication and repetitive behavior, but do not include psychotic symptoms (e.g. hallucinations and delusions), and the typical age of onset is before the age of three. Furthermore, unlike schizophrenia, autism is highly co-morbid with mental retardation and seizure disorders (Ghaziuddin, 2005). Despite researchers and clinicians treating schizophrenia and autism as markedly different disorders, recent research suggests that there may be some phenotypic overlap. Although rare, in the subset of children diagnosed with schizophrenia (Childhood-Onset Schizophrenia, or COS), roughly 25% also had a comorbid diagnosis of pervasive developmental disorder (PDD) (Sporn, Addington, Gotnay, Ordonez, et al., 2004). In addition, many children officially diagnosed with COS have had a history of socio-emotional deficits and language impairments that resemble PDD but have not been dually diagnosed on the autism spectrum (Reaven, Hepburn & Ross, 2008). Furthermore, thought disorder and disorganized speech associated with schizophrenia may be misconstrued as having
pragmatic difficulties such as those associated with high functioning autism. These special cases have sparked research interest because the presentation of autistic symptoms in some children with schizophrenia suggests that these two disorders may have phenotypic overlap. A few studies have tested this possibility by administering autism evaluation scales, such as the Autism Diagnostic Observation Schedule (ADOS) (Sugihara, Tsuchiya & Takei, 2008) and the Broad Autism Phenotype Questionnaire (BAP) (Reaven, Hepburn & Ross, 2008), to children and adults diagnosed with schizophrenia. The studies revealed that individuals in these samples, who responded well to antipsychotic medications, scored high on the aforementioned autism diagnostic assessments, which are highly reliable.

It is important to note, however, that although these data seem to suggest that schizophrenia and autism share similarities of symptoms, Reaven and colleagues (2008) interpret this finding with caution. While they concur with the large body of literature and the diagnostic criteria in the Diagnostic Statistical Manual that schizophrenia (including childhood-onset) and autism are indeed discrete disorders, they argue that current autism assessments are not sensitive enough to rule out psychotic and other psychiatric disorders. Reaven et al. (2008) also argue that aloof presence and limited social interaction displayed by the participants may have been attributed to them being overwhelmed by the new environment (of the lab setting and the interviewer), and not due to inherent autistic tendencies. Additionally, restricted, repetitive behaviors, echolalia, and the use of stereotyped speech, which are unique core deficits of autism,
were noticeably absent in the schizophrenic sample. Therefore, both studies (Sugihara, Tsuchiya & Takei, 2008; Reaven, Hepburn & Ross, 2008) strongly suggest that autism diagnostic assessments must be valid and sensitive enough to include items that exclude individuals with schizophrenia to ensure that individuals are not misdiagnosed or over-identified as having autism.

1.2 Current Diagnostic Criteria of Autism Spectrum Disorder (ASD)

Over the years, the nomenclature for autism has been modified to “autism spectrum disorder (ASD),” to acknowledge the disorder’s wide range of symptoms and characteristics. ASD describes the distribution of individuals with associated symptomatology ranging from severe to mild (Jensen & Spannagel, 2011). According to the DSM-IV-TR (4th ed., text. rev., DSM-IV-TR; American Psychiatric Association, 2000), ASD is a pervasive developmental disorder, which is characterized by abnormal, autistic-like functioning in three domains: a) social interaction and reciprocity; b) communication; and c) restricted and repetitive interests. In this edition of the DSM, ASD included the following subcategories: autism, Asperger syndrome, pervasive developmental disorder not otherwise specified (PDD-NOS), childhood disintegrative disorder, and Rett syndrome. Asperger syndrome describes individuals on the spectrum with substantial difficulties with social interaction/reciprocity, problems interpreting nonverbal communication, and having stereotyped interests; however, their verbal abilities, and cognitive faculties are comparable to typically developing peers (Jensen & Spannagel, 2011). PDD-NOS describes individuals who have met some of the criteria
for autism spectrum disorder (compared to other developmental disorders), but do not meet full criteria for autism or for Asperger syndrome (APA, 2000). Childhood disintegrative disorder is a rare condition in which children develop normal cognitive, social, and motor functioning before age two, and within a period of months thereafter, display regression and substantial loss in functioning in these areas. Rett syndrome is a genetic disorder caused by the X-linked MECP2 gene (encoding methyl-CpG-binding protein 2), and therefore, affects girls almost exclusively (Amir, Van den Veyver, Wan, Tran, Francke, & Zoghbi, 1999). Like childhood disintegrative disorder, normal development is followed by a drastic regression of faculties. However, the onset of symptoms of this progressive neurodevelopmental condition occurs much earlier (at around 6-18 months) and is more severe than childhood disintegrative disorder. Symptoms of Rett syndrome include poor muscle tone (hypotonia), language and speech loss, diminished purposeful hand use, and eventually, apraxia—the debilitating loss of all motor functions.

There has been much disagreement regarding diagnostic consensus in distinguishing individuals on the spectrum according to these established subtypes. Walter Kaufmann, member of the Neurodevelopmental Disorders working group for the new diagnostic criteria for ASD (2012), outlined proposed changes for ASD in the DSM-5. According to Kaufmann, there appears to be a misrepresentation of PDD-NOS as high functioning autism (but not as high functioning to meet Asperger syndrome criteria). Because this particular subcategory has not been adequately defined, individuals may
have been misdiagnosed, resulting in an autism “epidemic” due to over identification in the ASD population. Therefore, it was argued that as with any other “not otherwise specified (NOS)” subcategory for other mental disorders, this category should be also considered as “subthreshold symptomatology.” PDD-NOS should only refer to individuals who either have severe social interaction and communication impairments, or display restricted activities/repetitive behaviors, but not both, which is why these cases do not meet full criteria for ASD. Regarding Asperger syndrome, there is no research indicating that Asperger syndrome is a disorder that is discrete from autism. Essentially, Asperger syndrome is high-functioning autism and should be specified as such. Another justification for removal of this category is that there appears to be a differential rate of diagnosis related to race and SES, in which high-SES Caucasian males are more likely to be diagnosed with Asperger’s, whereas lower-SES non-Caucasian males and females are more likely to be diagnosed with PDD-NOS (Kaufmann, 2012). One concern about the collapsing of Asperger syndrome into the larger ASD category (mostly by parents) is that it results in the loss of identity and uniqueness of the Asperger distinction. However, it is important to note that many states deny access to services for children diagnosed with Asperger syndrome due to its high-functioning status, thus, merging it into the ASD category would enable these individuals to be eligible for the services they require.

According to Catherine Lord (2010), clinicians and researchers have considered reclassification of childhood disintegrative disorder and Rett syndrome as “atypical autism” due to their statistical rarity in the ASD population. Furthermore, autistic-like
behaviors in these disorders only appear during a brief period of development. What generally differentiates children with these disorders from others on the spectrum is the profound regression/loss of motor symptoms, which is not a salient characteristic of ASD.

The current edition of the Diagnostic Statistical Manual of Mental Disorders (5th ed.; DSM-5; American Psychiatric Association [APA], 2013) has made several revisions to redefine the autism spectrum in an effort to reflect the core characteristics related to autism. The first major change was to remove ASD as a subtype of “pervasive developmental disorders,” on the grounds that the symptoms expressed are actually not pervasive, but quite specific to social, communication, and restricted interests/stereotyped behaviors (Kaufmann, 2012). Another change was shifting from a categorical approach to a dimensional classification approach; therefore, the current diagnostic criteria of ASD capture the previous (DSM-IV-TR; American Psychiatric Association, 2000) diagnoses of autistic disorder, Asperger syndrome, PDD-NOS, childhood disintegrative disorder, and Rett syndrome, but currently these subcategories are subsumed into the larger category of “autism spectrum disorder.” This singular diagnostic category of ASD appears to be the best representation of individuals who share the same common core symptoms of autism, and any variability among individuals should be described by clinical specifiers (i.e. level of severity, IQ) and any known comorbid disorders (i.e. Fragile X, intellectual disability, epilepsy).
Furthermore, instead of using the three previous descriptors to characterize ASD (social interaction, communication, and restricted and repetitive behaviors/interests), the DSM-5 classification has collapsed the social interaction, and communication components into one category. The justification for merging these two components is that there is great overlap between social interaction and communication (and merging eliminates redundancy). Therefore, only two descriptors will serve as measures for diagnosis: social-communication, and fixation/repetitive behaviors. According to the current criteria, a solid diagnosis of ASD must include symptoms of all three of the following components listed within the social-communication category: failure of social reciprocity (e.g. flat affect, lack of joint attention, failure to initiate and maintain conversation, failure to share interests with others), difficulties with nonverbal communication (e.g. unusual body posturing, repetitive usage of stereotyped or eccentric language, lack of coordination of eye contact with appropriate gestures), and problems maintaining peer relationships (e.g. lack of social or emotional exchange, lack of theory of mind, prefers to engage in solitary play, lack of spontaneous, imaginative play). In addition, the diagnosis must satisfy two of three components listed in the restricted/repetitive behavior (RRB) category: repetitive behavior (gestural or verbal), engagement in rituals, and preoccupation of interests. Restricted and repetitive behaviors, the focus of this paper, are evidenced by fascination with narrow or restrictive interests, repeated movements, engagement in non-purposive routines, repetitive motor
behaviors (e.g. rocking back and forth, hand flapping, spinning body in circles), and fascination with parts of objects (American Psychiatric Association, 2013).

Researchers have found that what accounts for the variability in cognitive functioning within the autism spectrum is the severity of the particular symptoms in the restricted and repetitive behavior (RRB) domain (Kim & Lord, 2010; Georgiades, Szatmari, Zwaigenbaum, et al., 2007). It is important to note that RRBs are not exclusive to ASD: children with other intellectual disabilities and typically developing children also demonstrate repetitive behaviors (Leekam, Prior & Uljarevic, 2011). However, the significant prevalence of RRBs in children with ASD as compared to other diagnostic groups is why it is considered as a defining characteristic of the autism spectrum disorders. Furthermore, children with both autism subtypes exhibit a remarkable amount of RRBs compared to typically developing children (Honey, et al., 2007; Kim & Lord, 2010; Werner & Dawson, 2005) and children with non-spectrum disorders (Goldman, et al., 2009; Kim & Lord, 2010).

Although RRBs are found in typically developing children in the first year of life, repetitive arm movements tend to increase after the first year. Repetitive arm and hand movements seem to be correlated to vocal production and other motor movements (Iverson & Wozniak, 2007), but these movements decline over time as language and motor skills are coordinated and motor movement becomes purposive. Based on an exhaustive review of the literature on restricted and repetitive behaviors in ASD, Leekam and colleagues outlined developmental patterns based on research that have used various
methods of measurement: parental interviews and questionnaires (i.e. ADI-R, Repetitive Behavior Scale, Childhood Routines Inventory, Repetitive Behavior Questionnaire) and observation tools (e.g. ADOS-G). Their review illustrates the limited longitudinal data investigating the developmental trajectory of RRBs in children with ASD. The only research assessing RRBs by investigating repetitive motor behaviors and insistence of sameness in ASD was conducted by Richler, Huerta, Bishop, & Lord (2010). Although repetitive motor behaviors remained very high over time (ages 2, 3, 5 and 9), this trend decreased with children with high nonverbal IQs at age 9. The frequency of sensorimotor RRBs tends to be highly correlated in children with low-functioning ASD. As children with ASD age, insistence on sameness behaviors also increases. Regarding IQ, children with high nonverbal scores tend to display fewer sensorimotor repetitive behaviors but more instances of narrow interests and perseveration of sameness.

There are many theories about the cause of RRBs, one of which is executive dysfunction. Executive functions are high-order cognitive abilities that enable individuals to inhibit inappropriate behavior, engage in planning and goal-directed behavior, and respond to feedback from the environment, which is important for flexibility and adapting to change (Chan, Shum, Touloupoulou & Chen, 2008; Lezak, 2004). Individuals with frontal lobe damage have impairments in these areas, and such executive dysfunction has been characterized in individuals with ASD (Leekam, Prior & Uljarevic, 2011). Executive dysfunction expressed through restricted routines and rituals has also been associated with symptoms related to Obsessive Compulsive Disorder (OCD).
However, Leekam and colleagues note that while obsessive rituals are common in both disorders, those diagnosed with OCD seem to be distressed and tormented by these symptoms, whereas those diagnosed with ASD may find them to be stimulating.

Because the presence of restricted and repetitive behaviors (RRBs) increased the validity of an autism diagnosis in the Autism Diagnostic Observation Schedule (ADOS-G), it was reinstated as a diagnostic marker (Kim & Lord, 2010). Research has shown that there is some variability within the RRBs category (Leekam, Uljarevic & Prior, 2011). According to Cuccaro and colleagues (2003), longitudinal data from the Autism Diagnostic Interview—Revised (ADI-R) revealed two subtypes of RRB: a) repetitive sensory motor behaviors (repetitive mannerisms, repetitive use of objects, eccentric sensory fascinations); and b) insistence on sameness (engaging in routines and rituals, and difficulties with change in routine). The latter subtype, perseveration for sameness, or cognitive inflexibility, is the characteristic of ASD that this paper will heavily focus on in the context of everyday event representation.

I.3 Perseveration of Sameness Symptomology

Children with an ASD have a tendency to desire sameness, consistency, and completeness in a world that is dynamic and unpredictable. This rigid cognitive style is resistant to adapting to change or spontaneity (Loth, Gomez & Happe, 2011). A classic behavior of autism is lining up objects in a particular order or arrangement, and tantrums may occur if someone or something disrupts that order. Kanner’s (1943) example of a child who was extremely anxious when his family was moving to a new home is similar
to many experiences that autistic children encounter presently. The sheer panic of the movers removing his bedroom rug, furniture, and knickknacks that had been accumulated and arranged in a highly specific, yet nondescript pattern was placated as soon as the child finished reorganizing all of his belongings in the same pattern in his new room. The rug, each piece of furniture, and each bead and block had to be oriented precisely as it had been—in the same pattern and whose importance for this arrangement was only comprehensible to the child and no one else. Noticing a misplaced block or bead was promptly followed by a tantrum until “order” was restored. Kanner also noted that this uncanny ability for remembering specific details, exact amounts and the precise orientation of objects suggests that children with ASD have superior rote memory, one of the “cognitive potential” abilities of autism.

Proclivity for sameness is also evident in social exchanges in children with ASD. Although children with Asperger syndrome and high functioning autism do not have challenges with many fundamental features of language (e.g. phonology, morphology, grammar), pragmatics may present a challenge. Pragmatics is the feature of language that pertains to its social uses: understanding context of an utterance even when it is not explicitly stated and how utterances contribute to their meaning; appropriate intonation, knowledge about and intent of the speaker; identifying ambiguous messages and acting to clarify, etc. Considered the sophisticated and difficult aspect of linguistic knowledge, pragmatics is only acquired through experience (Fletcher, Happe, Frith, Baker, et al. 1995). The Gricean (1975) principle of cooperation, which includes specific
conversational maxims, emerged from pragmatic understanding and use in natural language. Grice argues that in everyday discourse, there are common assumptions that language users (both speakers and listeners) make for effective conversation in everyday social situations. Furthermore, those who abide by the cooperative principle and its maxims are ensuring that what they provide in the conversation will contribute to (and not hinder) its purpose.

Pragmatic and conversational breakdown in children with ASD greatly contributes to the language impairment characteristic of this disorder since perspective taking and understanding nonverbal communication are also challenges they face. Rating scales used to assess pragmatic challenges have analyzed speech in children with autism based on Gricean theory (Ghaziuddin & Gerstein, 1996) and have found that children with ASDs primarily violate aspects of this linguistic feature. In particular, their speech tends to have a robotic or formal intonation, delayed response, and they rarely initiate or maintaining conversations; they also tend to disengage from the conversation itself and abruptly switch topics (de Villiers, Fine, Ginsberg, Vaccarella & Szatmari, 2007). When they do engage in longer social exchanges, perseveration frequently occurs, where conversations specifically revolve around special interests. For instance, an ASD child, whose special interest is baseball may only discuss baseball in any conversation, and will do so in a pedantic fashion (e.g., reciting accurate information regarding statistics of teams and players, World Series winners, or games attended). The autistic child, who deviated from the initial topic, also will provide no segue or pause for entry to enable the
listener to contribute. The child with autism, breaching Gricean principles of cooperation, will more than likely fail to acknowledge nonverbal cues of the listener (i.e. diminished interest, attempted interruptions). The listener, having neither limited knowledge of baseball, nor interest to switch to this new topic, will fail to reciprocate, causing the conversation to become one-sided. In fact, research suggests that children with high functioning autism have challenges using strategies to process social information effectively. They have problems inhibiting irrelevant responses, adjusting their behavior based on environmental feedback, extracting rules from experience, and distinguishing between relevant and irrelevant information (Klin & Volkmar, 2000).

This insistence of sameness also extends to how individuals with ASD perceive common everyday events. Not only do children with ASD expect that the world functions in a predictable, consistent fashion, but they also expect that others will conform to their rigid routines and rituals. Any slight deviation that seems to violate their assumption about the world is enough to induce heightened anxiety. It is important to note that typically developing individuals also experience some level of anxiety when encountering a change in daily routine without preparation time. After all, we may experience some level of distress if one day, on our commute to work, our usual train is delayed by 30 minutes. Likewise, many students experience anxiety when a teacher announces a surprise quiz at the start of class. However, our assumptions about the world are different from those with autism—we know, for instance, that the world is unpredictable and that adapting to change in our external environment is essential for
survival. When faced with change in our everyday lives, spontaneity permits us to think of alternative options to solve a problem in order to move forward. Conversely, many children with autism engage in rituals, in which events and actions that occur in events must happen in the same exact way every time. Furthermore, individuals with autism insists that their routine is the only option to proceed; thus, anxiety and distress persists until the event is completed as precisely as possible. This cognitive inflexibility, which does not allow for variability within every day events, is a characteristic of autism that makes it a challenging disorder to treat.

I.4 Event Representation: Introduction

Event representation (also called event schemas, event knowledge, or scripts) is defined as memory for generalized predictions for what usually happens in familiar events (Mandler, 1979; Schank & Abelson, 1977). Knowledge about events becomes activated for a present situation (Abelson, 1981), which includes the actors, objects, routine actions and social norms in an event (Schank & Abelson, 1977). For instance, a doctor’s visit typically includes the doctor and patient (actors), scale, needles and stethoscope (objects), the doctor listening to patient’s heart beat (routine actions), and the patient remaining in the waiting room before being called by the doctor (social norms). Event representation categorizes information and activities from our past experiences into schemas that are used to guide inferences about novel situations and organizes activities within events in a hierarchical fashion (Luciarello & Nelson, 1985). Activities associated with an event are referred to as scenes. For instance, scenes in the “supermarket schema”
include: entering, getting items, paying, and leaving. Activities associated with each scene are called slots (i.e. getting food). Depending on frequency effects, some slots become central components to the event (paying bill), or are specific to an event (i.e. decorating tree at Christmas time). Other slots are considered optional because they are not specifically related to the event (saying “hi” to a neighbor). Furthermore, slots include a variety of slot fillers, which are specific activities or objects related to the slot (e.g. getting bread, getting non-fat yogurt). Events that we experience in real life consist of predictable sets of actions performed in a particular order, which are subject to some degree of variability (Loth, Gomez & Happe, 2011).

Although some research has investigated how infants and young children are able to access what they knew about everyday events and apply this knowledge to new situations, our current knowledge is limited (e.g., Bauer & Dow, 1994; McDonough & Mandler, 1998). As we collect data on the processes that guide generalizations in typically developing children, it becomes increasingly important to understand the extent to which these processes are also available in children with developmental disorders. After all, if we are to design training programs that will be beneficial to those with various learning disorders, we need to know whether those who undergo the interventions will be able to apply what they have learned. Construction of event representation requires two essential cognitive processes: generalization ability and awareness of temporal sequential ordering of actions within the event (Loth, Happe & Gomez, 2010). These processes allow us to represent events in the face of potential variation. In order to
understand how these processes work together in the context of everyday event representation, we must first review the literature on categorization, or the source of classifying familiar knowledge. Because research suggests that children with ASD have difficulties with categorization (Church, Krauss, Lopata & Toomey, 2010; Klinger & Dawson, 1995), this deficit could impede their ability to generalize to novel situations.

I.5 Category Development: Early Foundations for Generalization Skills

Event representation involves information about the objects and actions that are associated with objects within events. Young children quickly learn about the function of objects and props that are associated with routines that they experience on a daily basis. Although shopping carts and baskets are containers for transporting food while in a supermarket, young children come to realize that a shopping cart is larger than a basket, moves when someone pushes it, and serves a dual purpose as a “wagon.” As with activities within a specific event schema (e.g., bath time), objects used for causal and conventional actions are essential (i.e. soap and towel), whereas arbitrary props are not (i.e. rubber duck). How is it that young children come to make meaning of the functions of many objects? Do children with ASD and children with cognitive and language delays comprehend objects in the same way? In order to understand how children determine meaning, we must define the term “concept”. A concept is the product of an analytic process and refers to a unit of meaning that is an interpretation of a percept (Mandler, 2000). Our perceptual systems can identify what a “cup” looks like, however this is qualitatively different from knowledge that a cup is a container used for drinking. Thus,
concepts are not based on what something merely looks like; rather, concepts are a representation of what something really is, what it does, or what is done to it. A percept is implicit in that it typically uses automatic, unconscious processing for perceptual identification. Percepts can be very detailed, context-dependent and used to make distinctions based on physical appearance. A concept, by definition, is explicit and, as such, is consciously accessible for higher-order functions such as memory, problem solving and generalization. Concepts, general and independent of context, are used for determining kinds and functions (Mandler, 2000).

Categorization, an early cognitive skill, is one of the most fundamental schemas used by humans. Conceptual categories facilitate the identification and organization of objects independent of their perceptual orientation (Bornstein & Mash, 2010), and include the act of distributing things into classes or categories of the same type. Conceptually based categories are essential in efficiently clarifying, systematizing, and banking information—a necessary cognitive tool for making predictions about unfamiliar stimuli. Categorization involves the representation of similar entities into classes. However, it is important to note that when the expressions “similar” or “similarity” are used to describe the relations between objects, these terms must be qualified (Medin, Goldstone & Gentner, 1993). In what respect are objects within categories similar? For instance, dogs, cats, horses, lions and elephants are some good examples of the category ANIMAL, however, chair, motorcycle, bag and pencil are not. Additionally, the metric that one uses to include examples near the boundary or periphery of a category and define
the exclusion of others is also important. For example, would a preverbal infant consider a jellyfish to be an ANIMAL? What is the basis for forming this category? There has been much debate regarding how preverbal infants form categories given the limited exposure they have with objects and events. Do they form categories by generating an amalgamation of all of the physical attributes (i.e. color, shape, size) of objects associated with them, allowing categorization based on overall shape similarity? Or does conceptual thinking guide categorization? Perhaps children engage in multiple processes in an effort to classify information.

One of the first avenues of research with typically developing infants and children that should illuminate generalization processes concerns how they learn to categorize objects. Traditional views propose that children observe the similarities among objects and based on these observations assume that things that look similar are the same kind of thing. So, even though a Siamese cat may differ somewhat from a Persian cat, both tend to share overall shape and belong to the same category. Thus, when one observes a Siamese cat engaging in a particular behavior, one might generalize that observation by assuming that Persian cats engage in the same behavior. Research supporting the view that infants treat similarly shaped objects as belonging to the same category comes from two sources: infant habituation studies and language studies. Quinn and Eimas (1994) used a habituation measure and showed that infants as young as 3-months of age can categorize several different cats and recognize that cats perceptually differ from tigers, dogs, horses, and birds but resemble female lions. At this age, however, it is assumed
that infants know little about what kind of thing a cat is (e.g., cats are a kind of animal, they purr, meow, and like milk).

The similarity hypothesis was embraced by several developmental psychologists and was also commonly used as an explanation and predictor of adult categorization skills (e.g., Rosch, Mervis, Gray, Johnson & Broyles-Braem, 1976; Sloutsky & Fisher, 2003; Tversky, 1977). According to Tversky (1977), similarity judgments between two entities are largely dependent on the analysis and weighting of perceptual features such as color, shape, size, and texture. Whether a novel stimulus will be included or not as a category member depends largely on whether the physical properties common to category members are also evident in the novel stimulus. Sloutsky and Fisher (2003) elaborated on this argument by proposing that the process of judging matches and mismatches of stimuli will change similarity judgments as a function of the variability of the perceptual features. They predicted that high variability among category members decreases the likelihood that a novel item will be included in the category. The various experiments by Rosch and her colleagues (1976) convinced many that similarity was a useful heuristic both for children and adults for category formation, particularly for “basic-level” categories.

The similarity view of categorization, which is often used to explain how people generalize what they know to new situations, was not without controversy. Research on categorization with amnesic adults showed that they could make categorical distinctions based on perceptual information (arrays of dots) through prototype formation (Squire &
Knowlton, 1995), even though they had limited awareness of such categories. The formation of categories with which we have no awareness is presumably not useful when problem solving or making predictions about future events. The procedure used in the research with amnesic adults was similar to that used with young infants. This compelled some researchers to interpret the infant data conservatively—perhaps, just like amnesic adults; infants were forming categories of cats and dogs based on perceptual processes. Given the inaccessibility of such categories to conscious processes, it was deemed unlikely that these categories would provide a foundation to guide reasoning.

In an effort to uncover category formation that is based on what infants know about objects in the world rather than simply what objects look like, Mandler, Bauer, and McDonough (1991) examined infant categorization of perceptually varied objects, which would not be considered similar by any theory at the time. They tested categorization of animals and vehicles using tasks that were more interactive than those used by other researchers. Results indicated that 18-month-olds were quite good at differentiating animals and vehicles, yet these same infants had difficulties categorizing dogs and rabbits, categories that were perceptually distinguished by 3-month-olds (Eimas & Boutelle, 1995). This finding was in sharp contrast to what was predicted based knowledge of similarity at the time of this study.

Mandler and McDonough (1998) extended these findings with infants as young as 7 months of age and found they could categorize animals, vehicles, plants, and furniture items but not basic level categories such as dogs, rabbits, cats, fish. Before they could
interpret the data, they further evaluated their findings in two ways. First, they reasoned that similarity judgments might not be the same for infants as for older children and adults. They took photos of their stimuli and turned them over to the Peter Eimas, an expert at testing infant perceptual categorization using habituation and preferential looking measures. Using the slides, he and his student Jonathan Boutelle (1995) found that 3-month-olds did not distinguish the animals and vehicles but did categorize the dogs and cats. This suggested a dissociation between the measures that corresponded to the bases on which the categories were formed: habituation and looking time measures revealed perceptual categories whereas object examination, sequential touching, and match-to-sample measures suggested conceptual bases on which categories could be formed.

Mandler (2000) postulated that these findings suggest that young infants use two kinds of processes to classify objects: perceptual and conceptual categorization. These types of categorization strategies can process a stimulus in qualitatively different ways. Specifically, perceptual categorization is used to recognize what an object is, or looks like, based on perceptual properties (i.e. overall shape, color, texture). Even prototype formations of perceptual categories do not require a concept, since the development of prototypes derives from physical features. A prototype emerges from the average of salient features from many perceptually similar exemplars. Furthermore, prototype formation can be achieved without conscious analysis or intent (Mandler, 2000). Perceptual categorization is often an automatic, implicit process in which the information is not consciously accessible and does not require representation or produce meaning.
For example, knowing what a cat looks like based on physical appearance and overall shape will serve as a foundation (prototype) for identifying other cat shapes, but one may still not know what a cat is unless it is also conceptualized.

Conceptual categorization identifies an object in terms of what kind of thing the object is, what it does, or what is done to it or with it. It is an explicit process that is the interpretation of perception, requiring the abstraction of meaning about an object. Individual parts or physical features of objects do not provide this information. Indeed, similarity is a metric that we use as a basis to organize varying types of information, and the extent to which A is similar to B depends on the degree to which they share features in common (either directional or bidirectional) (Tversky, 1977). However, to make a comparison among entities, one must first qualify which function of similarity will be used to make a judgment. The processing system one decides to utilize in making judgments of similarity could yield different results (Medin, Goldstone & Gentner, 1993).

For example, asking someone to rate whether a golf ball is similar to a whole egg will need more clarification (McDonough, unpublished data) because a golf ball looks something like a whole egg—these objects have a high degree of perceptual similarity if one is looking at overall shape and if both are white. If one focuses on textures, however, these objects are dissimilar. Conversely, if one is thinking about similarity in a conceptual fashion, a whole egg is nothing like a golf ball, and therefore, would be rated low in terms of conceptual similarity. An egg we may cook for breakfast while a golf
ball we may hit to guide its entry into a hole. In a real-world context, that the two objects look similar is not meaningful if they do not operate in the same way.

It is important to note that categorization processes are not limited to objects. There is clear evidence that language has an influence on category formation. For instance, English and Korean languages categorize spatial relations in different ways. Particularly, the English language consists of spatial terms that make distinctions between containment (in) and physical contact and support (on). The Korean language, however, makes sensitive distinctions of containment describing “tight fit” (kkita) and “loose” (nehta) (McDonough, Choi & Mandler, 2003). Kkita describes “a tight fit,” which overlaps the two English meanings for in and on. For example, the word kkita encompasses “putting a piece in a puzzle” and “putting a ring on finger.” However, nehta is the equivalent Korean word for the concept of the English word that describes “loosely inside other objects” (Choi, McDonough, Bowerman & Mandler, 1999).

Research by McDonough and colleagues (2003) has illustrated that language can play a role in category formation by selecting particular features in spatial properties and labeling them. Using a preferential looking task, the findings revealed that although infants were able to categorize spatial understanding in either language regardless of the language they were beginning to acquire, adults tend to be successful at comprehending the spatial concepts specific to their primary language without being aware of those specific to other languages. Thus, categorization of spatial relations becomes influenced by language acquisition by around 24-months of age (Choi & McDonough, 2007).
Because the real world is dynamic, behaviors of and actions performed on objects are considered to a greater degree than perceptual details in an effort to establish meaning. As a result, superordinate categories that emerge in the first year of life (i.e. animate vs. inanimate) are based on inchoate principles of physics (i.e. causality), the function of objects, and bodily movements (i.e. drinking or sleeping) (Mandler, 1992; McDonough & Mandler, 1998). Furthermore, research indicates that young infants form animate vs. inanimate distinctions based on motion (i.e. jumping or walking) and sensory abilities (i.e. looking or listening), and they can also discriminate within the animate superordinate category—distinguishing between animals and people based on these conceptual properties (Poulin-Dubois, Frenkiel-Fishman, Nayer, & Johnson, 2006).

How does category formation become useful in everyday life? How do we come to represent events as we experience them daily, while adjusting to slight differences that occur in routines? To answer questions regarding the applicability of our concepts, we need to address the process of generalization. Generalization, one of the hallmarks of human cognition, is a tool that helps guide decision-making about new experiences based on previous experience and is a mechanism that facilitates problem solving, analogous transfer, tool use, and creativity. For generalization to occur, the stimulus presented must differ perceptually but retains some conceptual or representational similarity to an existing category in the knowledge base. The presentation of an unfamiliar stimulus requires some cognitive reflection in search for a category that would account for it. Next, abstraction of relevant information from the category is applied to make meaning
of the unfamiliar stimulus. By this description the process facilitating generalization is explicit. Generalization eventually results in accommodation—not only interpreting the stimulus and incorporating it in the category, but also modifying the category to a more rich and complex form. This enriched category will be helpful in generalizing future stimuli with lower degrees of perceptual variability that share a high degree of conceptual similarity. Future encounters of more discrepant stimuli may also be accommodated, resulting in further categorical enrichment. This illustrates the dynamic bidirectional relationship between categorization and generalization. Thus, the abstraction of categorized information and applying this knowledge in the presence of an unfamiliar situation is crucial for predictability, adaptability, and survival.

I.6 Early Generalized Knowledge Based on Object Function

McDonough and Mandler (1998) developed a measure of categorization that taps into the inferences or generalizations that infants make about the properties to conceptualize animals and vehicles. Their results indicated that around the age of 9-11 months, infants demonstrate knowledge that animals engage in drinking and sleeping actions (even animals they had not seen before) and vehicles are associated with keying, and they give rides to people (even novel vehicles). Further investigations to uncover what infants would understand about basic-level categories indicated that properties specific to dogs or to birds were not understood before 18- to 24-months of age. In terms of the concepts that guide categories as broad as animals and vehicles, infants seem to
know some of them much earlier than the concepts that are more restrictive (such as dogs), which are not learned until considerably later.

Researchers working with slightly older children focused on how children use the function of objects to guide categorization. They posited that form and function are highly correlated—thus arguments that characterize categorization processes as either perceptually or conceptually based are misleading (e.g., Medin & Ortony, 1989). After all, when people explore objects, they are usually interacting with object parts that are functional (Madole & Cohen, 1995; Tversky, 1989). Moreover, it is the function of an object that provides an understanding of what kind of object something is. Such understanding is crucial for problem solving and generalization. Using a slightly different argument, one might posit that infants learn that things with mouths drink while things with eyes sleep. However, infants tend not to give drinks to “flying tiger airplanes” that have prominent mouths and they also tend to put an animal into a bed even if the eyes are not visible (Mandler, 2000). Booth and Waxman (Booth, 2006; Booth & Waxman, 2002) posited that infants’ natural attraction to people might be associated with the salience of the function of objects (since they observe older children and adults manipulate objects). Such observations of the actions of others, coupled with one’s own actions, may give rise to cognitive concepts such as intentionality, causality, goals of agents and problem solving. Additionally, children first label objects the same way adults do through their social interactions. In addition, adults are primary facilitators in helping to hone event memory in young children (Nelson, 2007).
In research with 10-, 14- and 18-month old infants, Madole, Oakes and Cohen (1993) found support for the idea that infants recognize form-function correlations that could potentially guide their categorization of objects. They familiarized infants with two objects with form and function correlations. The infants were subsequently presented with three test stimuli: a toy with an intact form-function relation; a toy that violated the form-function relation in that it had the same form but the function was not working; and a novel toy. Results showed no significant change in infants’ amount of attention to the test objects that embodied identical form-function correlations. However, when shown a test object that was similar in form but violated this correlation, infants’ attention increased indicating that they recognized the violation. As expected, infants attended even longer to the novel toy that differed in both form and function. Their recognition of the two changes was indicated by longer examination of the novel toy than to the toy where only one functional change was evident.

Other research has shown that preverbal infants will readily ignore global perceptual features of objects when a violation of function is detected. For example, Kolstad and Baillargeon (1990; reported in Kemler Nelson et al., 2000) familiarized infants with a container and demonstrated the containment property by pouring sand into it. Infants were then shown a dissimilar container that functioned in the same way and their looking time did not increase (indicating that they thought it was a container just like the previous object). They were then shown a similar container that violated the function by appearing to have no bottom, yet still functioned by holding sand. Infants
increased their attention to this object, presumably because they had selectively attended to the critical part and were surprised when this bottomless cup actually held sand.

When one examines language acquisition, a similar finding is evident. Research with older children shows that function is the basis on which nouns are extended. Deák, Ray and Pick (2002) showed children three objects: a) a hybrid object that appeared like it was one kind of thing but functioned as if it were another (e.g., a football shaped telephone); b) an object perceptually similar to the hybrid but did not function in the same way (a football); and c) an object that was functionally the same as the hybrid but differed perceptually (a telephone with a typical shape and appearance). Only the hybrid object was labeled (e.g., “see, this is a fep”) and then children were asked to choose from two other objects the one with the same label (“show me the other fep”). Results indicated that children ignored the global appearances of the objects and extended the label based on functional information.

Using a more systematic approach, Kemler Nelson, Russell, Duke and Jones (2000) manipulated similarity and function using four objects, all of which appeared to have the same function. Only two of the objects, however, were functional and these two objects were not similar to each other. The other two objects had the same perceptual qualities of the first two, but did not share the same function. This experiment explicitly sought to test the interaction between similarity and function by investigating whether children would be able to identify and name functional objects with varied perceptual appearances. Although participants were two years of age, and thus much younger than
those tested by Deák and colleagues (2002), results were similar in that the children considered function when the relationship between form and function was comprehensible to them. Labels were extended based on function but not on form alone.

The authors concluded that children learn language, and use it in a meaningful way, under the following conditions: a) the structure that enables function is noticeable and well-defined; b) the design of the structure that enables function is easily comprehended; c) the relationship between structure and function is causally related; and d) the relationship is convincing in that the critical functional part is understood in terms of how it enables the function of the object. Under these circumstances, children’s information processing of function can operate in a meaningful way, and providing them with an understanding of how language and categorization of objects is extended and generalized. These results and conclusions are developmentally consistent with how both children and adults regard function in a mindful, meaningful fashion. Generalizing according to function is a meaningful process because functions are dependent on the relations among parts of objects rather than the parts themselves. Consistent with research by McDonough and colleagues in infants as young as 9-months, research by Kemler Nelson and colleagues demonstrated that perceptual similarity becomes undermined by relational similarity, especially under the conditions where causal relations of actions give clues about the function of an object.

I.7 Object Function within Everyday Events, and the Importance of Sequential Understanding
Conceptual categorization and generalization also involves understanding the functions and relations of objects within events (Mandler, 2000). This process requires higher order abstract cognitive thinking such as intentionality and perspective taking. Due to their attraction to movement, when infants observe adults interacting with an object (e.g., pouring milk into a bottle), the actions associated with the objects help infants form abstract representations about the functions of the object itself (container for holding liquid), those that slightly differ perceptually (e.g., cup, jar), and the role that the object plays within the context of events (feeding time).

Everyday event representation refers to the utilization of memory processes responsible for adjusting to day-to-day life (Jones, Happe, Pickles, et al., 2011). This kind of memory is especially functional because it allows us to make predictions about future events, which may initially be perceived as unfamiliar due to superficial differences in details and context. Recurring episodes of a particular event helps to form a salient representation, or schema for that event. Generalization serves as a mechanism that facilitates event representation by providing an understanding of actions and correctly ordered sequences that typically occur in an event.

The research discussed so far has focused on how infants and young children categorize and label objects in laboratory settings. In real world settings, however, infants learn about objects through their understanding of everyday events. Routines such as getting dressed in the morning, having breakfast, bathing, going to the grocery store, and hearing a bedtime story, occur on a regular basis. Infants learn these routines early in
life and can use them to form expectations about novel events (eating dinner at grandma’s house or taking a bath with cousins). Their memory for everyday events includes actors, objects, and actions that are customarily seen in these events, allow children to categorize them as “slot fillers” (Abelson, 1981; Luciarello & Nelson, 1985; Schank & Abelson, 1977). For example, one can form a category of food and dishes by observing the items that accompany mealtimes. A category of food can also be surmised from experiences at the grocery store. Bath time is not complete without water, soap, a towel, and perhaps a few bath toys. Most three-year-olds can tell you what happens when they go to McDonald’s or other restaurants.

Representations about a particular kind of event can happen after a single occasion, which are instances of episodic memory—memory for singular events. For example, in her analysis of the narratives of pre-school and kindergarten children, Fivush (1984) found that on the second day of school, children can accurately report in the correct temporal order what will occur without any intrusions of what had happened during school the previous year. This is evidence for intact event representation because each year there are both similarities and differences in classes and other activities. Slot fillers are variable and can change over many episodes. Therefore, generalization ability requires the awareness that variability is expected for an event or experience.

Generalized expectations of what one would anticipate in a familiar situation is an important cognitive tool that also provides information about associated activities and the temporal order in which they occur (Schank & Abelson, 1977). The sequential ordering
of activities associated with an event is crucial and helps to determine the course of action to take if the event is encountered in the future (Bauer & Dow, 1994). For example, the order of the event schema for “shopping at the supermarket” normally includes: entering, picking up a shopping cart, seating child in the cart (if child is young), wheeling the cart up and down aisles, selecting food items and placing them in the cart, putting items on counter at cashier, cashier tabulating a bill, paying the bill, waiting for items to be packed into bags, putting bags into the cart, and leaving the store. Actions that comprise everyday events are either linked by causal or enabling relations (e.g., opening a door before entering, using soap to remove dirt) or are ordered by social conventions due to frequency effects (e.g. leaving a tip). Optional, or arbitrary actions may not contribute to the completion of a particular event (e.g., buying milk). Through recurring events, preverbal children are able to form representations despite the variability encountered within episodes.

Everyday events are consistent not only in terms of the kinds of objects that are used but also with respect to the order in which activities that comprise an event are carried out (Loth, Happe & Gomez, 2010). Some orders are conventional for certain cultures (e.g., eating salad either before or after the main course). There is no apparent reason for why one order is preferred over another, it is just generally agreed that this will be the order followed based on what most people do in a given culture. Children learn that cereal or pancakes are good breakfast items, whereas meatloaf, even though it is a food item, may seem unusual as a breakfast food. Children also may learn to put on their
pajamas before a nighttime story is read. Ordering activities in this way is governed only by conventional agreement; the order could differ but typically does not.

Other activities are causally ordered or ordered such that one step enables the next one to be carried out. Orders are often governed to meet a particular goal. One boils the water, cooks the spaghetti, drains the spaghetti, and adds the sauce before serving it for dinner. Even though a child will not engage in cooking, by observing an adult, the child will presumably learn the order in which tasks occur. As adults, we understand the causal connection between the steps when making spaghetti. A child-appropriate activity would be making a rattle. One places a small object in a container, puts a lid on the container, and then shakes it to make a rattle sound. Using a different order either will not work (one must place the small object in the container before putting on the lid) or will not provide the same interesting result (shaking an empty container would not make noise). As illuminated in this example, some activities are “enabling” in terms of the order in which they can be carried out. As in another example, one needs to open a milk carton before pouring out the milk and drinking it. Therefore, an enabling order is one for which it is physically impossible to do the activity in the opposite order. If the cap stays on the milk, the milk stays in the carton. Both causal and enabling orders are fixed.

Sometimes activities are carried out in varied orders—the ordering is arbitrary and one can do one action before another or vice versa without consequence. For example, a happy meal at McDonald’s not only has food but also a toy included with it. One can eat the hamburger or apple slices before playing with the toy or vice versa.
Alternatively, one can switch off from one to other until the food is finished and the toy becomes boring. Notably, parents usually have specific order in mind when it comes to eating meals but a child eating at McDonald’s can challenge that order.

1.8 Event Representation in Individuals with Autism Spectrum Disorder (ASD)

To what extent can children with ASD spontaneously form a representation of everyday events? Generalization of everyday events requires an understanding that variability within the context of the event is expected at many levels (Loth, Happe & Gomez 2010). Frith (1989) describes typical cognition as a “built-in propensity to form coherence over as wide range of stimuli as possible, and to generalize over as wide a range of contexts as possible” (p. 159-160). Central coherence, or the natural drive for cohesion and global meaning, is an important cognitive tool for making sense of the world. This idea was influenced by the Gestalt movement of perceptual processing—the idea that part structures are determined after global analysis (Happe & Booth, 2008). Research by Navon (1977) using hierarchical visual arrays (e.g. H consisting of many S’s) has demonstrated that adults process global properties before local features. The Gestalt movement was not limited to perceptual processing; theorists applied this concept to other cognitive abilities. For example, Bartlett (1932) argued that regarding memory, adults tend to recall the “gist” rather than “verbatim,” and determine meaning at the expense of accuracy.

The weak central coherence theory (Frith, 1989; Happe & Frith, 2006) has been used to describe why children with ASD may have challenges with generalizing events.
Individuals with ASD have a tendency to attend to and encode irrelevant details at the expense of attempting to understand meaning. In fact, weak central coherence was empirically evidenced by proficient performance by ASD individuals compared to their typically developing counterparts on tests that require participants to locate simple features and parts within a larger complex whole. The Children’s Embedded Figures Test and the Un/Segmented Block Design Test (Shah & Frith, 1993) are tasks that require a bottom-up approach to understand the whole design in terms of its parts. Performance on these tasks was better for individuals with ASD than typically developing children. However, on Gestalt-like tests assessing global integration (by asking participants to identify a picture from its constituent parts), individuals with ASD needed to be shown more frames of the parts to identify the picture, suggesting poorer integrative processing. Weak central coherence can limit how one represents everyday events if generalization and the expectation of variability is compromised. According to Happe and Booth (2010), understanding the meaning of activities and their importance within an event is crucial for distinguishing between central slots from those that are optional. Additionally, local processing may hinder understanding everyday events by inadvertently categorizing slotfillers (lower-level components which probably occurred a few times) as central slots. Therefore, slight variations in a particular event would be considered as discrete episodes, making it difficult for children with ASD to make sense of the world and adapt to variability.
Research has also shown a trend of dissociation between performance and ability with regard to superior performance on various tasks in the lab setting versus profound challenges in naturalistic settings (McDonough, Stahmer, Shreibman & Thompson, 1997). One explanation for this finding is that not only do laboratory settings minimize distractions, but the experimenter also has preselected stimuli deemed relevant (Loth, Gomez & Happe, 2010). On the other hand, naturalistic, real life situations require individuals to spontaneously sift through what is relevant among a mixture of relevant and irrelevant data.

Loth, Gomez & Happe (2010) investigated how high-functioning children with autism and typically developing children spontaneously process relevant features in scenes, which is important for event representation and understanding social norms. The research was limited to boys to reflect the high prevalence rate of autism in boys. After participants read a story, they looked at a scene in which some of the objects were relevant, irrelevant, or neutral to the context. Results revealed no difference in the number of overall items recalled between the two participant groups. However, there were differences in kind of items remembered; typically developing boys remembered significantly more relevant items than the high-functioning autism group. These results suggest that typically developing boys had an understanding of context-relevant information for a particular episode.

In the replication experiment, which investigated adults, results revealed that typically developing adults looked more often at irrelevant items than individuals in the
ASD group and recalled more context-relevant than irrelevant items. On the other hand, the ASD group looked more often at neutral items than both relevant and irrelevant items, but recalled as many neutral as relevant items and more neutral than irrelevant items. Loth and colleagues proposed that a reason for these findings in the typically developing group is that “unexpected items are more ‘attention grabbing’ than schema-consistent objects.” Having a foundation for what is relevant can serve as a scaffold so that it is easier to identify abnormalities. Overall, typically developing adults were able to select both important and unimportant aspects in an environment whereas ASD individuals could not. Perhaps their limited event schemas could not help them to identify what did not belong in the scene. Furthermore, their ability to attend to both neutral and relevant items in the story increased memory load. It is useful and efficient to use relevant information as a basis for determining what is irrelevant, which is important for survival. Being able to determine what does not belong in an expeditious way is important for decision-making.

I.9 Purpose of Dissertation and Research Hypotheses

The current study is the first to comprehensively examine functional generalization and imitation as a function of action and correctly ordered sequence relations (causal, arbitrary or conventional) in children with mild- to high-functioning ASD, children with cognitive and language delays, and in typically developing children. In the elicited imitation method, the experimenter models 3- to 4-step test sequences with miniature objects, after which the child is given the opportunity to manipulate the same
objects the experimenter used to imitate the sequences. The order in which the actions are modeled is either causal (actions must be produced in a particular order to achieve a goal), arbitrary (actions can be produced in any order with the same resulting outcome), and for the familiar events, conventional (e.g., bedtime stories are typically read after the child is in bed). The mean proportion of actions and correctly ordered sequences that the child imitates is assessed.

The elicited imitation only assesses how much of a particular event is recalled. An appropriate methodology to examine generalization of the temporal order of sequences is the generalized imitation paradigm (Mandler & McDonough, 1996). Many developmental studies with typically developing children (Bauer, 2002; Mandler & McDonough, 1996, 1998) have utilized the generalized imitation paradigm to investigate representational capacity and flexibility. Like elicited imitation, the generalized imitation method also examines generalization of actions and correct temporal order of sequences; however, the major difference is a prop-change manipulation between assessment periods (Mandler & McDonough, 1996). The procedure only requires the child to engage in physical actions with objects and does not require expressive verbal ability of the child, mitigating language issues. Actions are modeled with miniature objects in a particular order sequence. The child, however, is then given props that are perceptually different (in size, shape, texture, and/or color), but have the same function as the modeling objects, enabling the child to execute the actions of the same task. Event sequences are
comprised of causal, arbitrary, and familiar action pairs. The mean proportion of actions and correctly ordered sequences to which the child generalizes are subject to analysis.

Each task consisted of several props, in which interaction between props in the correct sequential order was necessary for completion of the task. The stimuli that the children were presented with for generalization retained functional similarity, but were perceptually dissimilar for each test event compared to the modeling props. The goal for the current study is to increase ecological validity by not systematically controlling for the artifact characteristics of shape, size, color, and texture. Therefore, generalization props that paralleled modeling props variably differed in terms of perceptual similarity. This naturalistic approach is thought to reflect real world settings, which is especially important for children with ASD.

A question of importance for the current project is whether differences in generalization of modeled causal, arbitrary and conventional actions, and correctly ordered sequences will be found depending on the kind of task (novel vs. familiar) in children with mild- to high-functioning ASD, children with mild- to high-cognitive and language delays, and typically developing children. Additionally, language (assessed from IQ scores obtained from school reports or administration of receptive language test) was an ancillary topic of interest to determine whether language ability is correlated with generalization production.

*Typically Developing Children*
Research on how typically developing infants and young children remember event sequences reveals that episodic memory and generalize event knowledge takes place from a very early age. Overall, typically developing children can robustly imitate both novel and familiar actions and sequences (Bauer & Dow, 2004; Bauer & Fivush, 1992; Mandler & McDonough, 1996). Because older children are proficient at imitating others, we will utilize the imitation assessment as a comparison by which to determine whether generalization is performed similarly or is more difficult for children at different cognitive levels. This is because what is under investigation is the assessment of children’s transfer of knowledge, and not merely motor skills (or how precisely children are capable of copying behaviors). Regarding imitation of types relations (causal, arbitrary, conventional), although typically developing children tend to recall higher proportions of causal actions and sequences than arbitrary actions and sequences in novel tasks (Bauer, 1992; Bauer & Dow, 1994; Bauer & Thal, 1990), we expect all children to perform all types at near ceiling levels.

In the generalization literature, typically developing children around 14-20 months of age learn an activity on one set of objects and can recall the activity after lengthy delays and after the activity is carried out on a different set of objects. That is, they can distinguish the old objects when paired with new ones because they remember the original event and readily generalize it to another context and different objects (Bauer & Dow, 1994; Barnat, Klein & Meltzoff, 1996). There have also been instances, however, in which actions and temporal orders governed by causal or enabling
connections are generalized less often than those with arbitrary orders in novel tasks. That is, actions and sequences that are arbitrarily ordered are readily generalized but those that are causally ordered are difficult for young children to generalize (Bauer & Dow, 2004). Also, in 2-1/2 year olds, generalization substantially decreases in instances where one prop has changed in a causally related pair of actions compared to an arbitrary pair (Bauer & Fivush, 1992). Additional research suggests that 16- and 20-month-old children show no differences in generalization of these types (Bauer & Dow, 1994).

Because typically developing children have had much experience in variation of familiar sequences in everyday life, we expect successful performance of overall generalization and sequential ordering in all three groups. Additionally, previous research has shown that what guides memory is script knowledge in familiar events and causal links in novel events (Mandler & McDonough, 1995). However, based on inconsistent results in the prior research (Bauer & Dow, 1994; 2004), we take a non-directional approach regarding any interaction between action and sequence types and assessment periods. We also anticipate normal language ability from the typically developing children, and this control group will be used as a standard by which we compare the ASD and CLD groups.

*Children with autism spectrum disorder (ASD)*

Perseveration of sameness is an inherent characteristic in children with ASD, which could inhibit their ability to think flexibly by using what they were taught, and
generalizing, or applying what they have learned to different contexts. Based on this premise, we expect that children with ASD will perform poorly on generalization tasks.

To date, little to no research has investigated imitation and generalization in the context of everyday event representation in children with ASD, using the elicited and generalized imitation procedures in which children manipulate props. Using other kinds of imitation assessments, children with ASD have demonstrated profound decrements in performance (Smith, & Bryson, 1994; Soorya, Arnstein, Gillis, & Romanczyk 2003; Vivanti, Nadig, Ozonoff, & Rogers, 2008; Young, Rogers, Hutman, Rozga, Sigman, & Ozonoff, 2011). One theory (Ingersoll, 2008) suggests that social deficits associated with autism (i.e. joint attention, sharing interests, reciprocity) impede their ability to imitate, since imitation of another person’s behavior requires social engagement.

Are there particular instances in which children with autism do imitate? Marsh, Pearson, Ropar & Hamilton (2013) have shown evidence that children with ASD produce actions in imitation tasks, though they would not copy another’s behavior under particular circumstances. Specifically, children with ASD will not imitate behavior under several conditions: a) if the action is unnecessary and does not contribute to the overall goal of the task; and b) in an effort to socially connect with others or abide by the social norm to be cooperative with an adult, in this case, the experimenter. An explanation of the latter is attributable to the social characteristics that inhibit perspective taking in autism, which suppresses motivation to imitate a behavior for the sole purpose of engaging in shared interests with others. Typically developing children, on the other
hand, tend to be more interested in social engagement as they perform imitation tasks, which result in “overimitation,” or reproduction of atypical actions.

Regarding generalization, there has been an abundance of research using other paradigms (i.e. stimulus generalization/preferential looking, multiple baseline across settings design), which indicates that children with ASD have difficulties with generalization (Church, Rice, Dovgopoloy, Lopata, Thomeer, Nelson, & Mercado, 2015; Froehlich, Anderson, Bigler, Miller, Lange, DuBray, Cooperrider, Cariello, Nielsen, & Lainhart, 2012). However, a landmark research experiment by McDonough, Stahmer, Shreibman, & Thompson (1997) systematically investigated recall and generalization abilities in children with ASD using the generalized imitation procedure. Results revealed that children with ASD were indeed capable of imitation and generalization (children with ASD are able to imitate actions that were modeled using realistic objects, which is indicative of functional play). Additionally, they were capable of transferring these actions and generalizing to placeholder objects (indicative of symbolic play) all while retaining correct sequential order of actions. As mentioned in the categorization chapter, different research paradigms yield different results. The methodology of the generalized imitation procedure requires assessment of a child’s cognition based on the intentional manipulation of objects and sequencing of actions, which is different from preferential looking paradigms that primarily assess perception based on visual preference of two dimensional stimuli. Although the current research project is not investigating generalization from functional to symbolic play in children with ASD, the same method
of testing will be used. Based ASD children’s success generalization and imitation in the aforementioned research, we hypothesize that children with ASD may likewise show evidence of overall generalization ability, although we take a non-directional approach regarding any performance of action and sequence types across assessment periods.

In terms of the role that language plays in generalization, although there is no research examining event representation in children with ASD using the generalized imitation procedure, previous research indicates that language skills and imitation of familiar events develop in steps (Bates, Benigni, Bretherton, Camaioni & Volterra, 1979), as children at the beginning stages of language acquisition, and those with mild- to moderate-autism spectrum disorders, may have difficulties with familiar events (Hobson, Lee & Hobson, 2009; Stanley & Konstantareas, 2007). We therefore hypothesize that those with significantly higher language ability will generalize better than those with lower language ability.

*Children with Cognitive and Linguistic Disabilities (CLD)*

Regarding imitation assessments on children with cognitive and语言 delays, previous research (Cheatham, Bauer & Georgieff, 2006) indicates that infants born pre-term compared to their full-term counterparts show deficiencies in imitation tasks involving causal sequences. Specifically, there was a correlation between longer encoding time and decreased performance in deferred imitation. Research findings have also shown that encoding difficulties could be an issue for infants with low iron status born from mothers diagnosed with diabetes mellitus. Although these infants were able to
demonstrate immediate imitation of causal sequences, they were unsuccessful in recalling them after a one-week delay (Riggins, Miller, Bauer, Georgieff & Nelson, 2009). However, children in the current study will be considerably older, and therefore, we expect no difficulties with imitating the event sequences. Generalization assessments have yet to be conducted on this population.

For children diagnosed with mild- to high-functioning cognitive and linguistic disabilities, we expect that as with typically developing children, children with cognitive and language delays may be able to demonstrate overall generalization ability, but they will also have problems generalizing causal actions and sequences. However, we anticipate that because actions within arbitrary-ordered sequences are not causally related, sequential order is not meaningfully encoded. This may hinder participants’ ability to retain the correct sequential order, compared to causal and familiar sequences because there is more than one way to achieve the goal of an arbitrary sequence.

Additionally, based on literature in preterm infants (Cheatham, Bauer & Georgieff, 2006) and infants with low iron status due to maternal diabetes mellitus (in which problems with encoding yielded lower production of causal actions and sequences) (Riggins, Miller, Bauer, Georgieff & Nelson, 2009), children with cognitive and language delays may have problems generalizing and imitating causal actions and sequences. We make no predictions regarding differences in generalization performance between the CLD group and the ASD group since the current research is the first to explore these clinical populations using the generalized imitation paradigm.
Regarding language and generalization ability, low functional play is more often reported in children with ASD but this is also found with children with language delays (see Mundy, Sigman, Ungerer & Sherman, 1987; Lewis, Boucher, Lupton & Watson, 2000). Since the CLD group has been diagnosed with language and information-processing deficits, we expect that language will be correlated with generalization ability. Like the actions in generalized event sequences, words are used in multiple contexts via extension from one appropriate situation to another.
CHAPTER II. DISSERTATION STUDY

II.1 Experiment 1: Generalized Event Representation in Children with Cognitive and Linguistic Delays (CLD)

Method

Participants

Participants were recruited from a special needs private school located in New York City. Six classes were initially observed before the data collection period: two classes of children with low cognitive functioning, three classes with mild- to high-functioning children, and one integrated class consisting of both high-functioning and typically developing children. These classes were observed for a period of three weeks for children to gain familiarity with the experimenter. After this period of time, each child was given a packet that included informed consent forms: audio and video consent forms, a form requesting demographic information, and a flyer for parents that described the study’s purpose. Of 90 eligible children, 15 agreed to participate—13 boys and 2 girls. All participants were drawn from the three self-contained classrooms designed for mild- to high-functioning children diagnosed with intellectual disabilities, with the goal of eventually allowing the students to mainstream into an integrated classroom with typically developing children. Of the 15 children, 14 were diagnosed with cognitive processing and language delays (CLD), and 1 was diagnosed with autism spectrum disorder (ASD), specifically with pervasive developmental disorder-not otherwise specified (PDD-NOS). Data from the child diagnosed with ASD was not used in the
analysis with the CLD group; rather, the ASD data were reserved for future use when
data was collected from an exclusively ASD population. The remaining children with
cognitive and language delays (CLD, \( n = 14 \): 2 girls and 12 boys) were diagnosed with
varying types of cognitive processing and language/communication disorders with no
comorbid ASD diagnosis. Five of the children were diagnosed with Specific Language
Impairment (SLI), six were diagnosed with apraxia of speech, and the remaining children
were diagnosed with a speech disorder not yet specified. All children spoke English as
their primary language. The mean chronological age of the participants was 4 years, 6
months (range 3;9 – 4;10 years). The experimenter was naïve to the diagnoses of the
participants until after data collection was completed.

**Cognitive Assessment**

Full, verbal, and non-verbal Wechsler scale assessments were previously administered by
the school psychologist less than 1 year prior to testing in the present experiment (Full IQ
M = 85; range: 74 – 94; non-verbal IQ M = 85.2; verbal IQ M = 85). See Table 1 for
individual demographic information and IQ scores.
## Table 1. CLD Children: Demographic Information and IQ Scores

<table>
<thead>
<tr>
<th>Participant</th>
<th>Chronological Age</th>
<th>Nonverbal IQ</th>
<th>Verbal IQ</th>
<th>Full IQ</th>
</tr>
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<td><strong>Apraxia of Speech: n = 6</strong></td>
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<td>4;5</td>
<td>91</td>
<td>89</td>
<td>90</td>
</tr>
<tr>
<td><strong>MEAN</strong></td>
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<td><strong>86.8</strong></td>
<td><strong>85.8</strong></td>
<td><strong>85.8</strong></td>
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</table>
General Setting and Materials

Children were seen individually in a testing area at the school, in an open vestibule near administrative offices. The testing area was approximately 5’x5’ equipped with a child-size table, two chairs, a video camera mounted on a tripod and 2 four-drawer carts which contained the modeling and generalization props. The child was invited to the testing area and was seated directly across from the experimenter. Assent was obtained prior to each test session and was monitored during sessions to confirm each child’s willingness to participate. All participants complied with the instructions and were cooperative for all sessions.

Two sets of props were used for each of the eight tasks: modeling and generalization objects. The objects were selected so that the targeted activities could be produced with each set (each set was functionally similar) yet the objects were divergent in terms of their perceptual features such as overall shape, material, and color. Only one test event, the “Make a Rattle” task, consisted of one additional object within the modeling and generalization props. This extra object was a distractor prop, which was not a solution for completing the task with the modeling objects but was an essential prop for the completing the task with the generalization objects. A distractor object was also
included among the generalization set, which had been essential for completing the task with the modeling props. A detailed list of the modeling and generalization stimuli used in each task is listed in Appendix A.

**Procedure**

The session began with two warm-up tasks to facilitate engagement: a) expanding and constricting a Slinky toy and b) pushing down on the raised end of a toy see-saw, making the toy bunny “hop” off at the other end. Once the child was comfortable interacting with the experimenter and willing to share in the exchange of objects, the test session began. The experimenter gave the child the generalization objects for the first task to assess baseline. Objects were placed in a random array on the table. The child was allowed to play with and manipulate the objects in any way desired for no longer than 2 minutes. Baseline was measured to identify spontaneous discovery of the targeted actions without benefit of seeing them modeled. When the child clearly indicated loss of interest, the experimenter retrieved the objects and put them away. Then the experimenter brought out the modeling objects by placing them on the table slightly out of reach of the child. The experimenter said, “Watch what I can do,” and proceeded to model the target activities with the modeling objects three times in succession. As each action was modeled, the experimenter provided an accompanying verbalization (see Appendix A). The experimenter then removed the objects and returned the generalization objects to the table pushing them towards the child saying “Your turn!” and instructing the child to do what the experimenter just did (e.g., “Okay, now you make
a rattle!”). The child was then allowed to manipulate the objects again and the experimenter responded by providing neutral but encouraging comments such as “So that is what you can do with those things.” When the child was finished, the experimenter retrieved the items and put them away. The experimenter then brought out the modeling items again, said “My turn,” and proceeded to model the activities with the modeling objects three times. This time the modeling objects were returned to the child to assess imitation with the instructions “Your turn!” Again, the child was given neutral praise upon completion of any activities regardless of whether they were the target activities.

Each child received all eight sequences (four familiar and four novel). To reduce fatigue, the tasks were administered in four sessions across two days during which one familiar and one novel task was administered per session. A one-hour break was given between the two sessions held on the same day. Testing days were based on the child’s willingness to participate with the restriction that participation did not interfere with classroom assignments in the school. Order of task administration was counterbalanced among participants.

**Scoring**

**Coding.** Most of the test sessions were video recorded for later analysis. Eleven of the 14 children’s test sessions were video recorded and coded live by at least one research assistant. Due to a camera malfunction, four tasks were coded on line by two coders for 1 participant out of 11. The remaining 3 children were coded on line by two coders because their parents requested that they not be videotaped. Research assistants
conducted live coding sat behind the child and their presence did not appear to interfere with the child’s level of engagement. Although the coders were aware of the action sequences of each task, they were blind to the research hypotheses and diagnoses.

To assess inter-observer agreement, two raters used the video recording and coded one child (eight tasks) independently and compared their observations. The few disagreements were discussed and resolved. The raters continued to code four children independently and overall reliability between was 98% for actions and 98% for correctly ordered sequences produced.

Actions. Within each task, the main focus was to examine memory for target actions and the order in which they were produced, not simply the precision in producing the actions. Incidences of performance of target actions were credited without consideration of ordering. For future reference, the terms “causal,” “arbitrary” and “conventional” are used to describe actions only within the context of the sequences they are a part of. Note that actions are only qualified by their temporal relations with other actions within sequences but appear arbitrary in and of themselves. For novel tasks, target actions were derived from test sequences, which were composed of links among both causal and arbitrary actions. The “Make a Rattle” task, for example, consisted of three target actions that are temporally constraining: a) put the ball in container, b) cover the container with lid and c) shake. The construction of a rattle requires the performance of three causal target actions in one particular sequence, which is impossible to perform in any other fashion. Therefore, the “Make a Rattle” task constituted a maximum of three
causal target actions and zero arbitrary actions. Because some tasks constituted a combination of both enabling and arbitrary actions (i.e. Go Swimming, Make Spaghetti), for the analysis we determined the total possible number of enabling and arbitrary actions within each sequence, and also for all sequences for each type of task (novel and familiar) (see Appendix A). Proportion scores were then obtained by the sum of the target actions performed by each participant for each sequence type (causal, arbitrary, conventional) and task (novel, familiar) to the total possible number of target actions of each sequence type for each kind of task (Maximum values: Novel/Causal = 8; Novel/Arbitrary = 7; Familiar/Conventional = 16) for baseline, generalization, and imitation measures.

**Sequences.** A sequence is defined as a pair of target actions performed in succession. For example, in the task “Make a Rattle,” if a child 1) put the ball in, 2) closed the container with lid, and 3) shook the rattle, the child performed 3 target actions and 2 correctly-ordered sequences (for target pairs \{1,2\} and \{2,3\}). The repetition of an action that was first done out of order, and then in order of sequence, was not counted to eliminate the possibility of achieving temporal order by chance (Bauer & Dow, 1994). For instance, if a child’s sequential production was: \{3, 1, 2, 3\}; although credited for three different actions, the child would only be credited for the ordered pair \{1, 2\}. Although the child eventually produced all the actions in the correct order, action 3 cannot be credited twice. The tasks were comprised of three kinds of sequences (causal, arbitrary and conventional). Note that although conventional sequences could consist of causal and arbitrary actions, these familiar sequences are only linked by virtue of
traditional social customs. For example, one could put on socks on after putting on shoes, but by convention, people typically put on socks before shoes. Socks are usually put on first to protect feet from shoes, keep feet dry, and keep the inside of shoes from getting smelly. Due to the repetitious nature of everyday events, frequency effects could be confounding and may explain why some activities within familiar events appear to be causally related, when in fact, they are not. Therefore, it can be quite difficult to disentangle causal versus arbitrary actions within familiar sequences. For instance, during a meal, a salad is usually offered before the main course to prepare the palate. Alternatively, salad could be offered at the end of a meal to provide a light and refreshing finish. Since testing familiar sequences provides an assessment of everyday event representation, the data were collapsed for causal and arbitrary target actions within sequences. The proportion of target actions produced in the correct sequential order to the total possible number of target sequences for each sequence type (Maximum values: Novel/Causal = 5; Novel/Arbitrary = 6; Conventional=12) was calculated for baseline, generalization, and imitation measures.

**Results and Discussion**

*Mean Proportion of Target Actions Produced*

Data were analyzed using two dependent measures in order to examine the degree to which participants generalized what they saw modeled on one set of objects to a second set of perceptually dissimilar objects. The proportion of targeted actions produced is the dependent measure for the first set of analyses and the proportion of correctly
ordered sequences (pairs of actions produced in the same order they were modeled) is examined in the second analyses.

A preliminary analysis revealed that the proportion of actions in the novel and familiar events were produced equally often overall (novel M = 0.83; SE = 0.03; familiar M = 0.80; SE = 0.03), p = .225. Of greater interest to the hypotheses tested were the action types within sequences (causal, arbitrary, conventional) rather than novel or familiar events per se, so the event factor was not entered into the following analyses. Furthermore, the novel events were composed of two types of action sequences, causal and arbitrary, and familiar events were composed entirely of conventionally ordered sequences.

Proportion data was used because more conventional (N = 16) than causal (N = 8) and arbitrary actions (N = 7) were tested. A 3 x 3 repeated-measures analysis of variance (ANOVA) was conducted with Action type (causal, arbitrary, conventional) and Assessment (baseline, generalization, imitation) as the within subject factors. The probability of a Type I error was maintained at .05 for all analyses. We can assume sphericity when examining the following significant $F$-statistics, since the results from the Maulchy’s test were all non-significant, indicating that none of the effects violated the assumption of sphericity. We first examined the data by comparing baseline, generalization, and imitation scores for each action type. The main effects were qualified by statistical significance between these two factors, $F (4, 52) = 12.683$, p < .001. The data revealed that significantly more actions were produced for generalization than at
baseline for the arbitrary and conventional actions (Tukey HSD p’s < .01) but not the causal actions (p = .838). These findings suggest that children could generalize what they observed to different objects as long as the activity was not involved in a causal relation.

At generalization, children produced significantly fewer causal actions (M = .67; SE = .05) compared to arbitrary (M = .94; SE = .03) and conventional actions (M = .91; SE = .02). One reason for this finding is that these children may have been encoding physical characteristics of objects during the modeling period, and using this as a cue for causal connections. However, the encoding did not provide them with any information on how to interact with the generalization objects. In examining the imitation data, we expected high performance, since all of the actions were well within the participants’ cognitive level. Looking at differences among the types of actions produced for imitation, the proportions of causal (M = 1.00) and arbitrary actions (M = 1.00) produced were at ceiling, but significantly greater than the conventional actions (M=0.95; SE=0.02) (Tukey HSD p = .043). Therefore, children were able to demonstrate knowledge of the original props that were only used during modeling, but were unable to transfer the temporal order of actions during the generalization period. Figure 1 provides a summary of mean proportion of actions produced for each action type across each assessment period. One should reserve interpretation of this finding, however, until the analyses are conducted on the correctly ordered sequences.


**Figure 1.** Mean proportion of target causal, arbitrary and conventional actions produced at baseline, generalization and imitation.

**Mean Proportion of Correctly Ordered Target Sequences Produced**

For the production of novel and familiar sequences, again, the means did not significantly differ (novel M = 0.58; SE = 0.05; familiar M = 0.59; SE = 0.05), p = .861. We conducted a 3x3 repeated measures ANOVA with sequence type (causal, arbitrary, conventional) and assessment (baseline, generalization, imitation) as the within factors. Once again, the interaction was statistically significant, F (4, 52) = 3.637, p = .011. As shown in Figure 2, the proportion of sequences for generalization exceeded baseline for all three sequence types (p’s < .05). No differences among the sequence types were found either at baseline or at generalization. Finally, the item analysis revealed that although
children produced fewer sequences in the “Make a Rattle” task, this finding was not significant (p = .234).

Turning to the imitation data, one can see that imitation was significantly greater than generalization for the causal and arbitrary sequence types (Tukey HSD p’s < .05), but not for conventional sequences (p = .147). These data indicate that participants’ ability to generalize was not due to forgetting, since children retained memory for the original sequences. Furthermore, it is important to note that children with cognitive and language delays had difficulty generalizing with new objects than imitating with the same objects (see Figure 2).

**Figure 2.** Mean proportion of target causal, arbitrary and conventional correctly ordered target sequences produced at baseline, generalization, and imitation assessment periods.
To summarize, in examining the data produced by children with cognitive and language delays, the locus of the interaction involved the generalization data. While children produced a greater proportion of arbitrary actions to causal actions, the few causal actions that were recalled were produced in correct sequential order. It appears that children were aware of the relations between pairs of actions, which facilitated recall of causal sequences. Although not significant, at generalization, the means suggest that slightly more conventional sequences (M=0.71; SE=0.05) were produced than the causal (M=0.57; SE=0.05) or arbitrary (M=0.56; SE=0.08) sequences.

**Generalization Ability of Novel and Familiar Events and Nonverbal IQ**

Another factor of interest was whether there was a relationship between generalization performance and language ability. The sample recruited for this research experiment consisted of a range of children with mild- to high- level of cognitive functioning, diagnosed with various cognitive and language/speech delays. Language was assessed via IQ data obtained from participants’ school records. First, the data were reanalyzed for both actions and sequences, with the nonverbal IQ scores included as a between-subjects factor using a median-split. We were initially interested in whether receptive language correlated with generalization performance because the literature suggests that young children with intellectual disabilities (particularly those with Williams syndrome), show greater impairment in receptive than expressive language (Hudry, Leadbitter, Temple, Slonims, et al., 2010; Maljaars, Noens, Scholte, & van Berckelaer-Onnes, 2012; Weismer, S., Lord, C., & Esler, A. 2010) compared to typically
developing controls (who show the reverse trend). However, no significant differences were found between the nonverbal IQ scores and generalization abilities for any of the within factors of assessment, action types, or sequence types. Taking a look at other verbal data available, we decided to also reanalyze the data with verbal IQ scores as the between-subjects factor. Results revealed a main effect of assessment—specifically, children with higher verbal IQs performed better than those with lower verbal IQs at generalization and imitation ($p = .020$). This is not surprising, considering that the diagnoses of children in this sample indicated expressive language impairment, and therefore, we would expect differences between those with low and high verbal IQ scores. It is important to note, that in typical development, receptive language is higher in proportion to productive language—children understand more than they can say. However, these children with cognitive and linguistic disabilities were diagnosed with impairments that affected their expressive language below the norms, which prompted speech intervention.

To summarize, results indicate that even though those with more severe expressive language underperformed on the generalization task compared to their counterparts, their nonverbal IQs had no bearing on their abilities to learn a task and to transfer this knowledge despite the change in context. It appears that the receptive linguistic abilities in the children with lower verbal IQs gave them some leverage in the ability to generalize, although not as optimally as compared to those with higher expressive language.
Experiment 1 was conducted with the assumption that the modeling objects and generalization objects differed perceptually between sets, but functioned similarly. In order to make this claim, however, we need to systematically investigate this assumption. The second experiment was conducted to empirically determine whether the stimuli used in the Modeling set (Set A) differed systematically from the Generalization set (Set B) with respect to perceptual between-category similarity in Experiment 1.

**II.2  Experiment 2: Adult Similarity Judgment of Objects**

**Method**

*Participants and Procedure*

A group of undergraduate students from the Brooklyn College subject pool, N = 28; 9 males, 19 females (M = 21 years, 5 months; range = 19 – 27 years) participated in the experiment. Testing took place in an 8’x5’ room inside the lab, which consisted of a 5’x3’ table, and 2 chairs. A small red sticker was placed on the window opposite the experimenter approximately 2 feet above the participant chair.

Each participant sat in a chair, was given a rating scale, and was shown one object pair for the pre-test session (plastic whole egg + white golf ball) to ensure that they understood the procedure. The object pair was placed on the table—at 1 foot and 6 inches distance from each other. The participant was then given 30 seconds to inspect and manipulate the objects. As the object pair was placed on the table, to eliminate experimental bias, the experimenter fixated on the red sticker for the duration of the inspection time. After the inspection/manipulation period, the participant was asked to
rate similarity among the pair of objects on a 7-point rating scale (1 = low similarity; 7 = high similarity) along two dimensions: perceptual and conceptual similarity. The actual items on the survey asked the participant to: a) rate objects based on the degree to which they looked similar; and b) rate objects based on the degree to which they are the same kind of thing. Therefore, participants were instructed to base their similarity judgments on the appearance of the stimuli and what they thought the objects represented in the real world. Questions about the procedure were clarified after this pre-test period.

Subsequently, the experimenter proceeded to test the participant with the 30 object pairs of Modeling and Generalization that were previously used with the children with cognitive and language delays. Table 2 presents the object pairs used in the experiment.

Notably, object pairs were randomized across tasks and the order of presentation of the sets of stimuli was counterbalanced across the sample.

**Table 2.** Modeling (Set A) and Generalization (Set B) Stimuli Object Pairs

<table>
<thead>
<tr>
<th>Task</th>
<th>#</th>
<th>Event Sequence</th>
<th>Object Pair</th>
</tr>
</thead>
<tbody>
<tr>
<td>Novel</td>
<td>1</td>
<td>Make a Rattle</td>
<td>Set A Modeling Stimuli: purple toothbrush tube</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td></td>
<td>purple toothbrush tube</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td></td>
<td>pink stick</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>Make a Face</td>
<td>white teeth</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td></td>
<td>black phone</td>
</tr>
<tr>
<td>6</td>
<td>orange pointy nose</td>
<td>red round nose</td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>-------------------</td>
<td>---------------</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>green cap</td>
<td>green top hat with red stripe</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>garlic press</td>
<td>Play Doh fun factory</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Make Spaghetti</td>
<td>small beige plate with black design</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>1 color clay (round)</td>
<td>different color clay (cube)</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>yellow watering pitcher with long spout</td>
<td>measuring cup</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Go Swimming</td>
<td>wind up ladybug</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>red bucket</td>
<td>clear fishbowl</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>large scissor tongs</td>
<td>large tweezer tongs</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Brown washcloth</td>
<td>white bib with orange trim</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>brown teddy bear</td>
<td>pink bunny</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>large yellow bowl</td>
<td>Small orange bowl</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>small Apple Jacks cereal box</td>
<td>tiny Cheerios box</td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>tall skinny white pitcher</td>
<td>short wide white cup</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>Small beige spoon</td>
<td>Small red spoon</td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>Brush Teeth</td>
<td>small blue Aqua Fresh toothpaste</td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>small transparent yellow tumbler with grooves</td>
<td>small white cup with handle</td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>small blue toothbrush</td>
<td>small yellow toothbrush</td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>white washcloth</td>
<td>purple washcloth</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>Bedtime</td>
<td>pink rectangular container with slots</td>
<td>white rectangular container</td>
</tr>
<tr>
<td>26</td>
<td></td>
<td>purple cotton onesie with pink trim</td>
<td>red velvet shirt with blue trim</td>
</tr>
<tr>
<td>27</td>
<td></td>
<td>Things I Like to Play book</td>
<td>Dumbo book</td>
</tr>
<tr>
<td>28</td>
<td>Bath time</td>
<td>large blue cubical container</td>
<td>beige rectangular container</td>
</tr>
<tr>
<td>29</td>
<td></td>
<td>pink washcloth</td>
<td>green washcloth</td>
</tr>
<tr>
<td>30</td>
<td></td>
<td>small circular soap</td>
<td>small rectangular soap</td>
</tr>
</tbody>
</table>

**Hypothesis**

We hypothesized that for the perceptual dimension, the objects pairs between modeling and generalization would be rated as dissimilar while for the conceptual dimension, object pairs would be rated as similar. If the results indicated that some object pairs were rated as highly similar on the perceptual dimension, a decision was made that changes to remove and replace stimuli will take place if and only if at least 2 object pairs were rated as highly perceptually similar within a particular test event in the main generalization experiment. The rationale is that each task in the main generalization experiment comprises 4-5 test stimuli in each Modeling and Generalization set. Retaining at least one perceptually similar object pair as rated by the adult participants will reflect some level of ecological validity. This is because within any event in the real world, there is a probability that objects related to actions may be used again (e.g. if towels of two different colors for bath time were given high perceptual similarity ratings). Therefore, allowing one pair that was rated highly similar will still be able to reveal...
flexible cognition, because the child has to incorporate the similar object among all of the other objects in the test event that were rated highly dissimilar. For the conceptual dimension, if any object has been rated as conceptually dissimilar, it will first be considered in the context of the tasks that were given, since for some of the novel tasks, the objects were so obscure, that it in isolation, it would be difficult to conceive how some of the object pairs could be related. In the context of the actual generalization task, when actions are performed on the modeling objects in a particular sequence, actions could be inferred and applied to the generalization objects (e.g. refer to “make a rattle task” in Appendix B).

The purpose of Experiments 1 and 3 is to assess whether children are able to generalize the function (or the actions related to the objects) from one set to the other in the context of event representation. Therefore, it is essential that the conceptual judgments are perceived as highly similar especially for familiar objects from Set A to Set B. In this experiment, any object pairs for familiar tasks rated as conceptually dissimilar will be considered confounding. As such, one of the objects from the pair will be replaced with an object that has been rated as functionally similar, after another round of judgment ratings by adults. The replaced object will be used for the replication experiment on typically developing children and ASD children.

Results obtained from the adult sample will be interpreted with caution because adult cognition is not the same as cognition in young children. Prior knowledge of many of the objects under investigation, combined with fully developed language abilities,
gives adults an advantage that young children may not have. Because time constraints with children were a concern, adults were recruited for the experiment. However, these data will yield information about the association between the modeling and generalization objects.

**Results and Discussion**

*Perceptual similarity.* This experiment tested the between-category perceptual similarity of the Modeling set (Set A) and the Generalization set (Set B). Raw scores were entered into SPSS for analysis to determine whether the two sets of stimuli were rated differently from each other when the adult participants focused solely on the appearance of the object pairs (Item 1 on survey for each object pair). Descriptive statistics revealed that out of all object pairs (N = 30), 29 had means ranging from 1.50 – 4.35 (SE mean range: .11 - .27). The only object pair that was rated as highly similar was a green washcloth from Set A and a pink washcloth from Set B (M = 6.9; SE Mean = .04).

*Conceptual similarity.* This experiment also tested the between-category conceptual similarity of the Modeling set (Set A) and the Generalization set (Set B). Raw scores were entered in SPSS for analysis to determine whether the stimuli of the two sets were rated differently from each other when the adult participants rated the objects based on whether the object pairs were the same kind of thing or had the same function (Item 2 on the survey for each object pair). Descriptive statistics indicated that out of all object pairs, (N = 30), 27 had means ranging from 4.5 – 6.9 (SE mean range: .05 - .29). Three object pairs were rated low in terms of conceptual similarity: pink stick/orange ball (M =
2.4; SE mean = .39), red square cover/half of a purple toothbrush holder with ridges (M = 3.1; SE mean = .35), and teal square container/other half of a purple toothbrush holder with ridges (M = 4.2; SE mean = .34).

This experiment was conducted as an internal validity check of the initial generalization experiment conducted on children with cognitive and language delays to test the assumption made that the Modeling (Set A) and Generalization (Set B) stimuli object pairs chosen were perceptually different. In order to conclude that Set A was indeed perceptually dissimilar from Set B, we systematically tested this assumption by asking adults to make similarity judgments based on appearance alone. Results indicate that of the 30 object pairs, our hypothesis was retained for 29 object pairs, as they were rated as quite dissimilar with respect to appearance. The only pair that was rated as perceptually similar was the green washcloth from Set A and the pink washcloth from Set B. This result is not surprising because they both were the same size and had the same pattern, but the only difference was the color.

A decision was made to keep both stimuli because within the main generalization study, the task in question that the objects were going to be manipulated was the “bedtime task.” In this test event, the washcloths were not going to be used for washing but rather as a “blanket” to cover the stuffed animal. Therefore, the function of the object was not going to be used in a literal sense and the task would require that the child inhibit the normal usage of the washcloth and generalize to another color based on the action modeled by the experimenter. Regarding conceptual similarity judgments, 3 of 30 object
pairs were rated on the low end of the scale. This was not surprising, however, because the three object pairs (pink stick/orange ball, red square cover/half of a purple toothbrush holder with ridges, and teal square container/half of a purple toothbrush holder with ridges) are all objects in the “make a rattle” task. The “make a rattle” test event is one of the novel tasks that has the most obscure objects in the experiment that could have been difficult to consider in isolation how the object pairs were related. As mentioned previously, actions were only qualified by their temporal relations with other actions within sequences, but appear arbitrary in and of themselves. Therefore, in the context of the experiment, as the experimenter modeled actions with the modeling objects in a 3-step sequence, one could infer how to generalize these actions to the generalization objects. Therefore the decision was made to retain these 3 object pairs in the replication experiment assessing children with ASD and typically developing children.

II.3 Experiment 3: Replication of Generalized Event Representation Experiment with Children with Autism Spectrum Disorder (ASD) and Typically Developing Children (TD)

Method

Participants

Twenty children, between the ages of 3 years; 6 months, and 6 years; 10 months, participated in the third experiment. They represented two distinct diagnostic categories: ASD and typical development (TD). We only recruited children whose primary language spoken at home was English. Table 3 presents participants’ demographic information.
Typically Developing Children

A sample of typically developing children (TD, \( n = 10 \): 3 girls, and 7 boys), were recruited from a Head Start program from the same early childhood education pre-school as the sample of children with ASD. The mean chronological age was 4 years, 7 months (range 3;6 – 5;5).

Children with autism spectrum disorder (ASD)

Children with ASD (\( n = 10 \): 10 boys) were recruited from self-contained classrooms at an early childhood education pre-school and an after-school program in Brooklyn, NY. These children had been classified within the range of ASD according to the DSM-IV-TR (e.g. autism, Asperger syndrome, or pervasive developmental disorder—not otherwise specified) prior to school entry. The mean chronological age of participants was 4 years, 10 months (range 4;3 – 5;11). Although the experimenter had knowledge of participants’ diagnoses in general, the experimenter was naïve to any specific diagnostic information of individual children with ASD until after all data were collected. Additionally, all diagnostic instruments (e.g. Childhood Autism Rating Scale) administered during research tasks were scored after all tasks were completed.

Diagnostic and Cognitive Assessments

For assessments, the experimenter administered all tests, while a trained research assistant conducting on-line coding sat approximately 3 feet behind the child. The research assistant’s presence did not appear to interfere with participants’ level of engagement or distractibility.

Participants in the ASD group ($n = 10$) were all diagnosed according to DSM-IV criteria prior to enrollment into preschool, which was the basis for separate, specialized instruction at the pre-school. The experimenter administered the Childhood Autism Rating Scale (CARS; Schopler, Reichler, & Ronchen Renner, 1988) while also performing the test events in Experiment 3. The CARS is a brief, valid, and reliable classification system for the diagnosis of autism (e.g., Chlebowski, Green, Garton, & Fein, 2010; Schopler et al. 1988; Tachimori, Osada, & Kurita, 2003). The CARS rates behavioral characteristics of autism in 14 areas. The rating scale for each area ranges from 1 to 4, with higher scores reflecting lower level of functioning. Overall scores range from 15 to 37+. Children who score below 30 are considered minimal- to non-autistic, scores between 30 and 36.5 indicate mild- to moderate autism, and scores between 37 and 60 indicate severe autism (Schopler et al. 1988).

Although most of the items were recorded online by a research assistant, videos used in the main research study were also used to obtain data. Furthermore, responses from the CARS parent forms were considered in an effort to corroborate observed behaviors during testing. The mean total raw score was 25.8 (range: 20.5 – 32.0), classifying this sample of children with ASD in the upper minimal- no ASD category. These children were thus characterized as having high-functioning ASD (as opposed to no ASD) since they were diagnosed with the disorder prior to being enrolled at the school, and were in self-contained ASD classrooms as a result.
Nonverbal Evaluation: Peabody Picture Vocabulary Test, 4th edition. The Peabody Picture Vocabulary Test: 4th edition (Dunn & Dunn, 2007) was administered to determine the verbal ability of ASD and TD children because no prior verbal IQ record was on file at the time of testing. It was also conducted to examine correlations between language and generalization abilities. The PPVT-IV is a norm-referenced, wide-range instrument that evaluates comprehension of the spoken word in Standard English, and therefore, is a measure of an examinee’s receptive vocabulary knowledge (Dunn & Dunn, 1997). All participants in the current experiment spoke English as their primary language. The test measures linguistic potential and is appropriate for those with expressive-language impairments, written-language difficulties, or extreme motor/speech impairments. Each PPVT item consists of two parts: the stimulus word and an array of four full-color art drawings—one of which is an illustration of the stimulus word. The other three pictures in the array are distractors that are appealing choices for participants who are unsure of the correct answer. The child is asked either to point or to say the number of the picture that corresponds to the stimulus word.

From the TD group, 6 boys and 3 girls were administered the PPVT test. Due to absences during days of testing, 1 child was unable to participate. The mean total raw score for the TD children was 85.7 (range: 66 – 103). In the ASD sample, 9 boys were administered the PPVT test. One child with ASD from the school with children with cognitive and language delays (from Experiment 1) was not given the PPVT test at the time the research was conducted at the school. The mean total raw score for the ASD
participants was 85.8 (range: 42 – 126). Like IQ tests, the norm score for the PPVT is 100. Table 3 presents participants’ demographic information and PPVT-IV scores.

Table 3. Demographic Information, CARS-2, and PPVT-IV Assessment Scores

<table>
<thead>
<tr>
<th>Participant</th>
<th>Chronological Age (y;m)</th>
<th>PPVT Score</th>
<th>CARS-2</th>
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<tbody>
<tr>
<td></td>
<td>Autism Spectrum Disorder (ASD): n = 10</td>
<td></td>
<td></td>
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<tr>
<td>1</td>
<td>4;8</td>
<td>74</td>
<td>20.5</td>
</tr>
<tr>
<td>2</td>
<td>5;11</td>
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<td>3</td>
<td>4;8</td>
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<tr>
<td>10</td>
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<td>30.5</td>
</tr>
<tr>
<td><strong>MEAN</strong></td>
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<td><strong>85.8</strong></td>
<td><strong>25.8</strong></td>
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<tr>
<td></td>
<td>Typically Developing: n = 10</td>
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<tr>
<td><strong>OVERALL MEAN</strong></td>
<td>4;9</td>
<td><strong>85.7</strong></td>
<td></td>
</tr>
</tbody>
</table>

**Materials**

Materials used in this experiment were identical to those used in Experiment 1.

**Setting.** Children were seen individually at school in an unoccupied administrative office. The testing area was equipped with a child-sized table, three child-sized chairs (for child, experimenter, and research assistant), a video camera mounted on a tripod, and 2 four-drawer carts, which contained the modeling and generalization props. Each child was invited to the testing area and seated directly across from the experimenter. Because each child was on a behavioral plan, the children with ASD were accompanied by a teacher, therapist, or parent during each testing session for support and to redirect any inappropriate or distracting behaviors (e.g. getting up from seat, throwing toys). The
teachers and therapists were clearly instructed not to lead participants to any response and not to reinforce correct responses.

**Procedure**

The test session was administered exactly the same as in Experiment 1.

**Scoring**

*Coding.* The test sessions were video recorded for later analysis. Although the coders were aware of the action sequences of each task, they were blind to the research hypotheses. In order to achieve inter-observer agreement, two raters used the video recording and coded one child (8 tasks) independently and compared their observations. The few disagreements were discussed and resolved. The raters continued to code four children independently and overall reliability between them was 99% for actions and 99% for the ordered sequences produced.

*Actions.* As in Experiment 1, proportion scores were obtained by the sum of the target actions performed by each participant for each sequence type (causal, arbitrary, conventional) and task (novel, familiar) divided by the total possible number of target behaviors of each sequence type for each kind of task (Maximum values: Novel/Causal = 8; Novel/Arbitrary = 7; Familiar/Conventional = 16) for baseline, generalization, and imitation measures.

*Sequences.* As in Experiment 1, the proportion of target behaviors produced in the correct sequential order to the total possible number of target sequences for each
sequence type (Maximum values: Novel/Causal = 5; Novel/Arbitrary = 6; Conventional=12) was calculated for baseline, generalization, and imitation measures.

**Results and Discussion**

The mean proportion of targeted actions produced was the first dependent measure analyzed, followed by the mean proportion of correctly ordered sequences (pairs of actions produced in the same order they were modeled).

A preliminary analysis revealed that the proportion of actions in the novel and familiar events were produced equally often overall (novel M = 0.81, SE = 0.03; familiar M = 0.81, SE = 0.23) p = .899. The analysis also revealed equal performance of novel and familiar correctly ordered target sequences (novel M = .64, SE = .04; familiar M = .68, SE = .04), p = .200. We were particularly interested in the assessment of actions and correctly ordered sequences with the manipulation of causal, arbitrary, and conventional action and sequence types that were embedded within the robust categories of the novel and familiar events.

*Mean Proportion of Target Actions Produced*

A 3 x 3 mixed factorial repeated-measures analysis of variance (ANOVA) was conducted with Assessment (baseline, generalization, imitation), and Action type (causal, arbitrary, conventional) as the within-subject factors and Diagnosis (TD, ASD) as the between-subject factor. The probability of a Type I error was maintained at .05 for all analyses, and sphericity was assumed for any significant values, since Maulchý’s test were all non-significant. The main effect of assessment was qualified by statistical
significance, $F(2, 36) = 95.47$, $p < .001$, and post hoc comparisons revealed that more actions were produced at generalization ($M = .890$, $SE = .016$) than at baseline ($M = .576$, $SE = .035$), with the greatest amount of actions produced at the imitation assessment ($M = .962$, $SE = .014$). There was also a main effect for action type, $F(2, 36) = 3.26$, $p = .05$ with fewer causal actions produced ($M = .769$, $SE = .028$) than arbitrary ($M = .848$, $SE = .016$) and conventional actions ($M = .810$, $SE = .025$). However, the between-subjects factor for Diagnosis was not significant, $F(1, 18) < 1$, $ns$. Furthermore, in examining the data for an interaction comparing assessment scores for each action type, no statistically significant interactions were found, indicating that typically developing children and those with ASD performed equally well in producing target actions irrespective of the various types that were manipulated (causal, arbitrary, conventional) across three assessment periods (Figure 3). Additionally, although the children with ASD produced fewer causal actions at baseline, they showed greater improvement from baseline to generalization than the TD children.
**Figure 3.** Mean proportion of target causal, arbitrary and conventional actions produced at baseline, generalization and imitation in ASD and TD children. Standard errors are represented in the figure by the error bars attached to each column.
Mean Proportion of Correctly Ordered Sequences Produced

We next examined the mean proportion of correctly ordered sequences. A 3 x 3 mixed factorial repeated measures ANOVA was used to analyze the data with Assessment (baseline, generalization, imitation) and Sequence type (causal, arbitrary, conventional) as the within factors, and Diagnosis (TD, ASD) as the between-subject factor. The only F-statistic that was significant was the main effect for assessment, $F(2, 36) = 100.08, p < .001$. As shown in Figure 4, the mean proportion of sequences for generalization exceeded baseline. The imitation data revealed a higher proportion of sequences produced at imitation compared to generalization (Tukey HSD $p$'s < .001). As with the actions produced no significant interactions were found (comparing assessment scores for each sequence type, including the 3-way interaction that included the between-subject factor of Diagnosis). Given that perseveration of sameness is one of the subtypes of the restricted and repetitive behaviors (RRBs), one would expect difficulty on some level with transfer of knowledge once the props have been changed. Looking at individual data, although this task appeared difficult for some of the ASD children, overall, when shown the modeling props (Set A), these children were able to abstract the actions in the correct order and apply their knowledge to carry out the event sequences at generalization with the Set B props. Notably, as with the actions, the children with ASD produced very few sequences at baseline ($M = .260; SE = .090$) but showed greater improvement at generalization compared to TD children (see Figure 4). Sequences at
imitation yielded ceiling effects, but again, this is not surprising, given that the task was well within their cognitive level.

*Figure 4.* Mean proportion of target causal, arbitrary, and conventional correctly ordered sequences produced at baseline, generalization, and imitation in ASD and TD children. Standard errors are represented in the figure by the error bars attached to each column.
As with the children with cognitive and language delays, we were especially interested in investigating whether receptive language was a factor (irrespective of diagnosis) in generalization performance in novel and familiar events in children with ASD and typically developing controls. Because IQ data was not available at the testing school, we administered the PPVT-4 to both ASD and TD groups. The data were reanalyzed with the PPVT scores as a between-subjects factor and no interactions of any kind were found between this nonverbal measure and generalization abilities. It appears that the ASD preschoolers performed equally well as the TD children in many areas, and any nonverbal differences did not hinder their production of actions and sequences in this
task involving generalization in the context of event representation. Research by Mundy, Sigman, Ungerer & Sherman (1987) supports these findings by showing that receptive language is highly correlated with play in children with autism.

Comparison between Experiments 1 and 3 (CLD, TD, and ASD Groups)

A final examination was conducted on all collected data from the three groups (CLD: \(n = 14\); TD: \(n = 10\); ASD: \(n = 10\)) to determine if the between-group factor of Diagnosis yielded any interactions.

Mean Proportion of Target Actions Produced

A 3 x 3 mixed factorial repeated-measures analysis of variance (ANOVA) was conducted with Assessment (baseline, generalization, imitation), and Action type (causal, arbitrary, conventional) as the within-subject factors, and Diagnosis (CLD, TD, ASD) as the between-subject factor. The probability of a Type I error was maintained at .05 for all analyses, and sphericity was assumed for any significant values, since Maulchy’s test were all non-significant.

Actions. Main effects were found for Assessment (p < .001) and Action type (p < .001). All children produced the fewest target actions at baseline (\(M = .598, SE = .025\)), a greater production of actions at the generalization period (\(M = .873, SE = .014\)), and the greatest at imitation (\(M = .969, SE = .009\)). Participants also produced fewer causal (\(M = .769, SE = .019\)) than conventional actions (\(M = .807, SE = .018\)), and produced the most arbitrary actions (\(M = .865, SE = .016\)).
The two 2-way interactions that were found with Diagnosis as one of the factors were reflected in 3-way interaction of Assessment x Action type x Diagnosis, F (8, 124) = 2.565, p = .013. The locus of the interaction was at the baseline and generalization assessment periods. As shown in Figure 5, the ASD children produced fewer target actions at baseline (M = .388, SE = .072) than the TD children (M = .650, SE = .072) and the CLD children (M = .643, SE = .061). However, at generalization, the ASD children caught up and performed as equally well as TD children. Although it appears that all groups performed fewer causal than arbitrary and conventional actions at generalization, this result was not significant for the TD (M = .800, SE = .053) and ASD (M = .825, SE = .053) children. However, this difference was only significant for the CLD children (M = .670, SE = .045), p < .001. Although the CLD children performed as comparable as the TD children at baseline (and even better than the ASD children), causal actions appeared to be more difficult for CLD children to generalize from baseline than other action types, and compared to the other diagnostic groups. Ceiling effects were found at imitation—children from all diagnostic groups were apt at imitating the actions and sequences related to the original props.
Figure 5. Mean proportion of target causal, arbitrary, and conventional actions produced by typically developing (TD) children, children with autism spectrum disorder (ASD), and children with cognitive and language delays (CLD) at baseline, generalization, and imitation assessment periods.
Children with Autism Spectrum Disorder

Children with Cognitive and Language Delays
Sequences. A 3 x 3 mixed factorial repeated-measures analysis of variance (ANOVA) was conducted with Assessment (baseline, generalization, imitation), and Sequence type (causal, arbitrary, conventional) as the within-subject factors, and Diagnosis (CLD, TD, ASD) as the between-subject factor. The probability of a Type I error was maintained at .05 for all analyses, and sphericity was assumed. A main effect was found for Assessment, F (2, 62) = 172.671, p < .001, with the same trend as actions, in which the fewest proportion of sequences was produced at baseline (M = .302, SE = .025), greater performance at generalization (M = .684, SE = .030), and ceiling effects at imitation (M = .902, SE = .020). An interaction was found for Assessment x Sequence type, F (4, 124) = 3.441, p = .011. However, performance of the various sequence types was not significant at any of the assessment periods. Furthermore, there were no diagnostic interactions, indicating that there were no differences among the three diagnostic groups.
CHAPTER III: GENERAL DISCUSSION

One of the defining characteristics of ASD is perseveration of sameness or resistance to adapting to change in everyday life. Sequential understanding of actions that occur in reoccurring everyday events is essential in that it allows us to predict future events by accessing the memory for the objects, actors, individual actions, and correct temporal order of actions within the event. Additionally, because event representation is a flexible construct that accounts for potential variability that may occur when faced with a similar novel situation, it also requires the cognitive process of generalization, or the ability to access familiar knowledge and ignore irrelevant details, and spontaneously abstract and apply the relevant information, which in turn, enriches the original event schema.

Research has not systematically investigated event representation in children with ASD. TD children spontaneously generalize what they learn, often to the extent of over-generalizing activities to somewhat inappropriate situations or objects (Mandler & McDonough, 1996). However, children with ASD often establish rigid routines (Whalen, 2009) and have difficulties generalizing what they learn due to their tendency to focus on specific details. After learning a new skill, they often need to be explicitly taught to generalize that knowledge to other contexts. Intervention programs with children with intellectual disabilities, and with ASD in particular, train children to carry out target behaviors using reinforcement schedules in limited contexts. Yet a problem with these types of interventions is that training does not spontaneously generalize to other
appropriate objects or contexts, thus limiting the effectiveness of intervention. One source of cognitive delays in children with intellectual disabilities could be attributable to poor generalization of learning.

The generalized imitation paradigm, which had been primarily conducted on TD children, was implemented in the current research experiments to test the extent to which cognitive flexibility regarding event knowledge is possible in children with mild- to high-functioning ASD in comparison to children with cognitive and language delays (CLD), and typically developing controls (TD). With the use of miniature objects, we examined the generalization and recall of actions and correctly ordered 3- to 4-step sequences in novel and familiar events. Not only did we investigate generalization of individual actions, but we also assessed how well our participants could generalize the sequential order of an event as a function of sequence types (causal, arbitrary, conventional). Causal and arbitrary actions within novel sequences provide an understanding of children’s episodic memory, whereas production of conventional sequences in familiar tasks is indicative of event representation of everyday occurrences (Bauer & Mandler, 1992; Bauer, 1992).

### III.1 Performance of CLD, ASD, and TD Groups

In examining the results from all three groups, findings were consistent with our initial hypotheses that overall, regardless of diagnoses, children would be able to figure out the functions of objects. Participants demonstrated this ability by generalizing these functions to new objects that differed in color, shape, size and texture. Given that there
were two groups of participants in the present experiment diagnosed with intellectual disabilities, we took a non-directional approach to our hypothesis about their generalization abilities with respect to particular types of temporal relations between actions (causal, arbitrary and conventional). It was difficult to make a clear prediction because their chronological ages are considerably older than the TD children tested in previous research. Regardless of diagnosis, all groups generalized fewer causal actions, which confirms previous research on generalization research in young TD children that causal actions and sequences are more difficult than arbitrary ones to carry out with new objects (Bauer, Dow, Bittinger & Wenner, 1998; Bauer & Fivush, 1992; Fivush, Kuebli & Clubb, 1992). Regardless of age, we considered it possible that all groups would find it easier to generalize the familiar events in their canonical order because they had seen them produced in the same manner with several varying objects over their lifetime.

In ascertaining where the most extreme differences were found, the data are clear: although one would expect children with ASD to perform poorly on the generalized imitation tasks due to their unique insistence of sameness symptomology, it was the CLD group whose data yielded many more differences, specifically, the lowest production of causal actions at generalization compared to the ASD and TD groups (see Figure 6 for a summary of actions for each diagnostic group). This result was partially anticipated because some research on the generalization of actions has shown that TD children sometimes find causal sequences more difficult to generalize (Bauer & Fivush, 1992; Bauer, Dow, Bittinger & Wenner, 1998). While the TD and ASD groups did generalize
fewer causal actions compared to arbitrary and conventional ones, the mean proportion of target actions was much higher than for the CLD group.

**Figure 6.** Mean proportion of target causal, arbitrary, and conventional correctly ordered sequences produced by typically developing (TD) children, children with autism spectrum disorder (ASD), and children with cognitive and language delays (CLD) at baseline, generalization, and imitation assessment periods.
Of particular interest was the generalization of correctly ordered sequences, or the correct ordering of target actions (correct in terms of the order in which the actions were modeled), a cognitive ability that is especially important for problem solving and everyday event representation. While object generalization of 3-step sequences is found as early as 16 months in typically developing children (Bauer & Dow, 2004), to date, research has not investigated generalization in pre-school TD children or those with intellectual disabilities. The current research provides evidence that without consideration of the various sequence types (causal, arbitrary and conventional) all high-functioning children, regardless of diagnosis, have some capacity to abstract the function and generalize their knowledge to perceptually dissimilar objects of novel and familiar sequences (main effect for assessment periods: baseline, generalization, imitation, p < .001). After briefly observing a task being modeled, all groups readily generalized the function of various objects within events while accurately preserving the sequential ordering of target actions with functionally equivalent exemplars. Results further indicate that performance increased dramatically when children were given the opportunity to manipulate the modeling objects, which occurred only after the generalization period.

Furthermore, it is worth noting that no interaction was found with diagnosis as a factor. Although participants substantially generalized causal sequences from baseline (baseline causal mean = .36; generalization causal mean = .57), the production of proportion of causal (M = .57) versus arbitrary (M = .54) sequences was not statistically
significant at generalization. While children with cognitive and language delays had difficulties generalizing causal actions compared to the other types, the few target causal actions that they were able to recall were successfully produced in the correct temporal order, and performed as equally well as the other groups. This suggests that although participants found it difficult to generalize some actions, they took advantage of understanding relations and correct order for the few pairs of causal actions that they were able to generalize; therefore, they appear capable of generalized sequential understanding.

Regarding the imitation assessment, a ceiling pattern was found for all groups, which was expected since their motor skills were intact (participants therefore should have been capable of imitating what they saw). The dependent measure of importance, however, was flexible transfer of actions and sequences on new objects in events, and we found that the generalization assessment period was quite difficult for these children.

How did children with mild- to high-functioning ASD fare? Results indicate that like their TD counterparts, children with mild- to high-functioning ASD were able to generalize and imitate actions in the correct order within test events in novel and familiar tasks. With diagnosis as a between-subjects factor, no interactions were found. Given the symptomatology of autism, one would expect perseveration tendencies to hinder flexibility in learning. These data also seem to fly in the face of the autism literature, which suggests that because of social deficits (Ingersoll, 2008) or information-processing difficulties (Smith & Bryson, 1994), children with autism are incapable of imitating the
behaviors of others in a purposive way, let alone generalize to new contexts due to cognitive inflexibility and difficulties with abstraction (Church, Rice, Dovgopoloy, Lopata, Thomeer, Nelson, & Mercado, 2015; Froehlich, Anderson, Bigler, Miller, Lange, DuBray, Cooperrider, Cariello, Nielsen, & Lainhart, 2012).

The current experiments also support one of the few research studies (McDonough, Stahmer, Shreibman, & Thompson, 1997) to reveal that not only are children with autism capable of immediate imitation, but also generalization of actions and correctly ordered sequences with more obscure, abstract objects. McDonough and colleagues note that because their experiment was conducted in a highly structured laboratory setting, it is unclear whether this finding would generalize in naturalistic settings where distractions are difficult to control. Informal reports by parents and caretakers suggest that children with ASD have “favorite” items that are often part of daily routines to which considerable turmoil becomes evident should other items be substituted for these favorites. Therefore, the researchers questioned whether perseveration of sameness, and the failure to generalize, is evident not only in newly learned skills but also in skills they have learned in more naturalistic, everyday settings. Replication of these results as a function of change in test setting in an effort to increase external validity remained an issue left unexplored. The current research attempted to address this issue by examining whether children with ASD would be able to generalize and imitate novel and familiar tasks in a more naturalistic setting (at their school, in an office or open cubicle near classrooms, with a teacher/therapist/parent present), thereby
increasing ecological validity. We found that participants with ASD still yielded significant results in the generalization task in these naturalistic settings, despite increased levels of distractibility.

Given that insistence on sameness is a defining characteristic of autism, one would expect diminished generalization performance in the current experiment compared to other groups. However, it was not the children with ASD, but the group of children with cognitive and language delays that demonstrated poorer performance compared to the other groups. Participants in the CLD group did not meet criteria for autism and insistence on sameness is not a defining symptom associated with any other intellectual disability. How is it then, that the cognitive and language delayed group, although they demonstrated within-group success, showed more differences in generalization ability under the same circumstances in comparison to the ASD and TD groups? A possible explanation for the underperformance of causal actions is that children are encoding the ordering of the sequences and function along with some physical characteristics of the objects themselves. Because actions in causal tasks enable particular outcomes, children may be processing the perceptual details of the modeling objects, details that may or may not be essential for the outcomes to occur. Such precise encoding is likely prohibiting them from generalizing to new props that have different appearances.

**III.2 Limitations and Future Research**

A limitation of the current research is the small number of participants in each group (N = 34; CLD = 14, TD = 10, ASD = 10). Increased sample size not only would
increase the power of the experiment but would also allow us to generalize to the larger population. However, the participants were evenly matched on age (CLD: 4 years, 6 months; TD: 4 years, 7 months; ASD: 4 years, 10 months) and non-verbal ability (CLD nonverbal IQ M = 85.2; TD PPVT = 86; ASD PPVT M = 86), and despite this, differences were still observed.

Another limitation is that not all groups were administered the same language assessments. The CLD children were the first participants tested at the beginning of this research project that spanned 4 years. While verbal IQ data of the CLD children was available at their testing school, this information did not exist for the TD and ASD children, who attended a different school. Due to the stringent time constraint allocated for conducting research at the school, we were unable to administer IQ tests to these participants, and therefore, administered the PPVT-IV in an effort to obtain receptive vocabulary data. However, interpretations could still be made based on the data available, since in the literature, both receptive (Lewis, Boucher, Lupton, Watson, 2000; Mundy, Sigman, Ungerer, & Sherman, 1987) and expressive language (Honey, Leekam, Turner, & McConachie, 2007) are good predictors of functional play in typically developing children and children with intellectual disabilities.

In addressing whether the experiment should have manipulated perceptual dimensions of objects in the task to pinpoint which dimension was easier or more difficult to generalize to, this was not the focus of the current experiment, as our objective was to increase ecological validity. Previous research by Son, Smith &
Goldstone (2008) examined generalization ability by degrading all physical attributes except for shape. These authors found that performance improves in young children when they are shown new props after the intermediate training period with the degraded objects. However, in the current research, the variability of stimuli was intentional for two reasons. The ultimate goal of this research project was to assess generalization, and we wanted to make the research study as naturalistic as possible, while still maintaining the integrity of the experiment. First, in the real world context, objects that people manipulate within events are not controlled for—we generalize and are creative with tool use depending on which objects are immediately available. A hanger, for example, could be used in many ways: it can hang clothes, hook and retrieve objects, unclog sinks, and unlock doors. Generalization ability in everyday life fluctuates depending on the task and available resources. Therefore, our ability to generalize must adapt according to the current task or problem based on objects that are immediately available. Second, although we initially tested children with CLD, the goal was to target the population of children with ASD. Children with ASD reportedly are unable to generalize and maintain skills without consideration of perceptual detail and context and this may account for why they establish rigid routines (Plaisted, 2001). We wanted to replicate this naturalistic methodology to assess generalization and event representation in this particular population. Deciding to select objects for the generalization props that only differed from the modeling props by one physical element (i.e. color, size, shape) is essentially reinforcing rigidity, which would be counterproductive for the purpose of this research.
Future research in event representation in ASD should examine how rigid or tenuous these children’s episodic memories really are. If an unrelated action occurs within an event that a child encounters for the first time (novel event), what is the likelihood that the child would incorporate that unrelated action, should he or she encounter the same event the next day? This could be investigated by administering the deferred imitation method. Many studies with TD children (Bauer, 2002; Bauer & Thal 1990; Mandler & McDonough, 1995, 1998) have utilized Piaget’s deferred imitation method (1952) to investigate representational capacity. Deferred imitation has noteworthy reliability and assesses nonverbal long-term recall and representation in infants, children, and adults (McDonough, Mandler, McKee & Squire, 1995).

According to the weak central coherence theory (Happe & Frith, 2006), individuals with ASD have a tendency to process information locally and invest in accuracy at the expense of meaning or understanding the bigger picture. Because individuals with ASD tend to rely on specific details of events, we would expect that even after a time delay, they would incorporate the unrelated object-action within the sequence. On the other hand, when given similar tasks, TD children tend to be aware of causal relations and thus imitate causal sequences with ease (Mandler & McDonough 1995). Any unrelated object-action is either performed at the end of the sequence as an afterthought or is not acknowledged (Bauer, Dow, Bittinger, & Wenner, 1998). Therefore, given that children with ASD were able to imitate causal sequences in the
current experiment, it is possible that ASD children would be able to perform the unrelated object-action at the end of the sequence, or not at all.

III.4 Summary and Conclusions

Results suggest that the recall, generalization and ordering of both causal and arbitrary sequences after a brief exposure to modeling is indicative of episodic event memories. On the other hand, we can surmise that children’s ability to recall and generalize the correct order of familiar events (i.e. bath time, bed time) demonstrates the acquisition of everyday event representation, or script knowledge. Generalized knowledge of events serves as a guide for predicting what to expect in similar events in the future despite slight changes in context. For example, Billy, a child with a particular bedtime routine at home would not deviate much from the central components of his routine when away at his grandmother’s house. Because generalization is a cognitive process that naturally allows for some variability within an event, over time, the child’s reasoning about bedtime will accommodate superfluous components that may occur at his grandmother’s house, which is a different environment than his home and with different rules. Perhaps at grandma’s house, Billy is allowed to eat a snack right before sleep or sleep on the couch with a night-light—actions that are never done at home. However, Billy is able to adjust because actions that are central to his bedtime script (i.e. brushing teeth, changing into pajamas, going to sleep) are still intact. Sequential understanding is important for anticipating the course of action in event representation, especially for central components that appear to be enabling and contributing to the end
goal. For instance, one must open the toothpaste before squeezing it onto the toothbrush and subsequently brushing teeth. Performing these actions in any other sequence is either useless (squeezing toothpaste onto toothbrush before opening the toothpaste first) or does not contribute to the goal of the task (brushing teeth with toothbrush before putting toothpaste on toothbrush). Thus, generalization combined with sequential knowledge is a mechanism that facilitates problem-solving abilities.

The research is the first of its kind to explore the extent to which cognition is flexible in children with autism. Also, the current study challenges the assumption of insistence on sameness, the characteristic uniquely related to autism, as a cognitive deficit that greatly hinders generalization, and therefore, event representation. The purpose of the current research was to investigate how children with autism mentally organize routine events that occur everyday to predict future events and the extent to which they are able to flexibly apply what they have learned to novel situations. A question, one not well addressed, concerns the underlying processes that guide the rigidity with which those with autism interact with the world. Given the amount of “sameness” and predictability they seem to want in their daily lives, it would appear that generalization is overly narrow. Without the ability to generalize, the ability to predict future events is also compromised. Without expectations or with narrowly defined expectations, it becomes more understandable why those with autism would have difficulties encoding and organizing new experiences. But perhaps it is our attention that is too narrowly focused. These children may do significantly more generalization than previously thought.
Current results reveal that contrary to previous findings mild- to high-functioning pre-school children with ASD do generalize across contexts (McDonough, Stahmer, Schreibman, & Thompson, 1997). Furthermore, our results are consistent with other findings that children with ASD engage in global processing (central coherence), but only when explicitly instructed (Happe & Frith, 2006), or depending on their level of narrative comprehension (Nuske & Bavin, 2010). According to individual longitudinal data, some young children with ASD do show considerable cognitive strides in executive function and theory of mind (Pellicano, 2010).

Research increasingly suggests that there are islets of cognitive strengths in high functioning autistics, including the ability to identify complex patterns more readily than typically developing children (Remington, Swettenham, Lavie, 2012; Mottron, Dawson, et al., 2006; O’Riordan, Plaisted, Driver, & Baron-Cohen, 2001), and detecting underlying complex algorithms in some domains (math, chess) (Baron-Cohen, 2002; Baron-Cohen, Wheelwright, Burtenshaw, Hobson, 2007; Banda, McAfee, Lee, & Kubina, 2007). The mild- to high-functioning children with ASD in the present study (compared to their CLD peers) perhaps demonstrated overall superior results by utilizing their enhanced perceptual expertise to selectively attend to the underlying pattern of the task itself (the actions and sequences modeled), abstracted this pattern, and generalized to the new set of props. Thus, they performed well on this task, at least as equally as well as the TD group, and even better than non-autistic children with cognitive/language delays.
Expressive language deficits in the CLD children seem to have impeded the ability to generalize at the level of their mentally matched ASD cohorts because the higher verbal IQ CLD children generalized better than those with lower verbal IQs. There is extensive research demonstrating the correlation between expressive language and functional play in TD children and children with autism (Sigman & Ungerer, 1984). This correlation of language and symbolic play is also found in children with other cognitive and language delays such as in expressive Specific Language Impairment (Rescorla & Goossens, 1992; Rescorla & Ratner, 1996). While most researchers refer to generalization abilities in the literature, the term is typically used to describe lexical and morphological development in language learning to illustrate how children make extensions from words that they have just learned (e.g. Brooks, Tomasello, Dodson, & Lewis, 2003), such as overextension use of nouns (e.g. after hearing nouns with –s endings, calling the plural of foot, as “feets”) and overregularization of verbs (e.g. after hearing verbs with –ed endings, saying the past tense of go, as “goed”). However, research by Bates, Benigni, Bretherton, Camaioni, & Volterra (1979), was the first of its kind to theorize an association between language and generalization abilities in symbolic play in young children, as described in the current research.

Although we concluded that the ASD children in this sample performed as well as TD children on generalizing novel and familiar events, this does not simply imply that insistence on sameness is not a substantive core characteristic of autism that needs addressing. Insistence on sameness is a concrete cognitive challenge that affects decision-
making, often preventing children from moving forward to solve problems when their routine is not an option. The current research has revealed that this type of functional fixedness that is typically attributed to autistic cognition by researchers and clinicians alike is not a homogenous cognitive ability. Under some circumstances, some children diagnosed with mild- to high-functioning ASD are capable of applying taught skills to novel situations in naturalistic settings. Using the generalized imitation paradigm, a clever research method that we found to be age-appropriate for mild- to high-functioning children in different diagnostic categories, our results revealed that the ASD children performed as well as their typically developing counterparts. Furthermore, contrary to previous research (Williams, Costall, & Reddy, 1999), the results also demonstrate that some mild- to high-functioning children with ASD are capable of relating to objects and people, as some level of joint attention is required to attend to the verbal instructions and modeling sequences performed by the experimenter during the tasks.

This avenue of research seems promising in that results could lead to the design of training programs to help those with autism have a more stable yet flexible representation of daily life, and to use generalization abilities to enhance their learning in educational contexts. Rather than perceiving the characteristics that define autism as “deficits,” in light of evidence of cognitive strengths in these individuals, it is our hope that this paradigm shift will continue so that researchers and clinicians can refocus their perception by targeting these strengths to create training interventions. Such interventions
may not only be more effective for these children but may also reduce stigma associated with ASD and related disorders.
**APPENDIX A:** Description of Stimuli, Prompts, and Maximum Values for Actions and Sequences for Novel and Familiar Tasks

<table>
<thead>
<tr>
<th>Novel Tasks</th>
<th>Props</th>
<th>Modeled Steps (Accompanying Vocalizations)</th>
<th>Sequence Type</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Make a Rattle</strong></td>
<td><strong>Modeling:</strong> dark violet toothbrush holder with vertical ridges (2 pieces), pink stick*, red cover</td>
<td>a. Insert pink stick in one piece of toothbrush holder (“Put it in!”) b. Connect toothbrush holder with the other end (“Cover it up!”) c. Shake constructed rattle (“Shake, shake, shake!”)</td>
<td><strong>Maximum actions = 3</strong>  Maximum sequences = 2</td>
</tr>
</tbody>
</table>
|               | **Generalization:** red square cover, teal oblong rectangular bottom, small ball that looks like an orange, dark violet toothbrush holder with vertical ridges (1 piece)* |                                                                                           | Causal Actions = 3: {a,b,c}  Sequences = 2  
(aàbàc) | Arbitrary 
Actions = 0  
Sequences = 0 |
|               | * = distractor                                                          |                                                                                           |               |
| **Make a Face** | **Modeling:** white Styrofoam ball with Mr. Potato Head plastic eyes and blue shoes attached, small orange carrot nose, white teeth, dark green top hat, red toy phone receiver | a. Put nose on Styrofoam ball (“Put on the nose”) b. Put on mouth (“Put on the mouth”) c. Put on hat (“Put on the hat”) d. Bring phone to ear (“Ring, ring, ring! Hello?”) | **Maximum actions = 4**  Maximum sequences = 3 |
|               | **Generalization:** white Styrofoam ball with Mr. Potato head with eyes and feet attached, oval crimson nose, crimson tongue, light green cap, black life-size telephone receiver |                                                                                           | Causal 
Actions = 0  
Sequences = 0 |
|               |                                                                       |                                                                                           | Arbitrary 
Actions = 4:  
{a,b,c,d}  
Sequences = 3  
(aàbàcàd) |
<table>
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<tr>
<th>Novel Tasks</th>
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<th>Sequence Type</th>
<th>Maximum Values:</th>
</tr>
</thead>
</table>
| **Go Swimming** | **Modeling:** yellow pitcher, metal scissor tongs, red and black wind-up toy ladybug, red bucket | a. Pour pretend water from pitcher into bucket (“Pour in the water”)  
  b. Wind up toy animal and let it walk (“Wind it up!”)  
  c. Catch animal with tongs (“Catch him!”)  
  d. Put animal into water bucket (“Put him in. Look, he’s swimming!”) | Causal | Maximum actions = 4  
  Maximum sequences = 3  
  Causal Actions = 2: \{a,d\}  
  Sequences = 1 \(a \rightarrow d\)  
  Arbitrary Actions = 2: \{b,c\}  
  Sequences = 2 \((a \rightarrow b \rightarrow c)\) or \((b \rightarrow c \rightarrow d)\) |
| **Make Spaghetti** | **Modeling:** silver garlic press with white plastic handles, Play-Doh in container with lid, beige plate with dark brown design in center | a. Open the container and get the dough out (“Open the lid”)  
  b. Put dough in extruder (“Put it in”)  
  c. Push/squeeze handle (“Squeeze!”)  
  d. Retrieve “spaghetti” and put on plate (“Look, spaghetti! All done!”) | Causal | Maximum actions = 4  
  Maximum sequences = 3  
  Causal Actions = 3: \{a,b,d\}  
  Sequences = 2 \((a \rightarrow b \rightarrow c)\)  
  Arbitrary Actions = 1: \{d\}  
  Sequences = 1 \((a \text{ or } b \text{ or } c) \rightarrow d\) |
<table>
<thead>
<tr>
<th>Familiar Tasks</th>
<th>Props</th>
<th>Modeled Steps (Accompanying Vocalizations)</th>
<th>Sequence Type Maximum Values: Actions and Sequences</th>
</tr>
</thead>
<tbody>
<tr>
<td>Make Breakfast</td>
<td><strong>Modeling</strong>: brown teddy bear, large Apple Jacks box (2.75”x4.75”x1.75”), white spoon, small jug with cover, brown cloth</td>
<td>1. Pretend to pour the cereal from cereal box into bowl (&quot;Pour in the cereal&quot;) 2. Pretend to pour the milk from the jug into bowl (&quot;Pour in the milk&quot;) 3. Dip spoon in bowl and feed stuffed animal (&quot;Feed teddy…yum, yum, yum&quot;) 4. Wipe mouth with cloth (&quot;Wipe mouth&quot;)</td>
<td>Maximum actions = 4 Maximum sequences = 3 Conventional actions {a, b, c, d} Conventional sequences (a→b→c→d)</td>
</tr>
<tr>
<td></td>
<td><strong>Generalization</strong>: pink bunny, small Cheerios box (2”x3”x1.75”), red spoon, small jug with no cover, white bib with orange lining and string</td>
<td>1. Pretend to pour the cereal from cereal box into bowl (&quot;Pour in the cereal&quot;) 2. Pretend to pour the milk from the jug into bowl (&quot;Pour in the milk&quot;) 3. Dip spoon in bowl and feed stuffed animal (&quot;Feed teddy…yum, yum, yum&quot;) 4. Wipe mouth with cloth (&quot;Wipe mouth&quot;)</td>
<td>Maximum actions = 4 Maximum sequences = 3 Conventional actions {a, b, c, d} Conventional sequences (a→b→c→d)</td>
</tr>
<tr>
<td>Brush Teeth</td>
<td><strong>Modeling</strong>: brown teddy bear, blue toothbrush, travel-size AquaFresh toothpaste, small yellow tumbler with ridges, white cloth</td>
<td>1. Put toothpaste on toothbrush (&quot;Put on toothpaste&quot;) 2. Brush stuffed animal’s teeth with toothbrush (&quot;Brush teeth&quot;) 3. Rinse mouth by giving stuffed animal a drink from the cup (&quot;Rinse mouth&quot;) 4. Wipe mouth with cloth (&quot;Wipe mouth&quot;)</td>
<td>Maximum actions = 4 Maximum sequences = 3 Conventional actions {a, b, c, d} Conventional sequences (a→b→c→d)</td>
</tr>
<tr>
<td></td>
<td><strong>Generalization</strong>: pink bunny, yellow and red toothbrush, travel-size Crest toothpaste, small white cup with handle, purple cloth</td>
<td>1. Pretend to pour the cereal from cereal box into bowl (&quot;Pour in the cereal&quot;) 2. Pretend to pour the milk from the jug into bowl (&quot;Pour in the milk&quot;) 3. Dip spoon in bowl and feed stuffed animal (&quot;Feed teddy…yum, yum, yum&quot;) 4. Wipe mouth with cloth (&quot;Wipe mouth&quot;)</td>
<td>Maximum actions = 4 Maximum sequences = 3 Conventional actions {a, b, c, d} Conventional sequences (a→b→c→d)</td>
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<tr>
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<tr>
<td><strong>Bed Time</strong></td>
<td><strong>Modeling:</strong> brown teddy bear, pink 9.25”x5.75”x2” rectangular container with slots (bed), green cloth (blanket), large 4.75”x5”x.75” storybook (“Things I Like”), onesie with dark purple bodice and pink trim with snap bottom with word “smart” and picture of a bitten cookie</td>
<td>1. Put on clothes (“Put on PJ’s”) 2. “Read” stuffed animal a story by flipping pages in story book quickly (“Read teddy a story”) 3. Put stuffed animal to bed (“Put teddy to bed”) 4. Cover stuffed animal with blanket (“Cover him up”)</td>
<td>Maximum actions = 4 Maximum sequences = 3 Conventional actions {a, b, c, d} Conventional sequences (a→b→c→d)</td>
</tr>
<tr>
<td></td>
<td><strong>Generalization:</strong> light pink stuffed bunny, white 9”x6”x2” rectangular container (bed), pink cloth (blanket), small 4”x4”x1” storybook, red and black velvet shirt</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Bath Time</strong></td>
<td><strong>Modeling:</strong> brown teddy bear, blue 7.5”x6”x3” container (tub), circular soap (d=2”), pink cloth (towel)</td>
<td>1. Put stuffed animal into tub (“Put him in the tub”) 2. Wash stuffed animal with soap (“Wash him”) 3. Take bear out of the tub (“Take him out of the tub”) 4. Dry bear with cloth (“Dry him”)</td>
<td>Maximum actions = 4 Maximum sequences = 3 Conventional actions {a, b, c, d} Conventional sequences (a→b→c→d)</td>
</tr>
<tr>
<td></td>
<td><strong>Generalization:</strong> pink bunny, beige 8.5”x5.5”x2” container (tub), rectangular 1.75”x3x1.5” soap, green cloth (towel)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**APPENDIX B:** Stimuli Used in Experiment 1, Experiment 2, and Experiment 3

Modeling and Generalization Props Used in Novel Tasks

<table>
<thead>
<tr>
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<th>Generalization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Make a Rattle</td>
<td></td>
</tr>
<tr>
<td>Make a Face</td>
<td></td>
</tr>
<tr>
<td>Make Spaghetti</td>
<td></td>
</tr>
<tr>
<td>Go Swimming</td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX B: Stimuli Used in Experiment 1, Experiment 2, and Experiment 3 (cont’d)

Modeling and Generalization Props Used in Familiar Tasks

Modeling

- Make Breakfast
- Brush Teeth
- Bedtime
- Bath time

Generalization
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meeting of the Autism Consortium, Boston, Massachusetts.


play, functional play, verbal and non-verbal ability in young children.


http://dx.doi.org/10.1016/j.cub.2013.02.036


