The Use of Matrix Training to Teach
Concurrent Appropriate Actions and Vocalizations
During Sociodramatic Play in a Child with Autism

By
Hayley Sedgwick

A thesis submitted to the School of Community Services
in the partial fulfilment of the requirements for
the degree of
Bachelor of Applied Arts in Behavioural Psychology

St. Lawrence College
Kingston, Ontario
Canada
April, 2016
Dedication

For the kiddos I had the amazing opportunity of working with while completing this thesis. They have taught me so much and I have so many unique memories with each of them. I will never take for granted all of the funny and touching moments we shared or the important lessons they taught me about what’s really important in life. Each one of these children has helped me realize my passion and how beautiful the little things are in life. Each day with them, I learned how the smallest successes and failures are all incredibly important in learning and growth.

A failure is not always a mistake, it may simply be the best one can do under the circumstances. The real mistake is to stop trying...

B. F. Skinner
Abstract

Play skills are important for children to develop because they expand social and communicative skills (Lewis, 2003). Children with autism show impaired play skills because of repetitive or stereotypic behaviour (Jung & Sainato, 2013). Matrix training is defined as a generative form of instruction in which targets are organized in a matrix, and it is commonly used to teach communication (Axe & Sainato, 2010). After some skill combinations are taught, other untaught skill combinations within the matrix are tested for generative learning and responding (MacManus et al., 2015). A multiple-probe design was employed to test whether matrix training can teach play actions and language use during sociodramatic play in a 6-year-old boy with autism in an intensive behavioural intervention setting at Surrey Place Centre. Scripted actions and vocalizations were each arranged in a two-dimensional matrix and probe data were collected for correct responding with both components of the target play skills. The data showed an increasing trend and after teaching of three target combinations, the participant generalized four of the six alternative untrained combinations for actions and vocalizations. The mean level of acquired combinations was 83.33% by the end of the generalization phase. A visual analysis, using PEM, showed that the use of two parallel matrices was effective to concurrently increase both action and vocalization components of play. While no formal follow-up was conducted due to time constraints, instruction therapists did note that while in the IBI classroom setting, spontaneous play was initiated by the participant multiple times after the intervention was completed, which suggested generalization of skills and some social validity.
Acknowledgements

I want to take this opportunity to acknowledge several people whom, without their unyielding support this thesis would not have been possible. Thank you for all the support and encouragement you have provided in this undertaking over the past eight months.

Firstly, Dr. Gary Bernfeld – I could not have asked for a better college supervisor. Without your constructive feedback and direction, this thesis would not have been possible. You’re support and guidance throughout this process has made this endeavour successful and I have truly come to value you as a mentor for my work in ABA.

Jisan Phillips – For your ideas and suggestions that guided the direction this thesis took from beginning to end. I have so strongly valued your expertise and enthusiasm and want to thank you for allowing me to talk freely and share ideas to improve this thesis. Your guidance and support has been truly unsurpassable.

South Team 2 – The way you all so easily and happily included me as part of the team throughout my time at Surrey Place Centre made this undertaking seem so much more achievable. From my first day, the acceptance I felt and encouragement you all provided has truly touched me.

Shawna Simpson – For acting as the second reader for this thesis and providing such valued and constructive feedback. Your suggestions helped me to achieve a stronger thesis overall.

Finally, to my parents – for always being there to provide me with your ongoing support throughout my undergraduate education. Even when you had no idea what I was talking about, what ABA acronyms I was using, or why I was so excited about something called recombinative generalization, I know you were always there to guide me in my personal and professional growth.
TABLE OF CONTENTS

DEDICATION  ................................................................. ii
ABSTRACT ................................................................. iii
ACKNOWLEDGEMENTS .................................................... iv
TABLE OF CONTENTS .................................................... v
LIST OF TABLES ................................................................ vii
LIST OF FIGURES ................................................................ viii
CHAPTER 1 - INTRODUCTION ........................................... 1

CHAPTER 2 – LITERATURE REVIEW .................................. 3
  Autism and Intensive Behavioural Intervention .................. 3
  Promoting and Teaching Play Skills ............................... 4
  Language Development and Recombinative Generalization .. 6
  Matrix Training ............................................................. 8
  Summary ........................................................................ 11
  The Present Study ........................................................ 12

CHAPTER 3 - METHODOLOGY .......................................... 13
  Participant ...................................................................... 13
  Setting ........................................................................... 13
  Materials ........................................................................ 14
  Independent Variables ................................................... 14
  Dependent Measures ..................................................... 15
    Scripted Actions .......................................................... 15
    Scripted Vocalizations ............................................... 15
    Recombined Actions ................................................... 15
    Recombined Vocalizations .......................................... 16
  Experimental Design ..................................................... 16
  Procedures ...................................................................... 16
    Baseline ....................................................................... 16
    Teaching ...................................................................... 16
    Alternative Probes ...................................................... 17
    Interobserver Agreement ............................................ 18
LIST OF TABLES

Table 1. Scripted vocalization matrix ............................................................... 14
Table 2. Scripted action matrix ........................................................................ 15
Table 3. Teaching targets ................................................................................ 17
Table 4. Alternative probe targets .................................................................... 18
Table 5. Percentage of engagement for all components of concurrent matrices ................................................................................... 19
Table 6. Generalization of scripted actions and vocalizations during alternative probes ......................................................................................... 20
Table 7. Summary of generalization .................................................................. 21
LIST OF FIGURES

Figure 1. The results of matrix training for teaching and alternative probes.............23
Throughout childhood, typically developing children engage in play behaviour due to natural motivation, and they require little guidance to interact with peers and play materials (Jung & Sainato, 2013; Wolfberg, Bottema-Beutel, & DeWitt, 2012). Play is an important ability for children to develop, because it allows for opportunities to develop social and communicative skills (Lewis, 2003). However, children with autism show impaired play skills because of repetitive or stereotypic patterns in behaviour (Boutot, Guenther, & Crozier, 2005; Jung & Sainato, 2013). Schuler (2003) defined play as joint attention, action, and affect, which ultimately provides the context for communicative skills to develop. The American Psychiatric Association (2013) noted that two of the defining characteristics of autism spectrum disorder are deficits in social skills and communication. Because these behaviours naturally overlap in the context of social settings such as play, this is a commonly used context to improve the behavioural deficits exhibited by children with autism (Jung & Sainato, 2013).

Early in children’s development of language, “generative” repertoires are exhibited and emit language that has never been directly taught before (Schumaker & Sherman, 1970). Goldstein and Mousetis (1989) defined this process as recombinative generalization. Recombinative generalization describes the process in which responding to or producing novel vocalizations occurs when familiar stimuli are recombined to create new utterances that maintain precision and meaning (Goldstein & Mousetis, 1989). Language is a key component of play because both of these behaviours rely on the ability to conceptualize one thing representing another, known as symbolic representation (Lewis, 2003).

According to Goldstein & Cisar (1992) when children engage in role-playing, they learn to relate to each other through roles that coincide with a specific theme; this is called sociodramatic play. Sociodramatic play involves a child communicating or re-enacting things that are related in a thematic context within the play setting (Dauphin, Kinney, & Stromer, 2004). Sociodramatic play is absent in children with autism (Dauphin et al., 2004) and can be an important method to improve the skills of interacting among children with social deficits (Goldstein & Cisar, 1992). Currently, a limited number of studies have focused on the importance of the relationship between language and communicative skills, and sociodramatic play (Dauphin et al., 2004).

Matrix training is a commonly used approach to teach communication skills and is defined as a generative form of instruction in which target words are organized in a matrix (Axe & Sainato, 2010). Short phrases are taught and through the principle of recombinative generalization, others are evoked without the need to directly teach all of the phrases (Axe & Sainato, 2010). Matrix training has also been used to teach novel skill combinations (Axe & Sainato, 2010; MacManus, MacDonald, & Ahearn, 2015; Tanji & Noro, 2011). After some target skill combinations are taught using matrix training, other skill combinations within the matrix that were not originally taught are tested for generative learning and responding (MacManus et al., 2015). Although the existing literature demonstrates the effectiveness of matrix training to teach language components to children with developmental disabilities, more evidence is needed to demonstrate how this teaching procedure can be used to teach other social skills including play and social interaction.

The present study aimed to support and expand on current literature in a number of ways. First, the present study was designed to replicate the results of previous research that found matrix training to be an effective method of teaching language components to children with
autism. Second, this study was intended to replicate the existing research that found play skills have been taught successfully using matrix training. Third, the purpose of the present study was to determine whether matrix training could be used to teach both play skills and language skills concurrently using two matrices taught in a parallel approach to increase appropriate communication skills during sociodramatic play. Overall, the present study aimed to demonstrate that by using matrix training of two concurrent matrices for appropriate actions and vocalizations, communication and play skills could both be increased in a child with autism using a parallel approach.

This thesis provides a detailed analysis of the literature relating to autism and the associated deficits of play and language skills. Subjects to be reviewed will include intensive behavioural intervention for the treatment of autism in young children, the importance of play in childhood development and the research focusing on teaching play skills, language and the behavioural construct of recombinative generalization, and the use of matrix training to teach language generalization and play skills to children with autism. The method used for teaching communication skills during play is described. The method section includes a detailed description of the participant, as well as the design and procedure of matrix training to teach recombinative generalization of language and play skills. The results section outlines the findings of the thesis and refers to the two matrices used to teach scripted verbal statements and actions concurrently, which are presented in the appendices. Finally, a discussion and summary of the thesis is presented that gives detail about the limitations and recommendations of this thesis.
CHAPTER II – LITERATURE REVIEW

Autism and Intensive Behavioural Intervention

Autism Spectrum Disorder, more commonly known as autism, is classified by pervasive and severe deficits in communication and social skills, restricted interests, and repetitive or stereotyped behaviours (Horovitz & Matson, 2010; Matson, & Jang, 2013). While autism was once considered a rare disorder (Matson & Goldin, 2013), reported rates of autism have been increasing exponentially (Matson & Jang, 2013). Deficits in communication, social skills, and adaptive behaviour can be seen at a young age and must be treated early. Between 33-50% of children diagnosed with autism never acquire functional speech and for those who do, delays in effective communicative language are common (Horovitz & Matson, 2010). In recent years, the increase in autism rates have led to more interest in determining efficient methods of behavioural intervention for children with autism (Howlin, Magiati, & Charman, 2009).

Many forms of intervention based on psycho-education have been suggested for young children with autism (Corsello, 2005; Hayward, Eikeseth, Gale, & Morgan, 2009). While these proposed techniques vary, they share the common aspects of intensity and age during intervention (Corsello, 2005). However, few proposed techniques are supported by evidence-based research outcomes (Hayward, Eikeseth, et al., 2009). Intensive Behavioural Intervention (IBI) is an evidence based method that has been widely researched, and shows positive outcomes for treating young children with autism (Hayward, Eikeseth, et al., 2009). IBI, based on the principles of Applied Behaviour Analysis (ABA), is an intensive 1-to-1 treatment approach in which teaching is comprehensive, includes up to 40 hours per week of programming with an emphasis on discrete trial training, for an average of two years (Reichow, 2011) to target specific behaviours and skills in order to increase behavioural repertoires for children with autism (Stahmer, Ingersoll, & Carter, 2003). It is the most common and accepted choice, and is the most studied intervention model for treating children with autism (Reichow, 2011).

Many research studies have compared the effects of IBI versus other treatment methods for children with autism. In a study conducted by Smith, Groen, & Wynn (2000), 28 children diagnosed with autism spectrum disorder were randomly assigned to two experimental groups. A group of 15 children received IBI for an average of 24.5 hours each week, and another group of 13 were part of a parent-training group for 3-9 months (Smith et al., 2000). While all participants scored similarly during initial measures at intake, results of the IBI versus parent-training showed that IBI allowed for substantial development in all areas being reviewed (Smith et al., 2000). During follow-up, the IBI group showed dramatic gains in the areas of intelligence, language and visual skills, academic ability, and a decrease in undesirable behaviours (Smith et al., 2000).

Research has shown that IBI improves functioning in the domains of intellect, adaptive behaviour, and language among children with autism (Hayward, Eikeseth et al., 2009; Hayward, Gale, & Eikeseth, 2009). Because IBI focuses on basic skills and adaptive behaviour, play is often targeted during intervention as a way to improve social skills development. Van Berckelaer-Onnes (2003) found that teaching play skills to children with autism during early IBI can increase the acquisition of age-appropriate development, as well as improve social skills and peer relationships. Children with autism have been shown to respond positively to prompting, modelling, and naturalistic teaching (Jung & Sainato, 2013), which allows for positive interactions with typically developing peers (Goldstein & Cisar, 1992).
**Promoting and Teaching Play Skills**

Based on the evidence-based importance of play to childhood development, a large component of IBI is based on developing behavioural targets that can be focused on play skills in children with autism (Jung & Sainato, 2013). Within the first year of life, toy-play behaviour can be seen being exhibited by typically developing children (van Berckelaer-Onnes, 2003). However, children with autism demonstrate obvious abnormal play behaviours and difficulties in the simple manipulation of objects and toys for play (van Berckelaer-Onnes, 2003). In particular, any form of play that involves interaction, such as relational, pretend, or sociodramatic play, tends to evoke deviant behaviours (e.g., avoidance and withdrawal from interactions, rigid patterns of play, stereotypy, and self-stimulation with accessible toys) in children with autism (Wolfberg, Bottema-Beutel, & DeWitt, 2012). Children with autism can be observed engaging in restricted, stereotypic and repetitive behaviours with objects, which have broad impacts on childhood development (van Berckelaer-Onnes, 2003).

Play is an essential skill for childhood development because not only does it foster emotional and social growth, it also encourages social and linguistic understanding from a young age (Schuler, 2003). Since play is such an important behavioural skill, substantial research has been done surrounding different approaches to teaching many forms of play skills to children with autism (Jung & Sainato, 2013). In a review of the literature focusing on 26 play-based interventions, Jung and Sainato (2013) found that children with autism engage in functional play (i.e. using an object in its intended way such as pushing a toy car) similarly to typically developing children. However, the literature also demonstrates that symbolic play yields particular deficits and challenges among children with autism; symbolic play encompasses the ability to make use of an object as if it were something different (Jung & Sainato, 2013). Based on results of multiple studies, Jung and Sainato found common results suggesting that children with autism do not engage in symbolic play, which appears to be caused by or related to limited communication skills. Furthermore, studies concentrating on sociodramatic play (i.e., engaging in cooperative dramatizations and shared role-playing), were also reviewed (Jung & Sainato, 2013). The findings of this review support earlier research which suggests that children with autism do not engage in sociodramatic play, but that these skills can be taught and create positive change in their social interactions and communicative skills (Dauphin, Kinney, & Stromer, 2004; Goldstein & Cisar, 1992; Jung & Sainato, 2013).

Play skills such as functional and symbolic play are built on early item manipulation, as well as relational play (van Berckelaer-Onnes, 2003). Because children with autism do not engage in spontaneous play, these early skills must be taught as precursors to more complex forms of play (van Berckelaer-Onnes, 2003). This concept was the foundation for a study developed by van Berckelaer-Onnes (2003) in which 24 children, all diagnosed with autism, received treatment in the form of a ‘toy-play’ programme. ‘Toy-play’ behaviour is one of the primary play behaviours exhibited by typically developing children and one of the earliest opportunities to observe deficits in the behaviour of children with autism (van Berckelaer-Onnes, 2003). This behaviour involves manipulating toys and exploring their characteristics as a way to give meaning to different toy items (van Berckelaer-Onnes, 2003). Van Berckelaer-Onnes stated that this is a skill that children with autism do not demonstrate, rather object manipulation itself appears to be the function of ‘toy-play’ for children with autism. Using a training programme to allow the children to observe other functions of toys demonstrated by the trainer, this early play skill was taught to the children participating in this study. As noted by van Berckelaer-Onnes’s
outcome and follow-up measures, these ‘toy-play’ skills can be taught to children with autism as a way to encourage further play skill development and successful complex play interventions.

Involving a more complex form of play skills, sociodramatic play includes role-playing in which children are able to form relationships based on a particular theme and social activity (Goldstein & Cisar, 1992). Goldstein & Cisar (1992) defined this form of role-play as involving reciprocal roles that reflect social relationships, resulting in improving children’s interaction skills. In this pioneering experiment focusing on sociodramatic play, Goldstein & Cisar investigated how teaching scripts for sociodramatic play would affect the play skills of children with autism when interacting with typically developing children. During this study, triads were created including two typically developing children and one child with autism, who received script training for sociodramatic play scenarios with targeted behaviours outlined (Goldstein & Cisar, 1992). After completing script training, interactions and play skills of all the children were observed during free-play time (Goldstein & Cisar, 1992). Goldstein and Cisar reported that all children, including the children with autism, demonstrated improvements in theme-related interactions and social skills when interacting with peers through play. During more training sessions of subsequent related and unrelated scripts, the results were maintained and the findings provide support of systematic script training to teach sociodramatic play skills to children with autism (Goldstein & Cisar, 1992).

Play skills are one of the most critical aspects of childhood development. Without being acknowledged, the verbal and symbolic elements of play behaviour is immediately linked to the change from simple speech to symbolic, complex language development that takes place during childhood (Schuler, 2003). Research evidence has shown that interventions that incorporate or focus on play are very beneficial to children with autism in reaching developmental milestones of childhood (Schuler, 2003). Schuler (2003) suggests that typically, play-based programmes involve important aspects of pre-verbal language development such as gesturing, vocalizing, and imitation. Play and language skills are interrelated because both depend on one’s ability to interpret one thing representing another, known as symbolic representation (Lewis, 2003). In both play and language, one thing, be it a word or an object, is used to represent something and because of this shared symbolic ability, the development of language in children is very dependent on the ability to use symbolism in play; both require a certain level of complexity in terms of organization (Lewis, 2003). These skills develop co-dependently and naturally in typically developing children (Blanc, Adrien, Roux, & Barthelemy, 2005). However, children with autism do not appear to understand the social uses or meaning of speech and language, and therefore tend to engage in repetitive imitation of others’ communication rather than internalizing its meaning and using it to maintain and engage in social interactions (Schuler, 2003). This is why children with autism display high levels of routine and object-focused language, but do not demonstrate the ability to communicate their social needs or regulate interactions through conversation (Schuler, 2003).

Since play and communicative language both rely on joint attention and action, in addition to play being incompatible with repetitive language, play-based interventions provide an ideal context for children with autism to develop social communication (Schuler, 2003). However, there is an insignificant amount of research focusing on creating interventions to target play among children with autism (Wolfberg et al., 2012). Among the limited literature that does exist on promoting play skills children with autism, it has been determined that play must be targeted as an intervention on a broader scale and included in treatment programming (van
Berckelaer-Onnes, 2003). Furthermore, play is a broad area of development (Jung and Sainato, 2013). Jung and Sainato (2013) found that the current literature on teaching play skills identifies different types of play, but among the research there are inconsistencies on categorizing play skills. While it is widely accepted that there are important correlations between play and language development among children, these two areas of development during childhood are not often incorporated as interventions for children with autism. Lewis (2003) found that unexpectedly few play skills interventions actually focus on the relationship between building language skills concurrently with play skills in children with autism.

**Language Development and Recombinative Generalization**

Perhaps the most important and unique element of language in humans is the ability to respond to or produce statements that have never been heard or stated before (Kohler & Malott, 2014). Most research and theories surrounding language skills in children have agreed that early on in a child’s development of language, they begin to exhibit generative language skills (Schumaker & Sherman, 1970). This generative language is language that has not been directly demonstrated or taught to children (Schumaker & Sherman, 1970). However, this type of language generalization is not a skill that children with autism appear to naturally exhibit. Children with autism do not use language to maintain or initiate communicative interactions, which means that speech does not generalize across communicative partners or settings (Schuler, 2003). Because of these deficits, language skills among children with autism remain fragmented and do not function as social skills; vocalizations tend to be non-communicative and more focused on self-stimulatory intent (Schuler, 2003). One of the main challenges faced in eliciting language skills in children with autism is determining how to balance the need to teach structured and explicit instructions, and at the same time teach generalization and spontaneous language use (Schuler, 2003).

Extensive research has been completed focusing on teaching basic language skills to children with learning challenges. In one early study, Schumaker and Sherman (1970), focused on the use of imitation and reinforcement to teach children with developmental disabilities past and present tenses of verbs, commonly used in making verbal requests. During training sessions, three children with developmental disabilities were trained to verbalize both past and present tenses of commonly used verbs (Schumaker & Sherman, 1970). One verb’s tenses were taught in each training session and following training, a probe session focused on generalization of these taught verb tenses to novel, untrained verbs (Schumaker & Sherman, 1970). After training, results showed that all three children learned to correctly verbalize past and present tenses of both the trained and untrained verb forms (Schumaker & Sherman, 1970). Based on the findings of Schumaker and Sherman, it was suggested that children with language deficits, such as those with developmental disabilities or autism, can be taught to use verbs in proper tenses in a variety of forms and that this skill can be generalized. Generalization was an important finding in this study because it suggests that when some targets are taught, generalization of language skills will occur (Schumaker & Sherman, 1970). Essentially, after the learner is taught a language rule using a limited number of exemplars, there is a greater likelihood that the taught rule will be seen to be generalized to other novel stimuli. This ability, to express redistribution of learned language skills and understand novel utterances, is known as recombinative generalization (Goldstein, 1983).
The basic principles of recombinative generalization have been researched for more than 80 years, (Suchowierska, 2006). In some of the most well known literature focused on this principle in language development, Goldstein (1983) defines recombinative generalization as “differential responding to novel combinations of stimulus components that have been included previously in other stimulus contexts” (p. 281). Early research on the principles of recombinative generalization focused on miniature linguistic systems, and how simple word stimuli could be arranged to include all potential combinations of complex stimulus taught and acquired through generalization (Suchowierska, 2006). Literature has found that matrix training incorporating recombinative generalization can be used to teach individuals to produce spontaneous functional speech (Suchowierska, 2006).

Goldstein (1983), focused on conditions of the environment that promote generative language to develop, more specifically how a miniature linguistic system, or matrix, can be used to establish concrete recombinative generalization. In the context of recombinative generalization and teaching using a miniature linguistic system, components of targeted stimuli are associated with a particular verbal response (Goldstein, 1983). Through this type of teaching, individuals with language impairments and deficits are able to learn language rules, such as word order, using parts of speech including morphemes, words, and sentences (Goldstein, 1983). The most common research on miniature linguistic systems encompassed the development of recombined word combinations that include a subject and action (Goldstein, 1983), or put simply, common statements that involve a noun and verb. Literature on language development and reading skills has found that children learn word naming as an early stage of reading through the breakdown of words into syllables and phonemes (Mueller, Olmi, & Saunders, 2000). Using the principles of miniature linguistic systems and recombinative generalization identified by Goldstein, children can be trained to produce novel word identification. Based on this form of generalization, the foundations of word identification, seeing a printed word and saying it, allow for new words to be acquired and named easily, when letters and sounds that were previously learned create new combinations (Mueller et al., 2000).

In more advanced research on recombinative generalization and language development, this process has been demonstrated for within-syllable units in young children prior to being able to read (Mueller et al., 2000). In this study, five children in kindergarten, identified by their teachers as having lower than expected reading ability, participated to test whether miniature linguistic systems would result in more word-naming being acquired (Mueller et al., 2000). Three participants received training of word sets using matching-to-sample, while two children representing a control group, received no training (Mueller et al., 2000). Six sets of four words that shared common letters or sounds were taught during matching-to-sample sessions. After training, all five children were tested to determine if recombinative generalization of the trained components would elicit novel words (Mueller et al., 2000). Mueller et al. (2000) found that after one training session, two of the children who were taught using matching-to-sample demonstrated novel words due to recombinative generalization and the third child displayed the same gains in word naming after two training sessions. Mueller et al. also noted that the two children who received no training demonstrated low to zero accuracy across all of the six sets tested for generalization. The findings of this study supported the literature regarding recombinative generalization and how this process allows for language development to occur in an exponential way (Mueller et al., 2000). The principles of recombinative generalization can be expanded further from common sounds and syllables to whole, discrete words that allows for more advanced and complex generalization to occur (Mueller et al., 2000).
Recombinative generalization is a critical component in the development of functional speech and language (Goldstein & Mousetis, 1989). Language skills develop and grow rapidly due to the ability for an individual to generalize previously learned language components to new combinations of words and communications. In the recombinative generalization literature to date, there is a gap in the research that incorporates recombinative generalization into procedures that use stimulus equivalency (Mueller et al., 2000). In addition, there is a need for further research to establish a functional relationship between generative language development and differential reinforcement (Schumaker & Sherman, 1970). Matrix training encompasses all of the aspects of recombinative generalization (Mueller et al., 2000) and should be examined further to determine its effectiveness for broader areas of learning.

**Matrix Training**

Matrix training is defined as an approach to teaching in where a number of target combinations are taught, while other combinations that share stimulus components are intentionally not taught (MacManus, MacDonald, & Ahearn, 2015). Focusing on language development, matrix training involves arranging words into a grid, or matrix that allow combinations of words to form phrases (Axe & Sainato, 2010). During teaching, some phrases made up of words in the matrix are taught, while others are often seen to appear with no teaching (Axe & Sainato, 2010). A simple example of a teaching matrix could include two stimuli (objects) being arranged on one axis and two stimuli (colours) arranged on the opposite axis. In this simple matrix, four combinations of a colour and object would exist. Through matrix training, if two of these colour-object combinations were taught, the other two combinations would likely appear without teaching. Specifically, if an individual were taught to label or tact the “green car” and the “red bike”, the principles of recombinative generalization would suggest the emergence of the other combinations in the matrix, including “red car” and “green bike”. 

In some of the first research on the process of language generalization, matrix training was used to demonstrate how novel responding could be created (Goldstein & Mousetis, 1989). This milestone research by Goldstein and Mousetis (1989) involved teaching six children with developmental disabilities and deficits in functional language how to engage in two- or three-word vocalizations using matrix training and the process of recombinative generalization. Using known words, all six children generalized the use of these words and other unknown words after matrix training. Based on baseline levels for each child, two- or three- dimensional matrices were created for each child to be trained with (Goldstein & Mousetis, 1989). A multiple baseline across submatrices design was used in this study, allowing the researchers to determine that generalization of the responses was under experimental control (Goldstein & Mousetis, 1989). Through the use of expressive modelling of four to five responses within each matrix, recombinative generalization occurred and 95% of the children’s learning resulted from untrained generalization (Goldstein & Mousetis, 1989). As one of the first experimental studies examining the efficiency of teaching language to children with disabilities, this study provides evidence of the effectiveness of matrix training with observational learning to teach these skills to children with language skill deficits. As a result, matrix training has been explored further to determine its efficiency in teaching generalized learning of other skills to children with behaviour and skill deficits, such as children with autism.

In a study focusing on two-word utterances, matrix training was used to teach both expressive and receptive language to children with autism (Naoi, Yokoyama, & Yamamoto,
Receptive language refers to the ability to understand language, either in the form of vocal speech or written text, and expressive language refers to the ability to turn comprehension into functional language (Prelock, Hutchins, & Gascoe, 2008). Descriptive language, such as adjective-object utterances, is often impaired in children with autism (Naoi et al., 2006). Using matrix training of receptive and expressive responses, three children diagnosed with autism were taught two-word utterances (Naoi et al., 2006). Prior to the matrix training, all three participants in this multiple baseline across participants research design, exhibited no more than one-word responses (Naoi et al., 2006). During this study, the three children were taught three out of nine possible responses in a matrix, both expressively and receptively (Naoi et al., 2006). The results of this experiment demonstrated that due to recombinative generalization, all three low-functioning children with autism displayed generalization of the adjective-object combinations, including the six untrained combinations in the teaching matrix (Naoi et al., 2006). The findings of Naoi et al. (2006) support previous research on the effectiveness of matrix training to teach generalization to children with autism and provide further evidence in support of this approach for teaching a variety of language skills.

Evidence has demonstrated that matrix training is an efficient method of teaching basic language skills to children with autism (Goldstein & Mousetis, 1989). According to Axe (2009), the literature on matrix training procedures to teach generalization of skills including language and play to children with autism, has found this technique to be highly efficient. Based on the effectiveness of matrix training to teach these basic language skills, Axe and Sainato (2010) focused on expanding the literature to determine if this teaching approach would be successful in teaching children with autism pre-literacy skills such as instruction following. Axe and Sainato conducted an experiment to teach preliteracy skills in the form of following instructions, to four preschool aged children with autism. Using matrix training, action-picture combinations, i.e. underline the dog, circle the flower) were organized in a two-dimensional matrix consisting of six objects in one axis and six actions in the opposite axis (Axe & Sainato, 2010). Training along the matrix diagonal occurred through the use of least-to-most prompting, and after teaching, the untrained combinations were probed to test for generalization of the skills among all four children (Axe & Sainato, 2010). This study employed a multiple probe across behaviours design and training was completed once or twice per day, for approximately 10-minute intervals, five days per week (Axe & Sainato, 2010). While not all of the children progressed through the training at the same speed, the results showed that three of the four children with autism were able to perform both the trained and untrained object-action instructions by the end of the study (Axe & Sainato, 2010). The findings of this study suggest that matrix training is an effective method to teach both skills in language and literacy to children with autism (Axe & Sainato, 2010).

Researchers in Japan noted that the literature on matrix training for teaching language skills to children with autism focused primarily on generalized identification of items and words, and that this technique had not been evaluated for teaching the language component of spelling (Tanji & Noro, 2011). In this study of matrix training, taking place in Japan, two children with autism were taught generative spelling skills in Japanese, where in many Japanese words are composed of two-syllable character units (Tanji & Noro, 2011). Within-syllable units of Japanese words were arranged in a two-dimensional matrix with three syllable character units along each axis (Tanji & Noro, 2011). Matrix training was completed using Constructed-Response Matching to Sample. In this form of teaching, spoken syllables were used as sample stimuli with written syllables as stimuli for comparison (Tanji & Noro, 2011). Based on the
matching to sample and matrix training, with slight differences in the number of training sessions, both children with autism learned generative spelling of both the trained and untrained syllable characters within the matrices (Tanji & Noro, 2011). Spelling skills of both children corresponded to the words dictated after matrix training was completed, and provided further evidence to support the effectiveness of matrix training to teach many forms of language skills and generalization to children with autism (Tanji & Noro, 2011).

Since children with autism exhibit deficits in play skills as well as language skills, and these skills are so closely related in childhood development (Blanc, Adrien, Roux, & Barthelemy, 2005), the principles of matrix training and recombinative generalization have been applied to teaching play skills to children with autism in a number of cases. According to Dauphin, Kinney, & Stromer (2004), studies on matrix training suggest that the principle of recombinative generalization could be efficient in achieving generative play skills for children who demonstrate deficits in play. Generative play is described as repertoires of play behaviour that go further than the play skills targeted during direct teaching in play programs and are contextually appropriate during play (Dauphin et al., 2004). According to Goldstein and Mousetis (1989), matrix training and its applications, including observational learning of objects, enable learners to develop more complex forms of responding to novel conditions such as performances. Matrix training can be easily transferred for use in teaching play skills because such a large component of play is social communication skills and functional language (Dauphin et al., 2004). MacManus et al. (2015) found that much of the literature on the play skills of children with autism found play to be very stereotypic and of short duration. Because children with autism engage in so much stereotypic behaviour during play, generalized play skills are a very important target for teaching (Blanc et al., 2005). This suggests that matrix training and its foundation in recombinative generalization would be effective to teach a variety of play skills to children with autism.

Sociodramatic play is a form of play that can be observed in typically developing preschool aged children, but that appears to be absent in children with autism (Dauphin et al., 2004). Sociodramatic play involves an individual engaging in verbalizations and actions that are related to a specific theme and can be identified as distinct from other things that are unrelated to the theme of a play activity (Dauphin et al., 2004). In this case study, Dauphin et al. (2004) focused on applying the technique of matrix training, partnered with video modelling, to teaching sociodramatic play skills to a child with autism. Focusing on sociodramatic play scenes, three characters and three actions were arranged in a two-dimensional matrix and used in collaboration with video modelling to teach three of the target activities (Dauphin et al., 2004). Three or four home visits were made each week, at which time the three-year-old boy received teaching using the video modelling and matrix training package (Dauphin et al., 2004). Each combination of sociodramatic play skills in the matrix involved a verbal component and an action component (Dauphin et al., 2004). The experiment demonstrated that the participant learned generative sociodramatic play skills after matrix training and video modelling (Dauphin et al., 2004). The data showed that 21 of the 28 novel verbal components were learned accurately and four of the six action components were also learned correctly (Dauphin et al., 2004). The findings of this study provided evidence to support the earlier work of Goldstein and Mousetis (1989) on the effectiveness of matrix training and teaching social play and communicative skills (Dauphin et al., 2004).

Pretend play is an early form of complex play to materialize in typically developing children (MacManus et al., 2015). As early as 18 months, children begin to engage in this play,
and as they reach preschool age, pretend play becomes more elaborate and leads to other forms of complex play (MacManus et al., 2015). It is widely accepted that pretend play skills are inhibited in children with autism and that these children fail to use toys or other play materials in a symbolic ways to engage in social communication and play interactions (MacManus et al., 2015). Upon reviewing previous research in pretend play skills of children with autism, MacManus et al. (2015), found that video modelling is a widely used approach to teach these skills. However, it was also noted that these pretend play skills do not easily or often generalize to new settings or materials, and novelty of these skills is absent (MacManus et al., 2015).

Building on research of more advanced play skills, such as sociodramatic play, completed by Dauphin et al. (2004), an experimental study was completed to provide further evidence that matrix training and video modelling can be used in conjunction to teach pretend play skills to children with autism (MacManus et al., 2015). This study involved teaching three preschool aged boys diagnosed with autism to play with three play sets and engage in 40 actions and 30 vocalizations during sociodramatic play (MacManus et al., 2015). Matrix training was utilized to ensure generalization of pretend play skills to multiple scenarios and play sets (MacManus et al., 2015). A three-dimensional matrix was created for vocalizations, actions, and play sets, and probe data was collected prior to teaching to determine whether the three children engaged in appropriate play skills when presented with the play materials (MacManus et al., 2015). Results of this study provided evidence that using video modelling to complete matrix training, enabled all three children to learn the taught and not directly taught vocalizations and actions associated with each of the three play sets. Novel play skills not observed during baseline probes were evoked by the video modelling and matrix training and were observed in all three children during follow-up probes (MacManus et al., 2015).

While matrix training has proven to be an effective method of teaching language skills to children with autism, it has been examined primarily for following instructions, reading skills, and labelling (Axe & Sainato, 2010). Axe and Sainato (2010) suggested that matrix training could be evaluated for other components of language such as requesting or manding, and repertoires of conversation skills (Axe & Sainato, 2010). The literature of matrix training requires further evaluation of teaching programmes and fine-tuning the approaches used to teach children with autism using matrix training (Axe & Sainato, 2010). While matrix training has been evaluated for teaching children with autism, there is little research to support this method to teach individuals with developmental disabilities, which should be examined further (Tanji & Noro, 2011). MacManus et al. (2015) found that the use of matrix training has proven to be very effective to teach children with autism language and play skills, but in previous research, this procedure was often paired with video modelling. Further research should be conducted to determine if matrix training is effective when used independently, to teach children with autism language and play skills (MacManus et al., 2015).

**Summary**

It is a widely accepted fact that human beings are socially driven (Tsao, 2008). From infancy, humans are drawn to other people; they turn when they hear voices, gaze at one another, make physically contact, and smile (Tsao, 2008). However, children with autism do not engage in these social behaviours that typically developing people engage in as if by reflex (Tsao, 2008). Autism is a pervasive developmental disorder and causes individuals to face severe impairments and deficits in social behaviours such as interacting and communicating (Hayward, Eikeseth,
Once thought of as a rare disorder, autism has become more common in recent years (Matson & Goldin, 2014). In the United States, 1 in every 68 children is diagnosed with autism, and the prevalence rates are similar in Canada (Elsabbagh et al., 2012). It is well established that the best outcomes for teaching young children with autism adaptive behaviours, social interaction, and communication skills result from Intensive Behavioural Intervention (Hayward et al., 2009).

Intensive Behavioural Intervention improves communication, cognitive, and social skills in children with autism, while decreasing autistic behaviours and symptoms (Howlin, Magiati, & Charman, 2009). Since language and play skills are both deficits exhibited by children with autism, IBI incorporates both of these socially driven skills into teaching and intervention (Matson & Goldin, 2014). Language and play in children are closely related because of their shared dependence on organization and symbolic representation (Lewis, 2003). The principle of recombinative generalization describes the process of learning novel stimuli from recombining previously established stimuli (Goldstein, 1983). Matrix training is a teaching method that incorporates all of the processes of recombinative generalization (Goldstein, 1983; Goldstein & Mousetis, 1989; Mueller, et al., 2000). This approach has been established as an effective way to teach both language skills and play skills to children with autism and ensure that these skills generalize to novel environments and social interactions (Goldstein & Mousetis, 1989; MacManus, MacDonald, & Ahearn, 2015). However, most studies on play and language skills of children with autism have not examined the kinds of generative repertoires involved in sociodramatic play (Dauphin, Kinney, & Stromer, 2004). Therefore, more research on teaching generative play and social communication using matrix training is necessary (Dauphin et al., 2004).

**The Present Study**

The present study aimed to establish further evidence to support the existing literature on matrix training to teach sociodramatic play skills and language skills to children with autism in three ways. First, the present study was designed to replicate results of previous research that determined matrix training to be effective in teaching language components to children with autism. Second, this study aimed to replicate previous research that found play skills have also been taught successfully with matrix training. Finally, the main purpose of the present study was to determine whether matrix training could be used to teach both play skills and language skills concurrently, to a child with autism, as an effective way to increase appropriate communication during sociodramatic play.
CHAPTER III – METHODOLOGY

Participant

The participant selected for this study was a child diagnosed with autism spectrum disorder. Rory was 6 years, 3 months old at the time the study commenced. The participant was enrolled in an Intensive Behavioural Intervention (IBI) programme in a clinical setting. He attended IBI 5 days per week for 6 hours each day at Surrey Place Centre. At the beginning of the study, the participant had been in treatment for 11 months. Rory is evaluated every six months using the Assessment of Basic Language and Learning Skills-Revised (ABLLS-R; Partington, 2006), as per standard evaluation in the IBI clinical setting. At the time of the study, Rory was about to be evaluated on his progress during treatment based on the Ontario IBI programme Benchmark process (Blacklock & Perry, 2010). Testing was soon to be completed to determine if Rory had achieved Level 3 of the benchmark process.

Rory communicated verbally with adults and peers primarily using 3-6 word phrases with the purpose of requesting desired objects and activities. Rory did not exhibit skill in functional play with toys prior to the study. The participant was selected based on the requirement that he acquire play skills and appropriate communication to achieve success in his next level of testing for further IBI treatment. Furthermore, these skills were determined to be critical for Rory’s cognitive and social development.

Some suspected barriers to Rory’s ability to develop play skills did exist prior to the implementation of this study Rory displayed some stereotypic behaviours and often engaged in self-stimulatory behaviour when he had access to toys such as those used in this research study. This posed a potential barrier to Rory’s ability to develop play skills because he regularly used toys for this self-stimulatory behaviour rather than for their intended play use. In addition, when Rory was required to engage in an activity that was aversive to him and disrupt his ability to engage in self-stimulation with toys, he would sometime display aggressive behaviours towards anyone in his immediate access. Instructor therapists working with Rory ignored these challenging behaviours and used high probability behaviours to build behavioural momentum and ensure Rory completed the task or activity given to him in a previous direction.

After the Research Ethics Board at St. Lawrence College approved this thesis study, a consent form was given to Rory’s parents to review and provide consent for his participation in the study (Appendix A). This consent was signed in addition to the agency’s standard consent for Rory to participate in any programming during his IBI treatment. Rory’s parents signed the college’s consent form on October 30, 2015.

Setting

All sessions of this study were conducted in the clinical classrooms where IBI programming and teaching occurred at Surrey Place. Two classrooms within the clinic were used regularly for Rory’s programming and included individual work areas for each child in treatment. An area indicated by cubical dividers, referred to, as the participant’s “cubby,” was the main setting where teaching occurred. However, depending on where the participant’s programming was being completed and where reinforcement was being provided in the classrooms, other areas within the two IBI classrooms were also used for the study. During each
teaching session, a classroom table and chairs were used, and play materials were stored in a bin on a shelf in the participant’s cubby.

**Materials**

The materials used were three play sets arranged by the researcher prior to the study. The three play sets were made up of items already available in the play area of the classrooms or purchased specifically for use in the study. Each play set included a character and 1-2 objects to be used in conjunction with the character. The mealtime set included a plastic dog, small plastic bowl, and child spoon; the nursery set included a plastic baby, wooden and cloth bed, and a small felt blanket; and the dancing set included a plastic Thomas the Tank Engine train, and a plastic snare drum with drumsticks attached with a string.

The materials used regularly by the therapist during program implementation were also used in this study. These materials included the participant’s clipboard with data recording sheets and a pen to be used by the instructor therapist.

**Independent Variables**

The scripted actions and vocalizations were each arranged in a two-dimensional matrix and represented the independent variables. Teaching for all three play sets using matrix training was based on the research of Axe and Sainato (2010), and Dauphin, Kinney, and Stromer (2004). The matrices for scripted actions and concurrent scripted vocalizations describe the teaching targets and the untaught recombinations of the materials to be probed for generalization (Tables 1 & 2). On the left hand column of the 2D matrices, the characters for each teaching target were indicated. The first row of the matrices indicated the scripted vocalizations and actions respectively.

**Table 1. Scripted vocalization matrix.**

<table>
<thead>
<tr>
<th>Saying</th>
<th>Materials</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>EATING</td>
<td>SLEEPING</td>
</tr>
<tr>
<td>DOG</td>
<td>PROBE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BABY</td>
<td>PROBE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>THOMAS (train)</td>
<td>PROBE</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 2. *Scripted action matrix.*

<table>
<thead>
<tr>
<th>Doing</th>
<th>Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>EATING (spoon &amp; bowl)</td>
</tr>
<tr>
<td></td>
<td>SLEEPING (bed &amp; blanket)</td>
</tr>
<tr>
<td></td>
<td>DANCING (drums &amp; sticks)</td>
</tr>
<tr>
<td>DOG</td>
<td>PROBE</td>
</tr>
<tr>
<td>BABY</td>
<td>PROBE</td>
</tr>
<tr>
<td>THOMAS (train)</td>
<td>PROBE</td>
</tr>
</tbody>
</table>

**Dependent Measures**

Probe data were collected on the first trial during each baseline and teaching session for both scripted actions and scripted vocalizations. Probe data were collected for recombined actions and vocalizations on the first trial during alternative probe sessions. Session length was variable based on the length of time required for the participant to engage in each teaching target. Data were collected for the occurrence of scripted actions and scripted vocalizations during teaching sessions. Data were collected for recombined actions and recombined scripts during alternative probe sessions.

*Scripted Actions.* Scripted actions were defined as actions matching or similar to those taught during the teaching session, such as the participant copying the movements and directions in which the teacher moves a character or object. For example, the participant moving the Thomas the Tank Engine train forward and backwards while playing the drum would be considered similar to the model of moving the train up and down, and would be considered a correct scripted action. However, using the train to play the drum would not be considered to match or be similar to the modelled action and will not be marked as a correct trial.

*Scripted Vocalizations.* Scripted vocalizations were defined as vocal phrases matching the statement taught during the teaching session; phrases similar to the taught phrase were also scored, such as if the participant stated “Dog, eat the food” instead of “Eat the food dog”. If the participant drops an article of speech in the scripted vocalization, for example, “eat food dog”, the response would be considered correct and marked as an accurate trial in the session. However, if an article of speech is added to the statement, for example, “eat the food the dog”, the response will not be considered correct and an inaccurate response will be marked for the trial.

*Recombined Actions.* Recombined actions were defined as actions in which the participant used the available character as a substitute to complete the action with the objects that had been taught during a teaching session, such as making the dog character dance around with the drum and drumsticks.
Recombined Vocalizations. Recombined vocalizations were defined as vocal phrases in which the participant used the appropriate character name as a substitute to complete a logical script for the actions being completed with the play set, such as stating “The dog is dancing” when engaging in the correct recombined action using the dog character and the drum and drumsticks.

Experimental Design

A multiple probe design across scripted actions and vocalizations was used to evaluate the effectiveness of concurrent matrix training on the dependent measures. According to a review of literature on teaching play skills to children with autism, a multiple probe design is the most commonly used design for matrix training procedures (Jung & Sainato, 2013). In the multiple probe design, baseline measures of the participant’s correct engagement with each play set were taken prior to teaching taking place. Alternative probes were conducted using the combinations of characters, actions, and vocalizations that were not taught along the matrix diagonal. For example, during the first alternative probe the participant will be given the Thomas the Tank Engine toy and the nursery items.

Procedures

Baseline. During the baseline sessions, each play set was presented to the participant on a variable schedule during one of the three teaching sessions each day in the IBI clinic. The conditions and instructions given by the instructor therapist were identical during baseline and teaching sessions. During baseline sessions, one trial involved the presentation of one play set to the participant and the instruction “play with it” being given by the instructor therapist. Prior to the presentation of the play sets, the instructor therapist modelled the scripted action and vocalization for the particular play set. Following the participant’s response to the presentation of the play set, a “plus” or “minus” score was recorded for both appropriate vocalizations and appropriate actions (Appendix B). During baseline sessions, therapists delivering the instructions and recording the participant’s responses did not provide any form of feedback, as probe data was being used to determine if the participant engaged in any components of correct play skills prior to intervention. Three baseline sessions were conducted for the purpose of determining whether any functional play and communication skills were exhibited prior to teaching.

Throughout all phases of the intervention, implementation was completed by the four instructor therapists who regularly worked with the participant in the IBI setting. Prior to the study beginning, the instructor therapists were trained on the proper implementation of all components and phases of the intervention. Instructions were also made readily accessible and included on the data sheets used to record results during each phase.

Teaching. Probes were conducted at the onset of each teaching session. The procedure was identical to that used during baseline. Sessions were conducted 1 time per day during one of three teaching sessions in the IBI clinic. All three play sets were taught during the same session to ensure completion of all three targets each day. For each play set, one teaching trial of the concurrent vocalization and action matrices occurred during each session. During the three-trial concurrent teaching session of both matrices, the instructor therapist provided teaching for the initial teaching targets (identified as T1) along the matrix diagonal (Table 3). The participant
received teaching for the first three targets until mastery was considered met (Appendix C). Mastery requirements were 100% for both the scripted action and its concurrent scripted vocalization over three consecutive sessions, or three days. Probe data was collected for all of the initial targets until all three concurrent actions and vocalizations were mastered.

Table 3. Teaching targets.

<table>
<thead>
<tr>
<th></th>
<th>EATING</th>
<th>SLEEPING</th>
<th>DANCING</th>
</tr>
</thead>
<tbody>
<tr>
<td>Saying/ Doing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DOG</td>
<td>T^1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BABY</td>
<td>T^1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>THOMAS (train)</td>
<td></td>
<td></td>
<td>T^1</td>
</tr>
</tbody>
</table>

During each teaching session, the instructor therapist began by modelling the scripted action and vocalization for the particular play set. During teaching sessions, the order in which the trials were conducted was variable to ensure generalization and that the participant did not learn the scripted actions and vocalizations dependent on presentation order. After modelling the target, the instructor therapist allowed for a 3-second time-delay before presentation of the materials. The instructor therapist then presented the materials on the table in front of the child and gave the instruction “play with it”. If the participant engaged in scripted vocalizations and scripted actions during the trial’s probe, socially mediated reinforcement was delivered and a “plus” symbol was recorded for each matrix cell that was completed. Socially mediated reinforcement included verbal praise and intermittently included giving a ‘high five’ to the participant. If the participant did not engage in either the scripted action or scripted vocalization during the trial’s probe, a “minus” symbol was recorded for the corresponding matrix cell. If the child exhibited an incorrect response such as unscripted vocalizations or unscripted actions, physical and verbal prompting was used to teach the target to independence within the session. Both physical and verbal prompting was used concurrently in a most-to-least fading procedure to teach the correct scripted actions and vocalizations during the teaching sessions. The most-to-least prompt hierarchy used was standard procedure in the IBI setting and was common practise among all instructor therapists in the classroom settings. A description of the prompt hierarchy could be found on each child’s data sheet clipboard used throughout the day while implementing IBI programming.

Alternative Probes. Alternative probes were conducted after mastery of the initial teaching targets was achieved. The alternative probes sessions utilized an identical procedure to the baseline and teaching sessions. During the alternative probes, recombined actions and recombined vocalizations were scored using a “plus” or “minus” symbol in the corresponding untaught matrix cell. The alternative probes were identical to teaching probes except that the participant was required to complete the action for the objects from the play set with a substitute
character (Table 4). Three-trial sessions allowed to probe a recombined action and vocalization for each play set in the first alternative targets (identified as T\(^2\)). After mastery of the first alternative targets were achieved, the second alternative targets were probed (identified as T\(^3\)). The alternative probes ensured that recombination of the action and vocalization scripts were generalized by the participant for all of the play sets. If an alternative target was not displayed during the probe trial, the teaching procedure was implemented during the session to increase the action and vocalization response to an independent level.

Table 4. *Alternative probe targets.*

<table>
<thead>
<tr>
<th>Saying/Doing</th>
<th>EATING</th>
<th>SLEEPING</th>
<th>DANCING</th>
</tr>
</thead>
<tbody>
<tr>
<td>DOG</td>
<td></td>
<td>T(^3)</td>
<td>T(^2)</td>
</tr>
<tr>
<td>BABY</td>
<td></td>
<td>T(^2)</td>
<td>T(^3)</td>
</tr>
<tr>
<td>THOMAS (train)</td>
<td></td>
<td>T(^3)</td>
<td>T(^2)</td>
</tr>
</tbody>
</table>

*Interobserver Agreement*

Sessions were observed by a second instructor therapist or student in the clinical classroom, for purposes of interobserver agreement (IOA). Interobserver agreement was collected during teaching probe and alternative probe sessions. The observer scored scripted vocalizations and scripted actions during teaching probe sessions, as well as recombined actions and recombined vocalizations during alternative probe sessions.

Trial-by-trial IOA was used to measure the occurrence or non-occurrence of the actions and vocalizations during both teaching and alternative probe sessions. Trial-by-trial IOA is used to calculate agreement for behaviours in which the outcome of each trial can be scored only as 0 or 1 (Cooper, Heron, & Heward, 2007). IOA was calculated by dividing the number of trials with agreement by the total number of trials and multiplying by 100.
CHAPTER IV – RESULTS

Baseline

The participant made no correct responses during the baseline probes. Baseline probes were conducted once daily for three days before the teaching procedure began. Rory scored 0.00% on all three concurrent matrix combinations during baseline probes (Appendix D).

While Rory frequently engaged in single components of both the ‘Dog eating’ and ‘Baby sleeping’ matrices, none of the three concurrent matrix baseline combinations were exhibited during initial probes. For the scripted action and vocalization combinations for ‘Dog eating’ and ‘Baby sleeping’ Rory engaged in a single component, either the scripted vocalization or the action, 33.33% of the possible trials (Table 5). However, because the goal of the study was to achieve both scripted actions and vocalizations for appropriate play concurrently, these single components were scored as 0.00% during all probes.

Table 5. Percentage of engagement for all components of concurrent matrices.

<table>
<thead>
<tr>
<th>Day</th>
<th>Dog eating</th>
<th>Baby sleeping</th>
<th>Thomas dancing</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>-</td>
<td>+</td>
<td>0.00%</td>
</tr>
<tr>
<td>2</td>
<td>+</td>
<td>-</td>
<td>0.00%</td>
</tr>
<tr>
<td>3</td>
<td>-</td>
<td>-</td>
<td>0.00%</td>
</tr>
</tbody>
</table>

Teaching and Generalization

During teaching, training began on the same concurrent matrix combinations that were probed during baseline for scripted vocalizations and actions (refer to Table 3). The same probe data were collected during teaching as was used during baseline, in which both the scripted action and vocalization components of the concurrent matrix cells needed to be exhibited to be scored as 100.00%. After three sessions of teaching, Rory reached mastery of 100.00% for both the scripted vocalization and action components of the ‘Dog eating’ concurrent matrices (Figure 1). Rory reached mastery of the ‘Thomas dancing’ concurrent matrices for scripted actions and vocalizations after four sessions of teaching. These two targets were probed for maintenance during all sessions until the third teaching target, ‘Baby sleeping’, reached mastery after 12 days of teaching. The number of trials that Rory exhibited both components of the concurrent matrices during teaching averaged 82.05% (Appendix E).

Stability was calculated for the data collected during the teaching phase based on the calculation of stability defined by Gast and Ledford (2014). According to this calculation procedure, 80% to 90% of the target data points should fall within 25% of the median level; during training 82.05% of the combinations were exhibited. Based on the calculation for stability (Appendix E), none of the data points fell within the 25% range of the median and did not show
stability. However, this was due to probe data being collected and the non-continuous form of data collection.

The Trendline function of Microsoft Excel was used to calculate the trend lines for all three teaching targets. As the baseline data were consistently 0.00% for correct responding, there was a zero trend for the baseline phase. However, during the teaching sessions data showed an increasing trend (Appendix F).

After the initial three targets were mastered, alternative combinations were probed to test for generalization of both the scripted action and vocalization components of the appropriate play skills targets. During the alternative probes, Rory exhibited correct responding for 13 of the 18 trials (72.22%) for all six alternative action/vocalization combinations in the matrices (Appendix G). Rory demonstrated generalization of both the scripted action and vocalization for the first three alternate combinations during three sessions when these combinations were probed, as well as correct responding for one of the three alternative combinations that were probed lastly (Table 6).

Table 6. Generalization of scripted actions and vocalizations during alternative probes.

<table>
<thead>
<tr>
<th></th>
<th>Eating</th>
<th>Sleeping</th>
<th>Dancing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dog</td>
<td>T²</td>
<td>T² (Mastered)</td>
<td></td>
</tr>
<tr>
<td>Baby</td>
<td>T² (Mastered)</td>
<td>T³ (Mastered)</td>
<td></td>
</tr>
<tr>
<td>Thomas</td>
<td>T³</td>
<td>T² (Mastered)</td>
<td></td>
</tr>
</tbody>
</table>

The percentage of data points exceeding the median (PEM) was calculated for all subsequent phases after baseline using the formula outlined by Ma (2006). The PEM was calculated to be 78.95% for all data points during teaching, alternative, and maintenance probes (Appendix G). According to the guidelines for determining effectiveness outlined by Scruggs and Mastropieri (1998), a PEM score between 70.00% and 90.00% is considered effective. Therefore the above PEM score shown above suggests that the use of concurrent matrices for scripted actions and vocalizations was effective to teach Rory appropriate play skills.

**Maintenance**

During the maintenance probes, Rory responded correctly to all three (100.00%) of the combinations from the concurrent matrices (Appendix G). The maintenance probe was conducted after all six untrained combinations of the scripted actions and vocalizations had been probed for three trials each. The maintenance probe was conducted after a two-week period in which the participant was absent from the clinical setting due to illness.

**Follow-up**

While no formal follow-up was conducted due to time constraints, instruction therapists did note that while in the IBI classroom setting, spontaneous play was initiated by the participant multiple times after the intervention was completed. Instructor therapists reported that the participant would locate the play materials used during intervention and begin to arrange the
materials appropriately on his desk in his cubby and verbally request his instructor therapist to play with the materials with him. Instructor therapists reported that at these spontaneous initiations of play, the participant regularly engaged in appropriate vocalizations and actions across all combinations of the taught and untaught matrix pairings.

**Interobserver Agreement**

According to Cooper, Heron, and Heward (2007), the current guidelines for behavioural analytic research outline that data on interobserver agreement (IOA) should be obtained for a minimum of 20% of sessions. The frequency of IOA data collection will be dependent on a number of factors such as the experience of and number of observers collecting data, the number of phases and conditions during a study, and other circumstances that are outside of the researcher’s control (Cooper et al., 2007). In behaviour analytic research, the suggested mean level of agreement between observers should be no less than 80% for a new variable, but at least 90% for a previously established measure (Cooper et al., 2007).

In the present study, IOA was obtained for 15 of the 63 trials (24.10%) conducted, or five of the 22 sessions that the study encompassed. The two independent observers simultaneously observed and recorded data for the three trials during each daily session and recorded whether the participant emitted the correct response during all three probes. Interobserver Agreement was calculated for trial-by-trial data by dividing the total number of agreements by the total number of trials and multiplying by 100%. Agreement was calculated to be 93.33% for the trials within these five sessions (Appendix H).

**Summary**

Overall, Rory mastered seven of the nine scripted action and vocalization combinations within 18 sessions, after receiving explicit training for three of the play combinations (Table 7). Rory demonstrated generalization of both the scripted action component and scripted vocalization component of the concurrent matrices and the mean level of acquired combinations was 83.33% by the end of the 18 sessions (Appendix G). The use of two matrices to teach multiple components of play concurrently proved to be very effective in teaching play skills to Rory. While he did not reach mastery of all nine possible combinations of the scripted actions and vocalizations, during alternative generalization probes and a maintenance probe, he did display correct responding of all combinations at least once (Figure 1).

**Table 7. Summary of generalization.**

<table>
<thead>
<tr>
<th>Number of action/vocalization combinations</th>
<th>Number of combinations directly taught</th>
<th>Sessions to mastery</th>
<th>Untrained action/vocalization combinations acquired</th>
<th>Number of combinations acquired</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>3</td>
<td>12</td>
<td>4</td>
<td>7</td>
</tr>
</tbody>
</table>

According to Gast, Lloyd, and Ledford (2014), a multiple probe design demonstrates intra-subject direct replication, which increases the findings’ internal validity. The use of a multiple probe design proved to be an effective method to test for generalization of the action and vocalization components of play and did not result in Rory becoming habituated to the
presentation of the play materials during teaching or alternative probes. In addition, a multiple probe design is practical for evaluating functional and social skills that are non-reversible once they have been acquired (Gast et al., 2014). Therefore, the above findings suggest that this method for teaching play skills to a child with autism using concurrent matrices for both actions and vocalizations is effective and allows for further naturalistic generalization of these skills.
Figure F1. The results of matrix training for Rory, measured in percentage correct of responses for teaching and alternative probe sessions. Each panel represents the results for one play set as recombined with each character to test for generalization of scripted actions and vocalizations.
CHAPTER V - DISCUSSION

Summary of Research Findings

Based on evidence-based research, Intensive Behavioural Intervention (IBI) is the most effective treatment for young children with autism and demonstrates the most positive outcomes for changes to behaviour often exhibited by individuals with autism (Hayward, Eikeseth, et al., 2009). The main areas of improvement seen during IBI treatment for children with autism are intellect, adaptive behaviour, and language skills (Hayward, Gale, & Eikeseth, 2009). In addition, IBI targets the teaching of basic and adaptive skills to increase social skills and interactions. Play has been found to be a critical skill for childhood development because it fosters emotional and social growth, as well as encouraging social and linguistic understanding at a young age (Schuler, 2003). Based on evidence that highlights the importance of play during childhood development, Jung and Sainato (2013) have found that teaching play to children with autism is a major aspect of IBI and that these children respond well to prompting, modelling, and naturalistic teaching. For this reason, more constructive ways to teach play should be incorporated into IBI programming as a way to elicit and improve social skills development in children with autism.

Matrix training is defined as a generative form of teaching communication in which a target words are arranged in a matrix (Axe & Sainato, 2010). Matrix training is based on the principle of recombinative generalization and involves the teaching of short phrases based on words in the matrix, after which other combinations of the same words are evoked without the need for formal training (Axe & Sainato, 2010). Existing research demonstrates the effectiveness of matrix training to teach language components to children with developmental disabilities. However, more evidence is needed to demonstrate how this teaching procedure can be used to teach other social skills including play and social interaction.

The purpose of the present study was threefold. First, the present study was designed to replicate the results of previous research that found matrix training to be an effective method of teaching language components to children with autism. Second, this study was intended to replicate the existing limited research that found play skills have been taught successfully using matrix training. Finally, the present study sought to determine whether matrix training could be used to teach both play skills and language skills concurrently using two matrices taught in a parallel approach to increase appropriate communication skills during sociodramatic play. The present study was conducted in two phases. The first phase of the study involved the teaching of target combinations of scripted actions and vocalizations for three play sets. The three play sets were comprised of materials and characters: specifically: eating, sleeping, and dancing materials, and a dog, baby, and train (Thomas the Tank Engine) characters. All play sets was arranged in a 2-dimensional matrix for appropriate vocalizations and a concurrent matrix for appropriate actions. During the first phase of this study, for each play set, a target scripted action and concurrent scripted vocalization arranged in the matrices was taught using modelling, supported by physical and verbal prompting. A multiple probe research design was employed and probe data was collected for each session. The second phase of the study involved probing for generalization of actions and vocalizations during the presentation of other combinations of the materials and characters.

The results of the first phase of the study suggested that both scripted actions and scripted vocalizations could be taught concurrently to a child with autism as a way to teach appropriate
play skills. These results supported the use of matrix training to teach communication and phrases as well as teaching modelled play actions. These results were observed across all three target combinations of scripted actions and vocalizations for each play set. The results of the second phase of the study were found to support the use of matrix training and its foundation of recombinative generalization. During alternative probes, when presented with untaught recombinated materials and characters, the participant was observed to engage in appropriate actions and vocalizations as outlined in both matrices with little training.

While no formal follow-up data was collected to test for social validity and generalization of skills to other environments, it was found that the play skills taught using concurrent matrix training did demonstrate some generalization to a natural environment. The participant engaged in appropriate play with the materials from intervention and more than once following the intervention. All occurrences of spontaneous initiation of sociodramatic play occurred in the IBI classroom setting. However, that this time this setting could be considered a natural setting for the participant to engage in play behaviour as this is his regular classroom environment. Instructor therapists reported that on multiple occasions the participant retrieved the materials used during matrix training and began to assemble the play sets appropriately on his desk and would then verbally request for his instructor therapist to engage in play with him (e.g. “Come play with me”). This implies that some social validity was demonstrated informally following intervention and suggests that generalization of the taught and untaught combinations of vocalizations and actions involved in sociodramatic play did occur in a more natural context.

Overall, the results demonstrated that matrix training an effective way to teach both vocalizations and actions during play. The results support the research that finds matrix training to be an effective way to teach language and communication skills to children with autism. In addition, this study found that matrix training is be an important method to teach difficult play skills and interactions such as sociodramatic play to children who display deficits in these areas of early social interactions. Finally, the results of the present study found that the use of two matrices concurrently was effective to teach two components of play, actions and vocalizations, at the same time and that both components were under the influence of recombinative generalization when materials were presented in untaught combinations. Based on these findings, future research should be directed towards furthering the use of matrix training to teach more than one skill or components of a skill concurrently.

**Implications for the Behavioural Psychology Field**

The results of the present study supported the existing research on the use of matrix training to teach communication and language skills to children with autism. In addition, the present study expanded on past research in several ways. There are both immediate and broad implications of the present research for the field. Immediately, the results of this study should promote the use of matrix training in an IBI setting to teach other skills than language and communication to children with autism. The present study has demonstrated that matrix training can effectively be implemented to teach play to children with autism who display deficits in these complex yet critical childhood skills. In addition, the results of the present study suggest that it is possible to teach multiple components of appropriate play concurrently using two matrices.

The results of the present study also have broad implications, in that these findings could promote the use of matrix training to teach a variety of skills. The majority of literature on matrix
training is limited to teaching children with autism language and communication skills. However, the findings of this study support the use of matrix training to improve deficits in other areas. Overall, the implication of this study should lead to further research to support the use of matrix training as an effective method to teach communication and play skills to children with autism. Accordingly, the results found in this study could impact in teaching a variety of skills using matrix training and multiple concurrent matrices to other populations who demonstrate skill deficits.

**Limitations**

While the results of the present study demonstrated success for the use of matrix training to teach concurrent components of play to a child with autism, it is important that these results be interpreted with a degree of caution due to limitations of the research. Firstly, the present study was conducted as a single-subject case design and limitations arise from this form of research, as would be found in any research design. According to Gravetter and Forzano (2012), one limitation of the single-subject design is that researchers have little or no control of extraneous variables. In the case of the present study, other factors such as the participant’s family circumstances outside of the IBI setting and prolonged illness resulting in absence from treatment could have impacted the results. The present study was impacted by one confounding variable in particular, the two-week absence of the participant due to illness. While this could have impeded the results of the research, upon the participant’s return to IBI treatment, all teaching and alternative probes had been conducted and mastery was already achieved.

Secondly, because the present study was conducted as a single case design, results were not replicated with other children in the IBI setting to support the study’s findings. The fact that findings were only gathered for one participant should leave researchers with questions regarding whether an experimental relationship could demonstrate external validity and be replicated with other individuals (Gravetter & Forzano, 2012). While the present study supports past literature on the effectiveness of matrix training to teach children with autism, the use of a single participant poses the limitation that results of the visual analysis could be interpreted differently by individuals reviewing the results versus the empirically derived statistical findings of a group design.

Additional limitations should also be noted. The present study was conducted in an IBI clinical treatment setting and was incorporated into the participating child’s daily treatment goals. Because the research was conducted in the child’s natural IBI classroom environment, sessions were being conducted and data collected by a variety of instructor therapists throughout the experimental period. While not all instructor therapists working with the participant conducted sessions for the study, it should be noted that there might have been inconsistencies among how each therapist was conducting the sessions. In addition, the responses demonstrated by the participant when engaging in scripted actions and vocalizations, and recombined actions and vocalizations were potentially interpreted differently by each therapist. However, the high level of interobserver agreement suggests that any inconsistencies in the interpretations were minimized during sessions.
**Multilevel Challenges**

*Client Level.* Children with autism do not demonstrate communication and play skills under natural circumstances as typically developing children do. Because play skills are important aspects of childhood development and improve communication and social skills, it is important that play be incorporated into treatment for young children with autism. Teaching play skills to the participant of this study was found to be a challenging task in an IBI setting, because engaging in play involves communication and social interaction. The child who participated in this study engaged in many incompatible behaviours for appropriate play and this made teaching play skills a challenge. Because play relies on social interaction, learning to play is often an undesirable activity for children with autism and the participant was found to engage in self-stimulatory behaviour when presented with play materials prior to and during this study. Providing teaching to engage in appropriate play during this study often evoked challenging behaviours.

*Program Level.* Within Surrey Place Centre’s IBI setting, skill acquisition is the common target for developing programming for children with autism. Most teaching in the clinical IBI program focuses on basic development behaviour and pre-academic skills, and teaching occurs in a one-on-one setting with the therapist and child. There is little interaction between children with autism in the IBI setting and this caused challenges and barriers to teaching appropriate play to the participant prior to this study. Because IBI is individualized for each child in the program, the children do not often engage in naturalistic interactions with their peers; rather their time is focused with a therapist. This means that at that program level, implementing programs to teach social play and communication skills was found to be challenging for IBI therapists to develop, implement, and generalize to natural settings. In the case of this study, social interactions occurred with the therapist rather than a peer.

*Organizational Level.* The IBI treatment of the child participating in this study took place at Surrey Place Centre. Within this organization, which provides services to individuals with autism and developmental disabilities as both children and adults, IBI treatment is delivered using a standardized method. Teaching a child with autism appropriate play skills within an organization that already specified the types of skills to focus on in IBI, brought about some challenges to effective implementation. Within this large organization, many different teams are responsible for implementing IBI treatment. Behaviour programs are often shared among therapists for children and then simply altered slightly to fit each child. It was found that there were areas of development in children with autism that are generally overlooked within the agency because the focus was more centred on teaching more independent skills to these individuals.

*Societal Level.* At a societal level, play skills are viewed as being a very important aspect of childhood and development. Parents are very observant to their child’s ability to engage in playing, both independently and with their peers. However, teaching children to play properly is considered to be a very challenging skill for adults to teach young children, particularly among children with autism who demonstrate a deficit in social skills and the ability to interact appropriately with their peers. Teaching a child to play is viewed as a skills that is extremely challenging to teach, and for this reason, play is often ignored as a teaching goal for children.
with autism among those who interact with them in a natural setting. In addition, within the community of autism therapy and applied behaviour analysis, teaching play is an area with little research, suggesting appropriate ways to teach these skills so it is often left untargeted during treatment such as IBI. This means that a concern for effective delivery of this program on a societal level is that there is not enough focus on teaching young children with autism play skills. The use of matrix training in this study is also a topic that is not commonly understood and this could lead to misgivings about the complexity of this study’s procedure and effective implementation in other settings outside this agency’s IBI program.

**Recommendations for Future Research**

Both the results and limitations of the present study underscore the need for further research on the use of matrix training to teach children with autism. Firstly, the present study built on the existing literature regarding the use of matrix training to teach two independent skills, communication and play to children with autism. Future research should continue to examine the use of matrix training for teaching components of play to children with autism and should attempt to determine the effectiveness in teaching other forms of play to this population. In addition, it is widely accepted that play is an important behavioural component of childhood development (Jung & Sainato, 2013). Because research shows that children with autism display deficits in areas other than basic functional play, future research should be focused on teaching other forms of play using matrix training. The present study has demonstrated that matrix training can be used effectively to teach sociodramatic play skills to a child with autism; and so extensions of this research should compare and contrast the use of other techniques for teaching children with autism.

Secondly, the results observed in the present study add to the existing literature on teaching children with autism using matrix training in one critical way. The present study focused on teaching multiple components of sociodramatic play, including appropriate vocalizations and actions, using concurrent matrices simultaneously. Future research could consist of teaching other forms of play using this technique. The results suggest that based on the principle of recombinative generalization, other children with autism should have success in generalizing communication and play skills in the same way for types of play such as toy-play and symbolic play. Furthermore, research should extend the work achieved in the present study by replicating the technique of using multiple matrices to teach related components of a skill concurrently.

Thirdly, future research is necessary to test the validity if the current study. Because this study was implemented using a single case design, future research should be focused on the replication of the method and results of this research using multiple participants in a group design. It is important for the findings of the present study to be expanded on and for more participants to be involved in this form of concurrent matrix training to teach children with autism, in order for this intervention to become acknowledged by others as evidence-based. While this study focused on the use of matrix training using concurrent matrices during play, future research could expand on this form of teaching in other areas in which children with autism often exhibit deficits.

Finally, it is important for future research to replicate the findings of the present study to support the use of matrix training to teach sociodramatic play to children with autism. While the results observed in this research demonstrated that the use of concurrent matrices could be used
successfully, it is critical for future research to elaborate on this technique. A study focusing on teaching vocalizations and actions for symbolic play using multiple matrices concurrently would provide further evidence in support of this teaching strategy being an effective method to teach children with autism other forms of generalized play skills.

To conclude, the degree to which the results of this study demonstrated success is an important contribution to the literature related to matrix training for teaching generalization skills to children with autism. Future research should continue to use this method of concurrent matrix training to develop more successful strategies for teaching larger groups of children with autism a variety of adaptive skills.
REFERENCES


Appendix A
Consent Form

Project title: The Use of Matrix Training to Teach Communication During Sociodramatic Play in a Child with Autism

Principal Investigator: Hayley Sedgwick
Name of supervisor: Gary Bernfeld
Name of Institution: St. Lawrence College
Name of institution/agency: [Redacted]

Invitation
You are being invited to take part in a research study. I am a student in my 4th year of the Behavioural Psychology program at St. Lawrence College. I am currently on placement at [Redacted]. As a part of this placement, I am completing a research project (called an applied thesis). I would like to ask you for your help to complete this project. The information in this form will help you understand my project. Please read the information carefully and ask all the questions you might have before you decide if you want to give permission for your child to take part.

Why is this research study being done?
My project is on the use of the behavioural technique known as Matrix Training to improve your child’s ability to play with toys properly and help develop age appropriate play and social skills. Matrix training is a technique that has been used before to help teach children with autism many different parts of language and social interactions that are often hard for them to learn naturally. Play is a very important skill for children to develop and can often be impaired in children with autism. In addition, play and language development are closely linked and it is important to be able to use language correctly while playing dramatic or pretend play. Matrix training is a way of teaching children the right words and sentences in a certain context and helping them naturally learn other similar sentences that are related by generalizing the meanings and uses.

What will your child need to do if s/he takes part?
If you choose to allow your child to take part in this study, you will be asked to permit your child to receive individual teaching sessions, three times a day, during regularly scheduled play sessions of their IBI treatment. The sessions will be run by myself and my supervisor at [Redacted]. During the first session, before we begin teaching using the matrix training, we will test how well your child is already able to use language properly when he is given toys to play with. We will use toys such as a dump truck and a construction worker and see if your child plays with them properly and says things that make sense with the toys, such as “Eat the food” or “Dog, take a drink”. During the teaching sessions, we will use the matrix training technique to teach your child many correct things to say when playing with similar toys and then watch again to see if your child has learned more of the right things to say when playing with toys. These teaching sessions will take place three times a day during regularly scheduled play sessions for at least two weeks.
What are the potential benefits to my child if they take part?
Benefits of taking part in this research study may include your child learning more language and play skills that will help your child to engage in social interactions more easily.

What are the potential benefits of this research study to others?
The potential benefits of this research study to others may include better understanding of effective ways to teach children with autism to speak properly while playing dramatically with toys. Information gathered from this project could help other children participate in similar teaching methods by behaviour therapists to improve language and play skills.

What are the potential disadvantages or risks to my child if they take part?
Risks from taking part in this research study are minimal but may include a change in your child’s behaviour or mood. Staff will be present to assist in any challenges that may arise and you will be notified immediately if any behaviour change occurs as a result of the intervention.

What happens if something goes wrong?
If your child has any strong reactions to the project and its teaching procedures, or you see negative changes in your child’s behaviour, you may talk to me, or my supervisor at any time.

Will the information you collect from my child in this project be kept private?
We will make every attempt to keep any information that identifies your child strictly confidential unless required by law. Your child will never be identified on papers related to this project and a pseudonym will be used on every part of written documentation related to the project. The consent forms and data sheets will be kept in a locked filing cabinet at the [insert location]. The computer files with the study data will be kept in a password protected file on a secure, password protected computer. All study documents and results will be kept securely for 7 years at [insert location] after which they will be destroyed. Your child’s name, the agency, or other identifiers will not be used in any reports, publications, or presentations resulting from this project.

Does my child have to take part?
Taking part is voluntary. It is up to you to decide whether or not you want your child to take part in this research project. If you do decide to take part, you will be asked to sign this consent form. If you do decide to allow your child to take part in this research project, you are still free to stop at any time, without giving any reason, and without experiencing any penalty, or negative effects. If you decide to stop, please speak to me or my supervisor. If you choose not to take part in this study, you can still continue to use the services at Surrey Place Centre.

Before beginning each session, your child will be asked a simple question such as “do you want to go play?” to ensure that they are not forced to participate if they do not want to. As play is a regular part of IBI treatment, it is expected that your child will not refuse to play with the toys, but in the case that s/he says “no”, we will wait approximately 5 minutes and then ask again. If needed, this will occur three times before being considered as your child not wishing to take part.
that day. We will apply this same technique if your child verbally agrees to play, but then shows
behavioural signs of not wishing to proceed such as not moving to the play area, or when getting
there not engaging in play with any of the toys, as well as showing any types of behaviours that
are not a regular part of their daily behaviour patterns. This will not be viewed as withdrawal
from the study, more likely just an off day and this will be noted in the data collected during this
treatment.

Contact for further information
This project has been reviewed by the Research Ethics Board at St. Lawrence College. The
project will be developed under the supervision of Gary Bernfeld, PhD, my supervisor from St.
Lawrence College. I appreciate your cooperation and if you have any additional questions or
concerns, feel free to ask me, Hayley. You can always reach me at HSedgwick-pinn08@student.sl.on.ca . You can also contact my College Supervisor Gary Bernfeld at
GBernfeld@sl.on.ca or you may also contact the St. Lawrence College Research Ethics Board at
reb@sl.on.ca.

Consent
If you agree to take part in this research project, please complete the following form and return it
to me as soon as possible. A copy of this signed document will be given to you for your own
records. An additional copy of your consent will be retained at the agency and in a secure
location with the REB at St. Lawrence College.

By signing this form, I agree that:
✓ The study has been explained to me.
✓ All my questions were answered.
✓ Possible harm and discomforts and possible benefits (if any) of this study to my child
  have been explained to me.
✓ I understand that my child has the right not to participate and the right to stop at any time.
✓ I am free now, and in the future, to ask any questions I have about the study.
✓ I have been told that my child’s personal information will be kept confidential.
✓ I understand that no information that would identify my child will be released or printed
  without asking me first.
✓ I understand that I will receive a signed copy of this consent form.
I hereby consent for my child to take part.

---

Participant Name ___________________________ Signature of Parent/Guardian ___________________________
Date ___________________________

Student Printed Name ___________________________ Signature of Student ___________________________
Date ___________________________
Appendix B
Baseline Data Sheet

Program: **Appropriate Play Skills**

| Condition: | Materials: 3 playsets targeted for skill acquisition |
| Setting: at desk in cubby |

**Prompt Type for Error Correction:** FP-Full Physical FV-Full Verbal G-Gestural

**Mastery Criteria:** 3 consecutive ‘Yesses’ across 2 data points and 2 ITs

**Revision Criteria:** 5 consecutive data points of 40% or less or variable or decreasing trend

**S**: “Play with it”

**Correct Response:** Rory displays scripted action and statement within 3-5 seconds of S

**Sr**: FR1 R+ edible/tangible AND verbal praise

Score each script (say) and action (do) as ‘+’ if displayed and ‘-’ if not displayed.

<table>
<thead>
<tr>
<th>Client: Rory</th>
<th>I.T. _______________ Date: _______________</th>
</tr>
</thead>
</table>

**Matrix 1**

<table>
<thead>
<tr>
<th>Saying</th>
<th>EATING</th>
<th>SLEEPING</th>
<th>DANCING</th>
</tr>
</thead>
<tbody>
<tr>
<td>DOG</td>
<td>PROBE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BABY</td>
<td>PROBE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>THOMAS (train)</td>
<td>PROBE</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Matrix 2**

<table>
<thead>
<tr>
<th>Doing (spoon &amp; bowl)</th>
<th>EATING</th>
<th>SLEEPING (bed &amp; blanket)</th>
<th>DANCING (drums &amp; sticks)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DOG</td>
<td>PROBE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BABY</td>
<td>PROBE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>THOMAS (train)</td>
<td>PROBE</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
1. Gather the materials for the playset being taught in the session.
2. The IT will model the correct verbal statement and action using the playset for the session.
3. Deliver S_d “Play with it” and ensure materials are in front of Rory; allow 3-5 seconds for Rory to engage in appropriate verbal statements and actions:
   - If Rory correctly engages in both the scripted verbal statement and action, provide immediate reinforcement.
   - If Rory does not engage in a correct verbal statement and/or perform the action, begin error correction.
     - Redeliver the S_d
     - Provide a prompt to ensure the correct response is achieved.
     - Deliver a neutral statement (e.g. “That’s saying ‘eat the food, dog’”).
     - If Rory makes an error on either the verbal or action component, provide prompting for both of the components of the taught pairing during every error correction (e.g. if Rory correctly displays the taught action but does not engage in the scripted verbal statement, provide both a physical prompt for the scripted action and a verbal prompt for the scripted verbal statement.
   - If Rory engages in off-task/maladaptive behavior during a trial, use high-Ps to re-engage him in the teaching trial.
4. Immediately reinforce using preferred edible/tangible and social praise when Rory demonstrates correct verbal statement and action for the playset.
5. Record whether Rory correctly engages in the scripted verbal statement or the scripted action. Record any other unscripted statements and actions that occur if they are appropriate in the context of the play set.
6. Fade prompts throughout trial until an independent response is achieved.

### Instructional Matrices

<table>
<thead>
<tr>
<th>Saying</th>
<th>Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>EATING</td>
</tr>
<tr>
<td>DOG</td>
<td>“Eat the food, dog”</td>
</tr>
<tr>
<td>BABY</td>
<td></td>
</tr>
<tr>
<td>THOMAS (the train)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Doing</th>
<th>Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>EATING</td>
</tr>
<tr>
<td>DOG</td>
<td>Scoop the spoon into the bowl and feed it to the dog.</td>
</tr>
<tr>
<td>BABY</td>
<td>Place the baby in the bed and cover with the blanket.</td>
</tr>
<tr>
<td>THOMAS (the train)</td>
<td>Hit the drum with the stick and then make Thomas dance around, alternate.</td>
</tr>
</tbody>
</table>
Appendix C
Teaching Sessions Data Sheet

Program: Appropriate Play Skills
ABLLS Code: K2, K5, K6

<table>
<thead>
<tr>
<th>Condition</th>
<th>Materials: 3 playsets targeted for skill acquisition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prompt Type for Error Correction</td>
<td>FP-Full Physical FV-Full Verbal G-Gestural</td>
</tr>
<tr>
<td>Mastery Criteria:</td>
<td>3 consecutive ‘Yeses’ across 3 data points and 2 ITs</td>
</tr>
<tr>
<td>Revision Criteria:</td>
<td>5 consecutive data points of 40% or less or variable or decreasing trend</td>
</tr>
<tr>
<td>S(^0):</td>
<td>“Play with it”</td>
</tr>
<tr>
<td>Correct Response:</td>
<td>Rory displays scripted action and statement within 3-5 seconds of S(^0)</td>
</tr>
<tr>
<td>Sr(^+):</td>
<td>FR1 R+ edible/tangible AND verbal praise</td>
</tr>
</tbody>
</table>

Score each script (say) and action (do) as ‘+’ if displayed and ‘-’ if not displayed.

Client: Rory
I.T. _______________ Date: _______________

### Matrix 1

<table>
<thead>
<tr>
<th>Saying</th>
<th>Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>DOG</td>
<td>EATING</td>
</tr>
<tr>
<td>BABY</td>
<td>SLEEPING</td>
</tr>
<tr>
<td>THOMAS (train)</td>
<td>DANCING</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Doing</th>
<th>Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>DOG</td>
<td>EATING (spoon &amp; bowl)</td>
</tr>
<tr>
<td>BABY</td>
<td>SLEEPING (bed &amp; blanket)</td>
</tr>
<tr>
<td>THOMAS (train)</td>
<td>DANCING (drums &amp; sticks)</td>
</tr>
</tbody>
</table>

Table 2.
1. Gather the materials for the playset being taught in the session.
2. The IT will model the correct verbal statement and action using the playset for the session.
3. Deliver S<sup>d</sup> “Play with it” and ensure materials are in front of Rory; allow 3-5 seconds for Rory to engage in appropriate verbal statements and actions:
   - If Rory correctly engages in both the scripted verbal statement and action, provide immediate reinforcement.
   - If Rory does not engage in a correct verbal statement and/or perform the action, begin error correction.
     - Redeliver the S<sup>d</sup>
     - Provide a prompt to ensure the correct response is achieved.
     - Deliver a neutral statement (e.g. “That’s saying ‘eat the food, dog’”).
     - If Rory makes an error on either the verbal or action component, provide prompting for both of the components of the taught pairing during every error correction (e.g. if Rory correctly displays the taught action but does not engage in the scripted verbal statement, provide both a physical prompt for the scripted action and a verbal prompt for the scripted verbal statement).
   - If Rory engages in off-task/maladaptive behavior during a trial, use high-Ps to re-engage him in the teaching trial.
4. Immediately reinforce using preferred edible/tangible and social praise when Rory demonstrates correct verbal statement and action for the playset.
5. Record whether Rory correctly engages in the scripted verbal statement or the scripted action. Record any other unscripted statements and actions that occur if they are appropriate in the context of the play set.
6. Fade prompts throughout trial until an independent response is achieved.

### Instructional Matrices

<table>
<thead>
<tr>
<th></th>
<th>Materials</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Saying</td>
<td></td>
<td>EATING</td>
<td>SLEEPING</td>
<td>DANCING</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DOG</td>
<td>“Eat the food, dog”</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BABY</td>
<td>“Go to sleep, baby”</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>THOMAS (the train)</td>
<td>“Thomas is dancing”</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Doing</td>
<td></td>
<td>EATING</td>
<td>SLEEPING</td>
<td>DANCING</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DOG</td>
<td>Scoop the spoon into the bowl and feed it to the dog.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BABY</td>
<td>Place the baby in the bed and cover with the blanket.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>THOMAS (the train)</td>
<td>Hit the drum with the stick and then make Thomas dance around, alternate.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Appendix D - Baseline Data

### Baseline Targets

<table>
<thead>
<tr>
<th>Date</th>
<th>Dog eating</th>
<th>Baby sleeping</th>
<th>Thomas dancing</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Matrix 1 – Verbal Statement</td>
<td>Matrix 2 - Action</td>
<td>Percentage Correct</td>
</tr>
<tr>
<td>10/05/15</td>
<td>-</td>
<td>+</td>
<td>0.00%</td>
</tr>
<tr>
<td>10/06/15</td>
<td>+</td>
<td>-</td>
<td>0.00%</td>
</tr>
<tr>
<td>10/07/15</td>
<td>-</td>
<td>-</td>
<td>0.00%</td>
</tr>
</tbody>
</table>

### Baseline Average.

- Number of trials (items) correct
- Total number of trials (items)

\[
\frac{0 / 0}{100\%} = 0.00\%
\]

### Stability of Baseline Targets

Stability could not be calculated due to the baseline mean level being 0.00%.

### Single Components Exhibited.

- Number of components correct
- Total number of components

\[
\frac{2 / 6}{100\%} = 33.33\%
\]

**Baseline target – Dog eating**

\[(2 / 6) \times 100\% = 33.33\%\]

**Baseline target – Baby sleeping**

\[(2 / 6) \times 100\% = 33.33\%\]

**Baseline target – Thomas dancing**

\[(0 / 6) \times 100\% = 0.00\%\]
### Appendix E

**Teaching Data**

<table>
<thead>
<tr>
<th>Date</th>
<th>Dog eating</th>
<th>Baby sleeping</th>
<th>Thomas dancing</th>
</tr>
</thead>
<tbody>
<tr>
<td>----------</td>
<td>-------------</td>
<td>----------------</td>
<td>------------------</td>
</tr>
<tr>
<td>10/08/15</td>
<td>+</td>
<td>+</td>
<td>100.00%</td>
</tr>
<tr>
<td>10/14/15</td>
<td>+</td>
<td>+</td>
<td>100.00%</td>
</tr>
<tr>
<td>10/15/15</td>
<td>+</td>
<td>+</td>
<td>100.00%</td>
</tr>
<tr>
<td>10/19/15</td>
<td>+</td>
<td>-</td>
<td>0.00%</td>
</tr>
<tr>
<td>10/20/15</td>
<td>+</td>
<td>+</td>
<td>100.00%</td>
</tr>
<tr>
<td>10/22/15</td>
<td>+</td>
<td>+</td>
<td>100.00%</td>
</tr>
<tr>
<td>10/23/15</td>
<td>+</td>
<td>+</td>
<td>100.00%</td>
</tr>
<tr>
<td>10/26/15</td>
<td>+</td>
<td>+</td>
<td>100.00%</td>
</tr>
<tr>
<td>10/27/15</td>
<td>+</td>
<td>+</td>
<td>100.00%</td>
</tr>
<tr>
<td>10/29/15</td>
<td>+</td>
<td>+</td>
<td>100.00%</td>
</tr>
<tr>
<td>10/30/15</td>
<td>+</td>
<td>+</td>
<td>100.00%</td>
</tr>
<tr>
<td>11/02/15</td>
<td>+</td>
<td>+</td>
<td>100.00%</td>
</tr>
<tr>
<td>11/03/15</td>
<td>+</td>
<td>+</td>
<td>100.00%</td>
</tr>
</tbody>
</table>

**Teaching Average.**

\[
\text{Number of trials (items) correct} / \text{Total number of trials (items)} \times 100 = \text{Teaching average}
\]

\[
(32 / 39) \times 100\% = 82.05\%
\]

**Stability of Teaching Targets Acquired**

According to Gast and Ledford (2014), stability is defined as 80-90% of the data points falling within 25% of the median, calculated by 12.5 +/- the median.

\[
= (100.00 \times 0.125)
\]

\[
= 12.50
\]

\[
= (100.00 - 12.50) \text{ to } (100.00 + 12.50)
\]
= 87.50 to 112.50

Therefore, none of the data points fell within 25% of the median data point of 100.00%. This means that based on the Gast and Ledford (2014) standards, the data is unstable.
Appendix F
Graph of Results of Matrix Training Showing Trend Lines
Appendix G
Alternative and Maintenance Probe Data

### Alternative Probes

<table>
<thead>
<tr>
<th>Date</th>
<th>Baby eating</th>
<th>Thomas sleeping</th>
<th>Dog dancing</th>
</tr>
</thead>
<tbody>
<tr>
<td>11/05/15</td>
<td>+</td>
<td>+</td>
<td>100.00%</td>
</tr>
<tr>
<td>11/06/15</td>
<td>+</td>
<td>+</td>
<td>100.00%</td>
</tr>
<tr>
<td>11/09/15</td>
<td>+</td>
<td>+</td>
<td>100.00%</td>
</tr>
</tbody>
</table>

### Maintenance Probe

<table>
<thead>
<tr>
<th>Date</th>
<th>Thomas eating</th>
<th>Dog sleeping</th>
<th>Baby dancing</th>
</tr>
</thead>
<tbody>
<tr>
<td>11/10/15</td>
<td>-</td>
<td>-</td>
<td>0.00%</td>
</tr>
<tr>
<td>11/11/15</td>
<td>-</td>
<td>-</td>
<td>0.00%</td>
</tr>
<tr>
<td>11/12/15</td>
<td>-</td>
<td>-</td>
<td>0.00%</td>
</tr>
</tbody>
</table>

**Alternative Probe Average.**

\[
\frac{\text{Number of trials (items) correct}}{\text{Total number of trials (items)}} \times 100 = \text{Alternative Probe average}
\]

\[(13 / 18) \times 100\% = 72.22\%

**Maintenance Probe Average.**

\[
\frac{\text{Number of trials (items) correct}}{\text{Total number of trials (items)}} \times 100 = \text{Maintenance average}
\]

\[(3 / 3) \times 100\% = 100.00\%\]
Percentage of Data Points Exceeding the Median (PEM).

Baseline Median = 0.00%

\[
\text{Percentage of Data Points Exceeding the Median (PEM)} = \frac{\text{Number of data points above baseline median in teaching and alternative probes}}{\text{Number of data points in teaching and alternative probes}} \times 100 = \frac{45}{57} \times 100\% = 78.95\% 
\]

Total Acquired Combinations

Mastered teaching probes = 3/3  Alternative probes = 4/6

\[
\text{Total Acquired Combinations} = \frac{\text{Mastered teaching probes} + \text{mastered alternative probes}}{\text{Total combinations probed}} = \frac{3 + 4}{9} = 77.78\%
\]

Acquired Combinations Average.

\[
\text{Acquired Combinations Average} = \frac{\text{Number of trials (items) correct}}{\text{Total number of trials (items)}} \times 100 = \frac{45}{57} \times 100\% = 78.95\%
\]
Appendix H
Interobserver Agreement

<table>
<thead>
<tr>
<th>Day</th>
<th>Trial 1 Score</th>
<th>Second Observer Score</th>
<th>Interobserver Agreement</th>
</tr>
</thead>
<tbody>
<tr>
<td>18</td>
<td>100</td>
<td>100</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>Trial 2</td>
<td>100</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>Trial 3</td>
<td>100</td>
<td>✓</td>
</tr>
<tr>
<td>19</td>
<td>Trial 1</td>
<td>100</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>Trial 2</td>
<td>100</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>Trial 3</td>
<td>100</td>
<td>✓</td>
</tr>
<tr>
<td>20</td>
<td>Trial 1</td>
<td>0</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>Trial 2</td>
<td>No Data</td>
<td>×</td>
</tr>
<tr>
<td></td>
<td>Trial 3</td>
<td>100</td>
<td>✓</td>
</tr>
<tr>
<td>21</td>
<td>Trial 1</td>
<td>0</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>Trial 2</td>
<td>100</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>Trial 3</td>
<td>100</td>
<td>✓</td>
</tr>
<tr>
<td>22</td>
<td>Trial 1</td>
<td>0</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>Trial 2</td>
<td>0</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>Trial 3</td>
<td>100</td>
<td>✓</td>
</tr>
</tbody>
</table>

Trials in Agreement 14/15

Trial-by-trial IOA.

Number of trials (items) agreement
Total number of trials (items) x 100 = trial-by-trial IOA %

(14 / 15) x 100% = 93.33%