Use of lag schedules to increase play variability across settings for a young child with Autism.

A thesis

submitted in partial fulfilment

of the requirements for the degree

of

Master of Applied Psychology

(Behaviour Analysis)

at

The University of Waikato

by

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THE UNIVERSITY OF
WAIKATO
Te Whare Wānanga o Waikato

2021

Abstract

Play is important, contributing to the development of many key areas including cognitive, physical, sensory, social, and emotional well-being. Play in individuals with Autism Spectrum Disorder (ASD) is found to be impaired. Individuals with ASD commonly display delays across a range of play skills, do not develop more complex play skills and show lower levels of variability during play. Limited play variability and repetitive play behaviours result in many negative outcomes. These negative outcomes include decreased exposure to learning opportunities, language and social interactions, as well as decreased access to reinforcement. It has therefore been suggested that the negative outcomes associated with limited play variability may contribute to the cognitive, language and social deficits seen in individuals with ASD. This study investigated the use of lag schedules of reinforcement to increase the play variability seen in a 7-year-old boy with ASD. Intervention of lag 1, lag 2 and lag 3 schedules were used across three different settings: a music table, ball and playdoh play set. Results showed increases in play variability across all three settings. Limited maintenance data collected showed that increases in play seen in intervention phases remained in maintenance relative to baseline. Generalization was also seen to occur for all three settings with increases in play variability occurring in similar toys to those used in the experimental phase. These findings show support for the use of lag schedules as a method to increase play variability in individuals with ASD.

Keywords: autism, lag schedules, play, variability, toy play

Acknowledgments

I would like to thank my supervisor Associate Professor Angelika Anderson for her support, encouragement, and knowledge throughout. I would also like to thank my boyfriend, family, and friends for their support and understanding during this time. Finally, I would like to thank the participant and his family for being willing to participant in this study despite all the difficulties that COVID presented.

Ethical considerations

The Human Research Ethics Committee of the University of Waikato granted formal approval for this research. Written consent was given by the mother of the child for their participation in the research.

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Introduction

Play serves an important role in children's development. It is through play that children engage and interact with the world around them (Ginsburg, 2007). Play provides children with the opportunity to practice skills, try new things, develop problem solving skills and experience the various positive and negative consequences of their behaviour in a safe and engaging environment (Ginsburg, 2007; Nijhof et al., 2018; Piaget, 1962; Vygotsky, 1978). As a result of the important role play has in development, it has been of interest to a number of different disciplines, including, anthropology, education, history, zoology, sociology, psychology and applied behaviour analysis (Charlop et al., 2018; Pellegrini, 2009). Findings in these areas show that play is involved in many fundamental areas of development including, language, cognitive, physical, sensory, social, and emotional development (Ginsburg, 2007; Nijhof et al., 2018; Rubin et al., 1983). In addition to the wealth of research showing that play can lead to positive developmental outcomes, deficits in play have also been linked to unfavourable outcomes. Limited play variability is one way in which delays or deficits in play may present. Limited variability has been suggested to lead to a number of negative outcomes. These include decreased exposure and access to, learning opportunities, consequences, reinforcers, language, and social interactions (Bancroft et al., 2016; Brucker and Yoder, 2007; Honey et al., 2007; Miller & Neuringer, 2000; Wolfe et al., 2014). The limited access and exposure to vital learning opportunities as a result is therefore proposed to contribute to deficits in cognitive, social and language development.

Limited variability is commonly found in individuals with Autism Spectrum Disorder (ASD). One of the diagnostic criteria for ASD is restricted, repetitive patterns of behaviour, interests or activities (American Psychiatric Association, 2013). Restricted and repetitive patterns of responding have been shown to occur across a variety of areas for individuals with ASD, including, vocalisations, responses to questions, toy preferences, body movements,

food preferences and routines (Lee & Sturmey, 2006; Leekman et al., 2011; Silbaugh & Falcomata, 2017; Wetherby et al., 2004). One key area in which restricted and repetitive patterns of behaviour, interests or activities commonly present in individuals with ASD is play. Research has shown that individuals with ASD commonly display less variability in their play than typically developing children (Boucher, 1977; Firth, 1972; Honey et al., 2007; Stone et al., 1990). Children with ASD may be seen lining up toys, playing with a limited selection of toys or being hyper focused on one aspect of a toy (e.g., spinning the wheel on a toy truck repetitively). Limited play behaviours not only limit the individual's exposure to new situations and play items, but also limits their exposure to important social and language opportunities. It is likely that when children show rigid or repetitive play behaviours other children and adults are less likely to engage with them, therefore reducing exposure to social and language learning opportunities (Bancroft et al., 2016; Miller & Neuringer, 2000). It is proposed that the reduction in social, language and learning opportunities that result from limited play may contribute to some of the deficits and delays seen for individuals with ASD. Research has therefore been conducted across a number of disciplines to explore ways in which play variability can be targeted and increased. One intervention method that has shown promise as being an effective method to increase play variability is lag schedules of reinforcement. A lag X schedule is a schedule where X represents the number of prior responses that the current response must differ from to receive reinforcement (Neuringer, 2002). For example, under a lag 2 schedule a play behaviour must differ from the previous two play behaviours to receive reinforcement. Then under a lag 3 schedule a play behaviour must differ from the previous three play behaviours to receive reinforcement. The aim of this study was to use lag schedules of reinforcement to increase the play variability of a 7-year-old child with ASD, across three play settings.

Literature Review

Importance of play in development

Play is widely acknowledged as an important aspect of children's development. Time for play allows children to develop motor skills, experiment with their behavioural repertoire, stimulate alternative scenarios and address the various positive and negative consequences of their behaviour in a safe and engaging context (Nijhof et al., 2018). Given the well-established understanding of the importance of play on development the research in the area is extensive. As a result, a full summary of the influence of play on children's development is outside the scope of this study. The literature summarised here will therefore focus on the role play has on, social, language, and cognitive development. These specific areas are key areas of development for all children, but especially for children with Autism Spectrum Disorder (ASD) as these are areas in which deficits and delays are commonly seen.

Play and language development

The development of play is closely linked to the acquisition of language (Honey et al., 2007; McCune, 1995; Quinn et al., 2018). Play provides a framework in which children are exposed to language. It also provides a context in which children can practice their language skills and expand their vocabulary. A number of studies have proposed different ways in which the link between play and language development may occur. McCune (1995) reported significant relationships between the onset of symbolic play and beginning of word production, between sequences of symbolic play and word combinations and between planned symbolic play and multi-word utterances. Lewis (2003) put forward a number of hypotheses as to why this link between play and language may be present. One explanation suggested is that play and language could be related because they both depend upon symbolic representation, where one thing stands for something else. Another possibility proposed by Lewis (2003) was that play and language are related in terms of levels of organizational

complexity. Children initially produce single words and manipulate one object at a time. Over time they begin to produce increasingly longer utterances, while their play incorporates a number of different objects. It is also possible that play and language are related through some third factor, such as the ability to attend to what another person is doing or saying.

There is some evidence to support the idea that there is a directional influence between play and language, with play facilitating language development. Research conducted by Ungerer and Sigman (1984) observed children at 13 and 22 months of age. Results showed that several play measures at 13 months were correlated with aspects of language at 22 months. Importantly, they reported fewer correlations between language at 13 months and play at 22 months, suggesting that play may facilitate language development rather than vice versa. The findings of McCune (1995) provide further evidence for this showing that the beginning of symbolic play preceded the production of early language as sequences of symbolic play occurred several months before word combinations. Also, planned symbolic play was followed by multi-word utterances. The link between language and play development is also evident for individuals with ASD. Kasari et al. (2012) conducted a longitudinal study that demonstrated that children who presented with higher levels of play at ages 3 and 4, showed better language outcomes at ages 8 and 9. Many of these studies suggest that level of play is a predictor of language development, however further research is required to conclude this as a causal relationship. It is nonetheless clear that there is a link between play and language development, with play being important in the development of language in some capacity.

Play and social skills

Play serves an important role in providing exposure to social interactions and reinforcers. Play provides opportunities for social and communicative interactions with peers and adults (McConnell, 2002). Through play children learn how to work in groups, to share,

to negotiate, to resolve problems and learn self-advocacy skills (Ginsburg, 2007). Play also serves an important role in family relationships as it provides caregivers more opportunities to interact with their child (Childress, 2011; Lifter et al., 2011). A range of positive social outcomes including, increased empathy, compassion, and sharing, increased attention and improved nonverbal skills have been connected to play (Goldstein, 2012).

Play, learning and cognitive development

The growing child learns nearly everything through play. Play provides a context to practice new skills and increases the opportunities for learning (Lifter et al., 2011). Exposure to play helps to build strong learning foundations as later levels of learning are built upon earlier ones, a process referred to as 'scaffolding' (Goldstein, 2012). Research has shown that early play skills can influence many areas of development and future learning. Early play skills are linked to creativity, problem solving, spatial awareness and divergent thinking (Christie & Johnsen, 1983; Ginsburg, 2007; Whitebread et al., 2017). Play is also integral to academic learning (Ginsburg, 2007). School readiness and skills in math and literacy when children reach kindergarten have also been found to be linked to play skills (Bergen, 2015; Ginsburg, 2007; Pellegrini, 1992).

The role of play in children's development is a significant one, especially in the development of language, social skills and cognitive development. Further research is still needed to further understand exactly how this relationship interacts and if a causal relationship exists. However, the notion that a relationship of some form exists between play and language, social and cognitive development, is well established in the literature. Support for this relationship is strengthened further as a result of level of play development often being used as a measure of development. Lifter et al. (2011) and Vig (2007) highlighted that observation of play is commonly used by professionals to gain insight and understanding about a child's language, social and cognitive development based upon their play skills.

Definitions of play and play theories

Although there is widespread acknowledgment of the importance of play, this same consensus does not exist for the definition of play. As previously discussed, play is of interest to many disciplines and as a result has acquired many different definitions. The term "play" is commonly used to describe a diverse range of activities including "lap play (peek-a-boo), sensation seeking and motor exploration, rough and tumble, verbal experimentation, constructional play (blocks, Lego, puzzles), playground and outdoor play (swings, slides, bikes), messy play (sand, water), toy play (dolls, cars), clapping and singing games, chase and hide and seek games, pretend and imaginary play, teasing, jokes and humour, word games, card and board games, and team games" (Boucher & Wolfberg, 2003, p. 340). In today's modern society, games involving technology such as video games, computer games and iPad games are also now considered to be play (Lai et al., 2018).

In the literature, the terms used to describe play differ depending on the discipline the study was conducted. Inconsistencies in definitions and descriptions are largely a result of different conceptualizations of play (Lifter et al., 2011). In the current literature, descriptions of play such as "functional play" and "symbolic play" mean different things in different studies. A number of theories and frameworks have therefore been presented in an attempt to better define play, and sequence play development. Lifter et al. (2011) identified that perspectives of play can be broadly characterised as being from the behavioural perspective or the constructivist perspective. The behavioural perspective is interested in what the child does and how the behaviour presents, with focus given to describing the behaviour, considering the uses of play, and teaching play. The constructivist perspective is interested in why children perform the way they do and understanding the underlying developmental progress and stage that leads to the behaviours observed. Both perspectives are important and literature from each is often cited by the other. The summary of theories and definitions of

play outlined below explores the constructivist perspective first, followed by definitions and sequences more in line with the behavioural perspective.

Early theories of play emerged in the works of Freud, Erikson and Bronfenbrenner. Sigmund Freud's psychoanalytic theory focused on the role of the unconscious and early childhood experiences on development. Freud claimed that play was a means for children to express themselves and deal with anxiety-producing events. He considered play as cathartic and that it allowed children to express their feelings and dispel negative emotions, allowing them to replace them with positive ones (as cited in Saracho & Spodek, 1995). Erik Erikson's psychosocial theory expanded beyond the individual and also included the family and social environment around the child. Erikson viewed play sequences as models by which children relive aspects of the past, represent aspects of the present, and anticipate aspects of the future. Erikson also proposed that play allows children to deal with emotional and behavioural dilemmas they encounter in the "real world" (as cited in Bergen, 2015). Bronfenbrenner's ecological theory focused on the role of the environment around the child and the influence this had on their play and development. He considered how play development was influenced by interactions with family members and the wider community. Vygotsky (1978) also focused on the role social interactions had on play development. Vygotsky believed that play activities serve as the natural context for young children to learn through social interactions (as cited in Xu, 2010). Vygotskian theory states that play facilitates cognitive development. Through play children can practice what they already know and also learn new things. Vygotsky proposed that one-way children learn is through social interactions with more skilled peers or adults modelling higher level thinking, a process referred to as scaffolding (Xu, 2010).

These early views of play are still cited in the literature regarding play development to this day, but the theory most prevalent in the literature on play is that proposed by Piaget

(1962). Piaget defined play as assimilation, whereby children incorporate new experiences into existing frameworks of understanding (as cited in Lifter et al., 2011). Piaget claimed that play was just for pleasure, and while it allowed children to practice things they had previously learned, it did not necessarily result in the learning of new things. This differs from the views of Vygotsky who proposed that children not only express what they know through play, but also learn while engaged in play. According to Piaget, children engage in types of play that reflect their level of cognitive development with different types of play emerging at different ages and stages of development. Piaget proposed three different types of play: practice play, symbolic play, and rule-based games, proposing that these three types of play coincide with the three stages of cognitive development: sensorimotor, preoperational, and concrete operational (as cited in Casby, 2003). Piaget proposed that children engage in practice play when they are in the sensorimotor stage, in which learning occurs through sense, reflexes, and manipulating materials. Practice play consists of the use of bodily movements, with or without objects, such as running and jumping, sliding, gathering and dumping, manipulating and stacking objects, and informal games without rules. Around the age of 2 years, children begin to enter the pre-operational stage and symbolic play starts to emerge. Symbolic play begins the projection of symbolic schemes to more complex types of symbolic play, such as the ability to alter an episode through symbolic combinations and elaborations and anticipate outcomes and adapt their actions rather than just simply reproducing or copying reality (Casby, 2003). The third stage is concrete operations and occurs between the ages of 7-11years old. In this stage of development children are now able to think logically and follow rules.

Piaget's work was later extended by Smilansky (1968). Smilansky proposed four types of play: functional, constructive, dramatic or pretend, and games with rules. Like Piaget, he proposed that these stages of play reflect the child's cognitive development.

According to Smilansky, functional play consists of simple or repetitive muscle movements with or without objects (as cited in Rubin, 1977). This definition differs from the common definition seen in the literature that refers to functional play as appropriate use of an object (Casby, 2003; Charlop et al., 2018; Hancock, 2020; Ungerer & Sigman, 1981; Williams et al., 2001). The other stages Smilansky defined were constructive play (which involves building or creating something), dramatic play (which consists of make-believe play) and games with rules (which involves following externally pre-set rules) (Rubin, 1977).

Another play theory that is still widely cited and used today is that of Parten (1932). Parten developed a system for classifying play that focused on the social aspects of play. To identify the play stages, she observed young children at play and then identified six different types of play based upon these observations. These stages of play include: unoccupied play, onlooker behaviour, solitary play, parallel play, associate play and cooperative play. Unoccupied play, onlooker behaviour and solitary play are considered to be non-social activities (Xu, 2010). Unoccupied play consists of the child watching things that catch their attention and playing with their own body. Onlooker behaviour includes the observation of other children's play, asking questions, or giving suggestions, but not overtly entering into the play themselves. This type differs from unoccupied play in that the onlooker is observing particular groups of children, rather than anything that happens to be exciting. Solitary play then consists of the child playing alone and independently with toys. Following the development of these non-social types of play, children start to work towards more social play with the development of parallel play. This consists of the child playing independently, but the activity they choose naturally brings them among or in close proximity to other children. In parallel play, children play beside rather than with other children. The last two stages of play to develop according to Parten's theory are associative and cooperative play, which involve functional social interactions with other children. In associative play children

engage in a mutual activity, though they are not working towards a common goal. There may however be borrowing and loaning of play materials in associate play. In Cooperative play children work together with other children towards a common goal. This theory of play focuses on the social aspects of play rather than how the child interacts with the toy directly.

Lifter et al. (2011) proposed a play theory with greater focus on the interaction of the child with the play object. Based upon research conducted on play in the 70's, 80's and 90's it was identified that different play activities occurred as children developed from infancy through the preschool period. Lifter et al. (2011) suggested that this developmental sequence could be organised into two taxonomies, manipulative and symbolic play, with subcategories under each. Manipulative play included: indiscriminative actions on objects (e.g., mouthing all objects), actions of taking configurations of objects apart to take hold of objects (e.g., taking a set of nesting cups apart), actions of creating simple configurations of objects (e.g., putting the nesting cups back together; dropping beads into a nesting cup), and actions in which children begin to exploit the unique physical properties of objects in the relationships they construct (e.g., stacking the nesting cups; putting a bead on a string). Symbolic play includes: Actions which relate objects to the self in a pretend manner (e.g., pretending to drink from an empty cup); actions which relate pretend activities to dolls and caregivers (e.g., giving a doll a drink from a cup); actions displaying the unique conventional properties of objects and people (e.g., putting pretend food items into a pot to cook); and actions linking the same or different schemes together into chains of events that demonstrate increasing levels of planning (e.g., first cooking food and then feeding it to a doll) and actions in which children attribute animacy to doll figures (e.g., walks a truck driver figure to load cargo into a truck).

Ungerer and Sigman (1981) also proposed a sequence of play development that focuses on what play looks like. They proposed that the development of play follows a

reliable sequence in the first two years of life. This sequence consists of simple object manipulation, followed by relational play, then functional play, and finally symbolic play. Simple object manipulations include mouthing, waving, banging, throwing, and exploring objects with the fingers. This form of play is dominant before 12 months of age but declines sharply in frequency thereafter and is only minimally present by 18 months. Relational play occurs next, which consists of the combining of two or more objects in a non-functional manner, such as touching one object to another or banging two objects together. Relational play is common up to 12 or 13 months of age, it then declines to a low but constant level through the second year. Functional play occurs around 12 months and consists of appropriate use of an object or the conventional association of two or more objects (for example, using a spoon to feed a doll or placing a teacup on a saucer). Functional acts increase between 12 and 18 months. Symbolic play develops between 12 and 24 months, with mature symbolic play occurring around 18 and 24 months. Symbolic play is characterized by the differentiation of objects and actions. At this stage children are able to represent and transform objects internally in thought, fully independent of overt action. Play is now no longer constrained by the physical and functional properties of the available objects. Children can now use one object to represent or substitute for another different object, treat inanimate objects such as dolls as if they were real people, and create imaginary objects.

Play Defined

In this current study the definitions of play used will be those proposed by Ungerer and Sigman (1981) of object manipulation, relational play, functional play and symbolic play. Many previous studies have investigated functional and symbolic play in individuals with ASD (Boucher & Wolfberg, 2003; Van Berckelaer-Onnes, 2003). Research has demonstrated that individuals with ASD often have delays and deficits in object play, the first stage of play development, (Van Berckelaer-Onnes, 2003; Vig, 2007). In this study it was decided to not include functional play as a requirement for two reasons: 1) to allow for variability in earlier

play skills such as object manipulation and relational play to be targeted and 2) to not limit creativity. This is important to target as the literature suggests that deficits in earlier play skills such as object and relational play may limit an individual from progressing to later play skills, such as symbolic play (Hancock, 2020; Van Berckelaer-Onnes, 2003).

Autism Spectrum Disorder (ASD)

Autism Spectrum Disorder (ASD) is a developmental disorder of variable severity that is characterized by impairments in communication, reciprocal social interaction and restricted and repetitive behaviours or interests (Faras et al., 2010). Autism is estimated to effect approximately 1 in every 102 children in New Zealand (Bowden et al., 2020) and 1 in 160 children worldwide (World Health Organisation, 2019). Diagnosis of ASD is currently conducted via the diagnostic criteria outlined in the DSM-5. To meet diagnostic criteria for ASD the individual must have "persistent deficits in social communication and social interactions across multiple contexts" and "restricted, repetitive patterns of behaviour, interests or activities" (American Psychiatric Association, 2013, p. 50). ASD is suggested to have a genetic component, but the etiology of ASD is currently unknown (Faras et al., 2010; Myers & Johnson, 2007). ASD is more prevalent in males than females, with a ratio of 3:1 being reported (Loomes et al., 2017). ASD can be diagnosed as early as 18months, but most children receive a diagnosis between 3-10 years of age (Van 't Hof et al., 2020). Early signs of ASD include limited eye contact, not responding to sounds or their name, delays in language, lack of social reciprocation, and limited or obsessive interests. One of the core characteristics of ASD is restricted, repetitive patterns of behaviour, interests or activities. Links between ASD and restricted and repetitive patterns have been demonstrated across a range of areas including: vocalisations (Leekam et al., 2011; Wetherby et al., 2004), responses to questions (Lee & Sturmey, 2006), toy preferences (Wetherby et al., 2004), body

movements (Leekman et al., 2011; Wetherby et al., 2004), food preferences (Silbaugh & Falcomata, 2017), routines (Leekman et al., 2011) and play.

Play in children with ASD

Play in individuals with ASD is commonly reported to be impaired (Charlop et al., 2018; Honey et al., 2007; Jordan, 2003; Lewis, 2003; Lifter et al., 2011; Movahedazarhouligh, 2018; Vig, 2007). As a result, a number of studies have been conducted to investigate differences that exist between the play of children with ASD and typically developing children. The literature reports that when compared to typically developing children, individuals with ASD show delays across a range of play skills (Ungerer & Sigman, 1981; Van Berckelear-Onnes, 2003; Williams et al., 2001), commonly do not develop more complex play skills (Van Berckelear-Onnes, 2003; Williams et al., 2001) and show less variability in responding during play (Boucher, 1977; Firth, 1972; Honey et al., 2007; Stone et al., 1990). Differences in variability in play emerges as a significant area of distinction between children with ASD and typically developing children and will be the focus of this summary of play behaviours in children with ASD.

Early studies by Firth (1972) and Boucher (1977) demonstrated that individuals with Autism display less variability in play with individual toys, compared to typically developing children. Firth (1972) demonstrated that individuals with Autism showed less variability in play with a xylophone and stamps compared to typically developing children and children considered as mentally retarded. In this study children with Autism generated sequences that were more patterned and repetitive compared to the other two groups. Boucher (1977) found similar results for play with a car and garage playset. In this experiment, participants were presented with different garages in which they could park the toy car. Results showed that children with Autism were less likely to vary play behaviour and use the three different garages available, when compared to typically developing children. More recent findings by

Bancroft et al. (2016) further support these findings. In this study, play items used were dolls with different paper dresses, beads to thread and coloured markers for colouring shapes. Each time the participant made a selection for each play item the exact item was replaced, meaning that the participants were making selections from the same items each time a selection was made. Findings showed that individuals with Autism showed less variability in selections across the three play activities compared to typically developing children.

Restricted and repetitive patterns of play have also been observed in the free play behaviours of children with Autism. Stone et al. (1990) looked at free play behaviours of children with autism, compared to typically developing children and children with other disabilities. Play behaviours were assessed using structured observations of free play activities. Children with autism were found to spend less time interacting with toys, using toys appropriately and were engaged in fewer functional play acts compared to the other two groups of participants. Similar findings were also found by Honey et al. (2007) using a parent report measure rather than structured observation. In this study, parents of children with ASD and parents of typically developing children completed the questionnaire designed to assess variability in play. Findings showed that parents of children with Autism reported much less variability in play and more restricted play behaviours than parents of typically developing children did.

The lower play variability seen in free play and toy play for individuals with Autism is also evident in more structured games when compared to typically developing children. Murry and Healy (2015) used the “penny hiding game” to compare variability in responses between children with autism and typically developing children. The “penny hiding game” consisted of the experimenter hiding a penny in one of their hands and asking the participant to pick what hand. Results showed that children with Autism showed lower variability in their selections compared to typically developing children.

These studies support the view that limited play variability commonly occurs in individuals with ASD across a range of play settings, when compared to typically developing children. Since play is such an important factor in development it is important to consider how play variability influences developmental outcomes.

Outcomes of limited play variability

The level of variability seen in play can greatly influence how the child interacts with the world. Levels of variability influence the opportunity an individual has to experience new situations, learn new behavioural sequences and receive reinforcement. Variability allows for increased exposure to and acquisition of new behaviours and behavioural sequences (Miller & Neuringer, 2000). Varied responses also allow for more opportunities for reinforcement, and therefore, allow individuals to more effectively learn from their environment (Neuringer, 2002). Limited variability in play has been suggested to therefore lead to decreased learning opportunities, including decreased access to varied consequences and possible reinforcers (Bancroft et al., 2016; Miller & Neuringer, 2000). Decreased access to overall learning opportunities as a result of limited variability is therefore suggested to have a negative influence on an individual's ability to learn and acquire new skills (Boucher & Wolfberg, 2003). This suggests that limited play variability may limit learning opportunities and skill development across a range of areas, including language and social skills.

Play is a time in which children commonly are exposed to social interactions, and consequently language. As a result, limited variability is related to decreased exposure to language (Honey et al., 2007) and opportunities for social learning (Brucker and Yoder; 2007; Wolfe et al., 2014). Charlop et al. (2018) presented some possible examples of how limited play variability may lead to decreased opportunities for exposure to social interactions and language. One example of this being instead of building a block castle with a friend, a child with ASD may line the blocks up in a straight line and become upset if another child

approaches or tries to touch the block line. Another scenario proposed by Charlop et al. (2018) is that an individual with ASD may insist on playing the same game in the same way every time, which likely limits opportunities for new experiences and may drive away potential playmates. Over time it is likely that children will no longer try to engage with the child as a result of repetitive or restricted behaviours. This therefore leads to fewer opportunities to practice social learning and gain access to social reinforcers (Brucker and Yoder; 2007; Wolfe et al., 2014). This may therefore contribute to the deficits commonly seen in language and social skills of individuals with ASD.

Methods to increase play variability

With play being associated with many fundamental areas of development and limited play variability leading to possible deficits in key developmental areas, increasing play variability may therefore lead to many positive outcomes. Increases in play variability could increase exposure to language and assist with language development (Honey et al., 2007), facilitate acquisition of new behaviours and behavioural sequences (Miller & Neuringer 2000) and increase social development and socially appropriate behaviours (Bruckner & Yoder, 2007; Miller & Neuringer, 2000). Variable behaviour is also incompatible with stereotyped and repetitive behaviours (Miller and Neuringer, 2000). Therefore, increasing play variability can be used to decrease stereotyped behaviours (Lang et al., 2014). As a result of the possible positive outcomes increases in variable play may produce, it is not surprising that a number of studies have explored ways to increase variability in play. A number of these studies are discussed further below and possible limitations are considered.

Extinction

Extinction is one method that has been shown to increase novel responding. Pryor et al. (1969) used extinction to increase novel responding with two porpoises. Results of this study showed that when food reinforcers were discontinued for previously reinforced

topographies novel responding occurred. Lalli et al. (1994), later applied this method to increase response variability in toy play. Participants in this study were two young children aged 4 and 5 years with mild intellectual delays. Participants were trained to do a horizontal movement with a plane and a walking movement with a doll or animal. The participants received reinforcement for these behaviours, then after three instances of reinforcement the behaviours were placed on extinction. Results showed an increase in novel play responses for both participants, across both play items, when extinction was in place. However, the use of extinction comes with many possible side effects and limitations, such as extinction bursts, resistance to extinction, emotional outbursts and aggression (Cooper et al., 2019).

Video modelling

Video modelling provides children with exemplars of specific play skills and provides a script for appropriate play (Dupere at al., 2013). Video modelling has been shown to increase both verbal and play responses in play for individuals with Autism (Dupere et al., 2013; Lydon et al., 2011; MacManus et al., 2015). Video modelling could be a beneficial method for children who initially avoid interactions or who present with limited reinforcers (Lydon et al., 2011). Video modelling also offers benefits as a teaching method for individuals with Autism, as it can allow for extraneous features and factors to be filtered which may be distracting during in vivo modelling (Lydon et al., 2011). However, video modelling procedures can often be time consuming to set up and require that the individual can imitate. Variability within play is also not directly targeted and often participants' responding will be limited to what is demonstrated in the video. Therefore, it is likely that additional methods would be required to directly target and reinforce play variability within play sessions and further expand response variability (Dupere et al., 2013; MacManus et al, 2015).

Pivotal response training

Pivotal Response Training (PRT), has also been used to target play variability. (Koegel et al., 1987). Stahmer (1995) demonstrated the use of PRT to increase symbolic play and play complexity for seven males with Autism between the ages of 4-7years. PRT was also used by Lydon et al. (2011) to increase play behaviours. Participants in this study were five children with ASD. All participants showed an increase in number of independent play behaviours with a zoo or playground playset. However, as identified by Stahmer (1995) this method of intervention has the best outcomes for children who have higher language skills. This method therefore may not be well suited to individuals who have poor language skills or display stereotyped behaviours.

Percentile schedules

In percentile schedules the criterion for reinforcement is continually recalculated based upon the participant's responding. Frequencies of specific responses are monitored within a moving window (e.g., the 20 most recent responses) and ranked from least to most frequent after each trial (Wolfe et al., 2014). Reinforcement is then contingent upon a response being emitted that has occurred at or below a certain criterion ranking in the frequency hierarchy. Miller and Neuringer (2000) demonstrated the use of percentile schedules to increase variability in sequences of responses in a video game. Participants were five adolescents with Autism, along with a control group of typically developing adults and children. Participants played a computer game which involved sequences of responses between left and right keys. Findings showed that variability in responding increased for three out of the five participants with Autism. The use of percentile schedules may present with limitations for use in more naturalistic settings. As Miller and Neuringer (2000) discussed, percentile schedules may be difficult to define, record, and analyse in naturalistic settings and typically require the aid of a computer to implement.

Use of lag schedules to increase play variability

The use of lag schedules has been demonstrated to be a successful method to increase response variability and may offer a solution to many of the limitations identified above. A Lag X schedule is a schedule in which X indicates how many differing responses must be emitted before reinforcement is provided. A summary of past research that used lag schedules to increase play variability is provided below.

Goetz and Baer (1973) demonstrated increased variability in block building forms for three, 4-year-old girls. Participants did not display any developmental delays but were identified by teachers as having limited block building skills. An ABCB design was used for this study in which following baseline, reinforcement was given for variability in form. The reinforcement criteria then changed, and sameness was reinforced, followed by the final phase in which variability was reinforced again. When variability in form was being reinforced participants received teacher interest, delight and enthusiasm, as well as descriptive feedback such as “that’s nice, it's different” for new forms. When sameness was being reinforced, the same reinforcers were used. Effectively a lag 1 schedule of reinforcement was therefore implemented for variability and sameness. All three participants showed an increase in form diversity when reinforcement was delivered for diversity. The three participants also showed lower form diversity when reinforcement was given for sameness.

Cammilleri and Hanley (2005) also conducted a study involving typically developing children. This study demonstrated how a lag 12 schedule could be used to increase the number of tabletop activities two typically developing girls aged 5 and 7 years-old would engage in. Although participants were typically developing, both girls displayed limited variability in tabletop selections. During baseline both girls engaged in only three to four of the 12 activities available. Both girls allocated the majority of their playtime to engaging with

blocks. During baseline no consequences were given for play selections. During the intervention phase, changes in activities were prompted every five minutes with a bell. During this intervention phase, choices that met the lag schedule criterion in place resulted in a card which could be traded in for two minutes of the teacher's attention. Findings showed that the use of a lag 12 schedule was effective at not only increasing the number of activities the participants would engage in, but also increased the time spent doing educational programmed activities relative to baseline.

Lang et al. (2014) conducted a study to increase appropriate play behaviours of children with Autism. This study used lag schedules as an addition to fixed ratio (FR) and variable ratio (VR) schedules of reinforcement. Participants were three, 3-year-old children with Autism. All displayed stereotyped behaviours involving toys. In this study, two playsets were used: a home and an amusement park playset. One set was used for the intervention phases and one was used for baseline phases in which generalisation was also measured. During baseline phases participants were given free time to play with both playsets. Appropriate play and stereotyped behaviours were recorded. Following the initial baseline, phase one consisted of the experimenter using a least-to-most prompting hierarchy including gestural, model, verbal and physical prompts to teach appropriate play skills. Reinforcement in the form of social praise and small edibles was delivered on a FR1 schedule for appropriate play responses. Once appropriate responses increased to above baseline levels for two consecutive sessions, a VR3 schedule was introduced. Following this phase, a reversal occurred, and the baseline procedure was then reintroduced. Participants were given free play with each of the play sets and appropriate behaviour and stereotyped behaviour were recorded. Increases in appropriate play and decreases in stereotyped behaviours were seen for all three participants in the reversal phase for the experimental play set. Increases in appropriate play for the generalisation toy only occurred for one participant. As a result, a lag

schedule of reinforcement was therefore implemented for the two participants that did not show increases in appropriate play with the generalisation playset. Both lag 1 and lag 2 schedules of reinforcement were implemented with the same playset used in phase 1. Reinforcement was delivered for appropriate play behaviours that differed from the previous behaviour according to the lag schedule in place at the time. Following the lag schedule phase both participants demonstrated increased instances of appropriate play behaviour and a decrease in stereotyped behaviour across both playsets. Appropriate play remained above baseline levels and stereotyped play below baseline levels at four, six and eight week maintenance probes, for all three participants. This study provides support for the use of reinforcement schedules as an effective intervention to increase appropriate play behaviours and decrease stereotyped behaviours in children with Autism. Because lag schedules were used in combination with FR and VR schedules of reinforcement, it is difficult to conclude if lag schedules alone could have achieved the same changes in appropriate play and stereotyped play. Further research is therefore required to explore if lag schedules alone can lead to changes in play for individuals with Autism.

One study that did look at the use of lag schedules alone to increase play in individuals with Autism was conducted by Napolitano et al. (2010). This study expanded on the study by Goetz and Baer (1973) by looking at increasing diversity in block building forms. To measure diversity, participants' responses were defined as variant or invariant for form or colour. Variant responses differed to the previous colour or form and invariant responses did not differ from the previous. The number of variant responses and invariant responses were then divided by the total number of possible responses to calculate a percentage. Participants in this study were five boys and one girl aged between 6-10 years. All had an Autism diagnosis and an IQ below 70. Participants were given 24 blocks to build with and were scored on variability in both form and colour. An ABAB design was used.

During baseline, participants were given the blocks and told “build something”. Forms were recorded and praise was given intermittently at least once in the session. During intervention phases variable forms and colour combinations were reinforced with edibles or access to a preferred activity for 30 seconds. Performance improvements did not occur for four out of the six participants under lag 1 intervention, therefore a teaching phase was implemented. Teaching phases consisted of the experimenter modelling different block forms and then verbally prompting “now you build something different”. Teaching phases ranged in length from two to seven sessions. Overall, diverse responding increased for all participants with intervention. Findings showed lower rates of variable responding in baseline and an increase in variable responses when the lag 1 schedule was in place for all six participants. Five out of the six participants maintained increased response variability at follow up two to three months later when a lag 1 schedule identical to the original experimental phase was in place. However, only one participant showed an increase in variability during generalisation in which wooden blocks of a similar size and colour were used.

Baruni et al. (2014) provided another study that looked specifically at the use of lag schedules to change play variability in individuals with Autism. This study looked at the use of lag schedules to increase play variability with common children’s toys, including a plane, car and train. The measure of play variability used in this study was novel responses across sessions. Time engaged with the toy within sessions was also measured. Participants in the study were a 6-year-old and an 8-year-old boy with Autism and a 12-year-old girl with cerebral palsy and global delay. Each child was assigned the plane, car or train based on age appropriateness of the toy. A nonconcurrent multiple baseline across participants design was used. During baseline, participants were handed the toy and told “play”. Responses were recorded and no reinforcers or consequences were given for novel play responses. During the intervention phase, a lag 1 schedule was put in place and participants received an edible

reinforcer for play responses that differed from the previous one. Due to time constraints only the two participants with Autism moved onto a lag 2 schedule. All three participants showed increases in novel responding in lag 1. Decreases in time engaged with the toy were also observed in lag 1. Very little increase in novel responding was observed in lag 2, with only one novel behaviour occurring for each participant in lag 2. One possible explanation for this is that the play toys used resulted in a ceiling effect. It is possible that since individual play items were used only a certain number of novel play responses were possible, with the majority of these novel responses already occurring in baseline or lag 1 conditions, thus leaving limited possible novel play behaviours in the lag 2 condition.

Current research

Although a number of studies have been conducted using lag schedules with individuals with Autism, these studies have primarily been focused on increasing variability in verbal responding (Dagher, 2017; Esch et al., 2009; Heldt & Schlinger, 2012; Susa & Schlinger, 2012; Wolfe et al., 2014). The limited number of studies that have been conducted using lag schedules to change play variability in individuals with Autism show promising results, but research in this area is currently very limited. Therefore, further research is needed to explore the effectiveness of lag schedules as an intervention for limited play variability in individuals with Autism and to address some of the limitations of past studies.

This current study aims to build on and expand previous research on lag schedules and play variability for individuals with Autism, by answering the following research questions:

1) Do lag schedules produce an increase in the play variability of a young child with Autism?
2) Does play variability generalise to similar toys?

3) Are increases in play variability maintained when lag schedules of reinforcement are removed?

Method

Participant

The participant was a 7-year-old boy who had a formal diagnosis of Autism (ASD) and Global Developmental Delay. He was non-verbal and had recently received an Augmentative and alternative communication (AAC) device for communication. He attended a regular public school with a one-on-one aid and had an in-home aid 9 hours per week. He displayed a limited play repertoire and limited play variability within play. His independent play typically consisted of moving toy items back and forth across his line of vision, turning play items in his hand and running around with play items in his hand before dropping them. The participant was recruited via a recruitment email sent to families whose children were involved in an early intervention programme. The participant's mother responded to this email to express interest. The participant was then identified as meeting inclusion criteria and selected for the study. Inclusion criteria included being between the ages of 3-7 years, having a formal diagnosis of Autism, parent report of limited play variability, three to four effective reinforcers, and not displaying extreme aggression or behavioural concerns that would limit their participation in the study. Participation in the study was voluntary and informed consent was given by the participant's mother.

Setting and materials

A small room in the participant's home was used for sessions for the music table and ball setting. This room contained drawers and clothing, and was selected as it presented limited distractions for the participant. For the playdoh setting a small desk and chair were used in a nearby room in the home. The desk was clear of any items except those required for

the session. Two toys were used for each of the settings, one for the intervention phase and the other for the generalization probes.

Table 1.

Play Items Used in Intervention and Generalisation Probes

Setting	Intervention phase	Generalisation probe
Ball Setting	Spiderman ball	Tennis ball
Music table Setting	Baby Einstein music table	Leapfrog music table
Playdoh Setting	Playdoh and tools	Modelling Dough and tools

A Baby Einstein music table, Spiderman ball and homemade playdoh and tools were selected as toys for the experimental conditions (see Figure 1). A Leapfrog music table, tennis ball and modelling dough and tools were selected for the generalisation probes (see Figure 2). Toys were selected based upon the child's interests, developmental appropriateness, practicality of the item, and parent feedback. Items were novel to the child, although he had experienced exposure to similar toys in the past.

Figure 1

Play Items Used in Experimental Conditions

Figure 2

Play Items Used in Generalisation Probes

Reinforcers used included verbal praise and either sensory inputs or access to a preferred toy for a short period. Sensory inputs included tickles, squishes, high 5's, back taps, and blowing air on the participant's hand or face. Access to short instances of preferred activities included bubbles, a spinning top toy, or pop tube. Reinforcers were identified via an informal interview with parents and a free operant preference assessment. Pen and paper data sheets were used to record play responses during sessions (see Appendix A). An iPhone 11 and small tripod were used to record videos of sessions. Visuals were presented alongside verbal information to indicate to the participant when a session was going to start and when the session was over (see Appendix B).

Experimental design

A changing criterion design was used, embedded in a multiple baseline across settings probe design. The multiple probe design was used to limit inadvertent learning. A changing criterion design was used for intervention phases with reinforcement being delivered in accordance with the lag schedule of reinforcement in place at that time. When stable responding was seen in a condition, the lag schedule was increased and the criteria required to receive reinforcement changed accordingly. For example, under a lag 1 schedule the

participant was required to vary play behaviours from the previous behaviour to receive reinforcement. Then under a lag 2 schedule the criteria changed, and the participant was required to vary play behaviours from the previous two play behaviours to receive reinforcement.

Dependent variables

Three dependent variables were measured in this study. 1) Average play variability. This was defined as the average number of responses in which each play behaviour differed from the previous play behaviours within sessions. This was found by adding together the number of responses in which each play behaviour differed from the previous behaviours and dividing this by the total number of play behaviours in that session. This figure gives an average of how many play behaviours the participant was performing before repeating a previously seen play behaviour. 2) Number of different play behaviours that occurred in each session. This was defined as the number of play behaviours that differed topographically within the session. This was found by adding up the number of different play behaviours seen within the session. 3) Novel responses across sessions. Novel play behaviours were defined as behaviours that had not been seen in any previous sessions. Novel play behaviours that occurred in each session were identified and calculated across all sessions.

To measure these dependent variables, a coding system was identified for each condition (see Appendix C). To create this coding system, a range of possible play behaviours were identified by the researcher and each play behaviour given a description and assigned a code. If play behaviours occurred in sessions that did not fit the play behaviours identified by the researcher, the new play behaviour was added to the list and received a description and code. Following the completion of each session, play behaviours that occurred in the session were coded. Based on the code that each play behaviour was assigned, it was then possible to identify the number of different behaviours in the session, novel

behaviours that occurred, and average play behaviour variability. From this information the dependent variables of interest could then be calculated.

Procedure

Pre-experimental procedures

Approval was gained from the Psychology Research and Ethics Committee, School of Psychology, University of Waikato prior to recruiting participants. The participant was then recruited via a group email to families involved in an early intervention program. An information sheet about the study was given to the parents (see Appendix D) and written consent obtained from the participant's mother for her child to be involved in the study (see Appendix E). Participation was voluntary and the parent could withdraw their child from the study at any time. Prior to experimental sessions, an informal interview was conducted with parents to help identify effective reinforcers. Pre-experimental sessions were also conducted with the participant for them to gain familiarity with the researcher and to conduct a free operant preference assessment.

Baseline

Baseline sessions were conducted for each setting. During baseline sessions the participant was presented with the toy on the floor and told "play with the ball/playdoh/music table". Play behaviours were recorded during these sessions but no reinforcers were delivered. Verbal praise such as "I like how you are playing" was delivered one to three times throughout the sessions to maintain engagement. Verbal praise was not contingent on varied play responses. Baseline sessions lasted 3 minutes, with the number of baseline sessions conducted differing for each setting.

Experimental sessions

Experimental sessions were 3 minutes in length. Up to six sessions occurred per day, with breaks for free play in between sessions. Prior to sessions starting the participant was

shown a visual (see Appendix B) and presented with a 10-second count down using the researcher's fingers to indicate a session was going to occur. This was used to assist in transitioning the participant to the room or table in which sessions occurred. Sessions began with the play item being placed on the floor and the participant instructed "play with the ball/playdoh/music table". Play behaviours were recorded on the data sheet and play behaviours that varied from the previous number of play behaviours required to meet the lag schedule criterion in place at that time were reinforced. The experimental phase was implemented for the music table setting first, followed by the ball setting, and then finally the playdoh setting. Baseline probe sessions continued to occur while intervention sessions were in progress for the earlier settings. When stable responding was seen for lag 1 in the music table setting, lag 1 for the ball setting was implemented. The intervention session for the playdoh setting was then started when stable responding was seen for the lag 1 phase of the ball condition.

Lag 1

A lag 1 schedule of reinforcement was implemented first for all settings. Under a lag 1 schedule of reinforcement any play behaviour that differed topographically from the previous play behaviour was reinforced. When stable responding was seen for a lag 1 condition, a lag 2 schedule of reinforcement was implemented for that setting.

Lag 2

Under a lag 2 schedule, reinforcement was delivered for any behaviour that differed topographically from the previous two play behaviours. When stable responding was seen for a lag 2 schedule of reinforcement, a lag 3 schedule of reinforcement was implemented for that setting.

Lag 3

Under a lag 3 schedule, reinforcement was delivered for any play behaviours that varied topographically from the previous three play behaviours. When stable responding was seen in lag 3, a fade condition was implemented. Due to COVID-19 restrictions, the research study had to be stopped early. As a result, intervention was stopped for the ball and playdoh settings at the end of lag 3.

Fade condition

A fade condition was implemented to help reduce the impact of extinction due to withdrawal of reinforcement. During this fade condition, a lag 3 schedule of reinforcement remained in place, but only verbal praise was implemented as a reinforcer. This fade condition was only implemented for the music table setting.

Maintenance condition

During maintenance, baseline conditions were implemented. Maintenance probes were taken four sessions apart. The maintenance condition was only implemented for the music table setting.

Response definitions

A list of possible play behaviours for each toy was made prior to the intervention and play behaviours coded (see appendix C). Additional play behaviours were added if they presented and were not on the original list. Functional play was not a requirement to allow for creativity and flexibility in play. Therefore, any changes in topography or how the item was manipulated were considered to be different from the previous behaviour, irrelevant of function. For example, kicking the ball with the outside of the foot, inside of the foot and the toes were considered three different play behaviours even though the function is the same. Lying on the ball was also considered to be a play behaviour even though this may not be considered functional play with a ball. Under the lag schedules used, high levels of novel responding were not required. If responding differed sufficiently to meet the lag schedule

criteria in place at the time, reinforcement would be delivered. This meant that the participant could alternate between two behaviours under a lag 1 schedule or cycle between the same three or four behaviours under a lag 2 or lag 3 schedule. Therefore, novel play behaviours across sessions and number of different play behaviours in sessions were also measured to help understand overall variability of play responses.

Generalisation probes

Generalisation probes were conducted at baseline, prior to an increase in a lag schedule and at follow up. Toys used in generalisation were similar in form and function to those used in experimental sessions for each setting (see Figure 2). Generalisation probes were conducted under baseline conditions.

Interobserver agreement

All sessions were videoed and 25% were then reviewed by a second observer for interobserver agreement (IOA). Videos selected for review were identified using a random number generator with each number being linked to a session. As a result, sessions reviewed included sessions from all conditions across the three settings. However, a set number was not reviewed for each condition, and the number of sessions reviewed from each session was dependent on the random numbers generated. The second observer was a behavioural aid who volunteered her time. During training, response definitions were explained to her and the different behaviours listed on the coding sheet modelled. She then had the opportunity to watch one or two practice sessions where she could ask questions and compare her results to the primary investigator. Agreement of 80% or higher between the investigator and second observer was achieved during these training videos. During collection of interobserver data, videos were presented in randomized order and the second observer was blind to the lag schedule in place. The secondary observer was required to record what play behaviours they observed during the session and the corresponding code they believed the behaviour fit into.

Two methods were used to calculate interobserver agreement. Firstly, total count IOA was used to calculate agreement for reinforcer delivery within sessions. Because the secondary observer was blind to condition and therefore what lag schedule was in place, this was done by having the secondary observer code all behaviours they observed in session using the coding system (see Appendix C). Based upon the behaviours they coded, it was then identified what behaviours would meet the lag schedule criterion in place at the time and therefore receive reinforcement. The number of behaviours that were identified as meeting criteria for reinforcement were then calculated and compared to the number of behaviours that received reinforcement in the experimental session. The smaller number was then divided by the larger to get a percentage for total IOA (Cooper et al., 2019). The second type of IOA calculated was an adaptation of exact count per interval IOA. This IOA considered if the researcher and secondary observer were coding the play behaviours in the same way. This was important as how behaviours were coded influenced the measurement of dependent variables. To calculate this, coding of play behaviours by the researcher and the secondary observer were compared, and every play behaviour recorded by each observer scored as an agreement or a disagreement. An agreement was scored for a play behaviour that both the researcher and secondary observer assigned the same code. A disagreement was when a play behaviour was assigned different codes by the researcher and the secondary observer or when one person recorded a play behaviour, but the other did not. To calculate the IOA for the coding of play behaviours, the number of agreed upon play behaviours were divided by total number of play behaviours coded in the session and multiplied by 100 to get a percentage.

Data analysis

To analyse the data, a visual analysis of the graphed data was used to assess variability, level, trend, and immediacy of change (Cooper et al., 2019). Variability refers to the extent to which data points are similar in value. Level refers to the value on the vertical

axis in which data points converge. When data points fall at or near a specific level, the behaviour is considered to be stable. Trend refers to the overall direction taken by the data path. Trend can be described as either increasing, decreasing, or zero trend.

Mean and range were also calculated. Mean is the average of the numbers and was found by adding up the sum of the data points in a condition and dividing that by the number of data points in the condition. Range was found by taking away the number of the lowest data point from the number of the highest data point in each condition. Mean and range were calculated for each condition, within each setting.

Effect size was also used to analyse the data by calculating the percentage of non-overlapping data (PND). PND was calculated by dividing the number of data points in the lag 3 condition that exceeded the highest data point in the baseline condition, by the total number of data points in the lag 3 condition and multiplying the outcome by 100. This gave the effect size between the lag 3 condition and the baseline condition in each setting. For the music table setting, the effect size was also calculated between the maintenance condition and baseline using this same procedure.

Results

The effectiveness of lag schedules of reinforcement on increasing a child's play variability was assessed by analysing changes in average play behaviour variability, number of different play behaviours in-session, and novel play behaviours. Visual analysis of trend, level and variability was used to assess changes within conditions. The mean, range, and PND effect size were calculated and used alongside visual analysis of trend, level, variability, and immediacy of change for between condition analysis. Results presented below are organized by the three dependent variables assessed: average play variability, number of different play behaviours and novel responding.

Average play variability

Average play variability was defined as the average number of responses in which each play behaviour differed from the previous play behaviours within each session. Average play variability across sessions is presented in Figure 3. Visual analysis of variability, trend, and level demonstrate increases in average play variability in intervention when compared to baseline. Average play variability remained higher than at baseline for the fade and follow up condition for the music table. Fade and follow up sessions were not conducted for the other two settings. In addition to increases in play variability seen between baseline and the lag 3 condition, increases in average play variability were also seen between conditions.

An increasing trend was seen for all intervention conditions for both the music table and the ball setting, although the trend was very small for the lag 2 condition for the music table. For the playdoh setting, an increasing trend was seen in lag 1, but a decreasing trend was observed in lag 2 and lag 3. Levels were seen to increase between baseline and final intervention conditions for all three settings. Increases in level were also seen between conditions, with levels increasing between lag 1, lag 2 and lag 3 conditions for all three settings. Visual analysis of data points before and after a change in lag schedule was used to assess immediacy of change. Increases in average play variability were seen following a change in lag schedule for the majority of the conditions. This included lag 1 and lag 3 conditions for the music table, lag 2 and lag 3 conditions for the ball and all three intervention conditions in the playdoh setting. However, despite these increases seen following the introduction of a new lag schedule, responding was often variable. High variability was evident across all intervention conditions for the ball setting. In the music table setting, variability was high for lag 1 and lag 3, with stable responding seen in lag 2. In the playdoh setting, responding was moderately stable in the lag 1 and lag 2 conditions, with outliers evident that influenced variability. High variability was evident in the lag 3 condition for the

playdoh. High levels of overlap can be seen between the lag 1 and lag 2 conditions for the music table, lag 2 and lag 3 conditions for the ball, and all three intervention conditions for the playdoh. A decrease in average play variability was seen for the fade and maintenance conditions, when compared to lag 3 for the music table. Responding in the fade and maintenance conditions occurred at similar levels to the lag 2 condition. However, despite a decrease in average play variability compared to lag 3, average play variability in the fade and maintenance conditions occurred at higher rates than was seen in baseline.

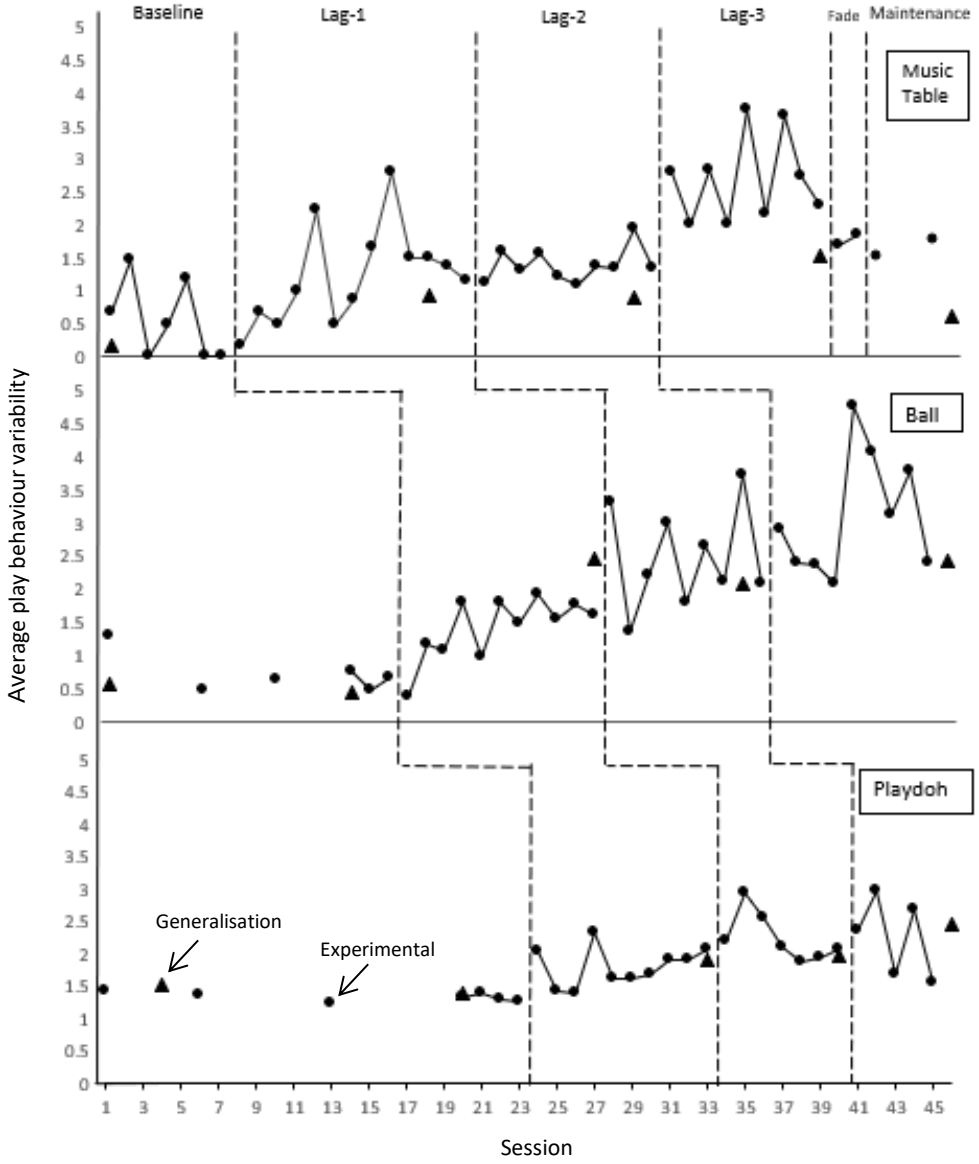
Generalisation

Generalisation probes were conducted at baseline and prior to a change in lag schedule. Average play variability for generalisation probes is shown in Figure 3. Increases in average play variability at generalisation were seen compared to baseline conditions for all three settings. Increases were also evident across conditions, with higher lag schedules in place in the equivalent experimental session leading to higher average play variability in generalisation. One exception to this was the ball setting, where the highest average play variability for generalisation probes was seen in lag 1. In the ball and playdoh settings, average play variability in generalisation probes occurred at similar levels or in some cases higher levels than the equivalent experimental sessions. For the music table, average play variability seen in generalisation was lower than levels seen in the equivalent experimental sessions. In lag 1, average play variability in generalisation fell within the range of responding in the experimental condition, but below the level of responding seen in the equivalent experimental datapoint. For lag 2 and lag 3, play variability in generalisation fell below the ranges seen for average play variability in the experimental conditions. Overall, it appears that the increases seen in average play variability with experimental toys generalised to the toys used in generalisation probes. This is supported by the fact that increases in

average play variability were seen for generalisation toys for all three settings, despite no intervention being implemented with these toys.

Figure 3.

Average Play Behaviour Variability



Mean and range

Mean and range of average play behaviours within condition were calculated (see Table 2). A visual representation of the mean and range for average play variability is shown in Figure 4. Overall, mean average play variability increased across conditions, with higher lag schedules leading to higher mean average play variability. One exception to this was the

lag 3 condition for the playdoh setting. In this setting, mean average play variability was the same for both the lag 2 and lag 3 conditions. A decrease in mean average play variability was also seen in the fade and maintenance conditions for the music table setting compared to the lag 3 condition. A small range was seen for all three conditions in the playdoh setting and the lag 2 condition in the music table setting. A large range was evident for all three conditions in the ball setting and lag 1 and lag 3 conditions in the music table setting. The range was also small for the fade and maintenance conditions in the music table setting. However, this was likely influenced by the limited data points collected in these conditions. The mean for average play variability met the current lag schedule in place for all conditions in the ball setting, lag 1 and lag 2 in the playdoh setting, and lag 1 in the music table setting. The mean average play variability was at or above the number of the lag schedule currently in place for these conditions. The mean average play variability was below the current lag schedule in place for lag 2 and lag 3 for the music table setting and lag 3 for the playdoh setting.

Table 2.

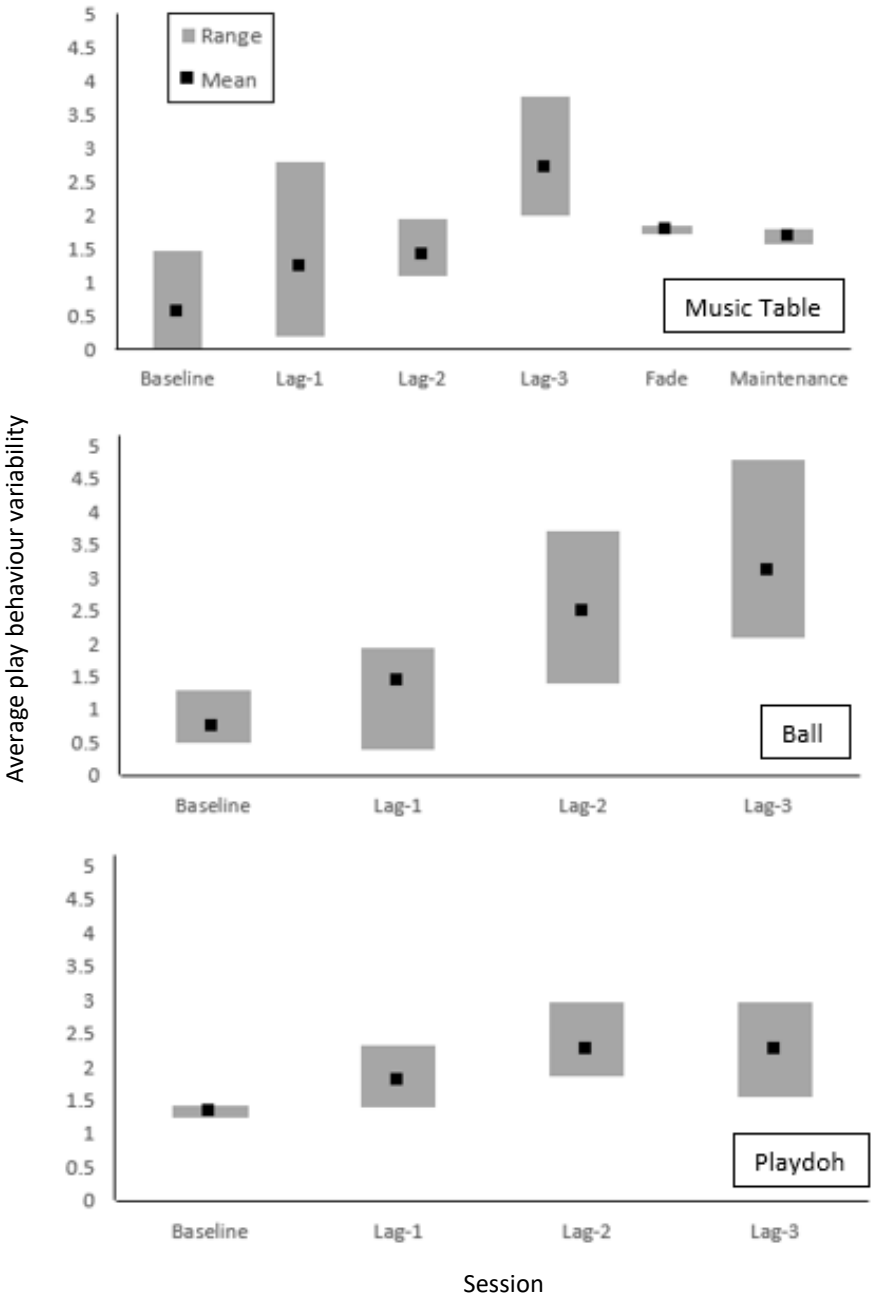
Mean and Range of Average Play Behaviours Within Conditions

Condition	Music table Setting		Ball Setting		Playdoh Setting	
	M	Range	M	Range	M	Range
Baseline	0.55	0.0-1.5	0.73	0.5-1.3	1.33	1.2-1.4
Lag-1	1.23	0.2-2.8	1.43	0.4-1.9	1.79	1.4-2.3
Lag-2	1.39	1.1-1.9	2.48	1.4-3.7	2.24	1.9-2.9
Lag-3	2.70	2.0-3.8	3.10	2.1-4.8	2.24	1.6-2.9
Fade	1.78	1.7-1.9	-	-	-	-
Maintenance	1.67	1.6-1.8	-	-	-	-

Note. Fade and maintenance conditions were not conducted for the ball and playdoh settings.

Figure 4.

Mean and Range of Average Play Behaviours within Conditions



Effect size

Effect size was calculated for average play variability between the lag 3 condition and baseline for each setting using PND. PND was 100% for the music table setting, 100% for the ball setting and 100% for the playdoh setting. PND was also calculated between the maintenance condition and baseline for the music table setting, resulting in a PND of 100%.

When considered together, visual analysis, mean, range and the effect size show support for a functional relationship between lag schedules of reinforcement and increases in average play variability. Support for this relationship is evident across the music table, ball, and playdoh settings.

Number of different play behaviours in session

The number of different play behaviours occurring within session is presented in Figure 5. Visual analysis of variability, trend, and level were used to assess changes in the number of different play behaviours in session, within and across conditions for each of the three settings.

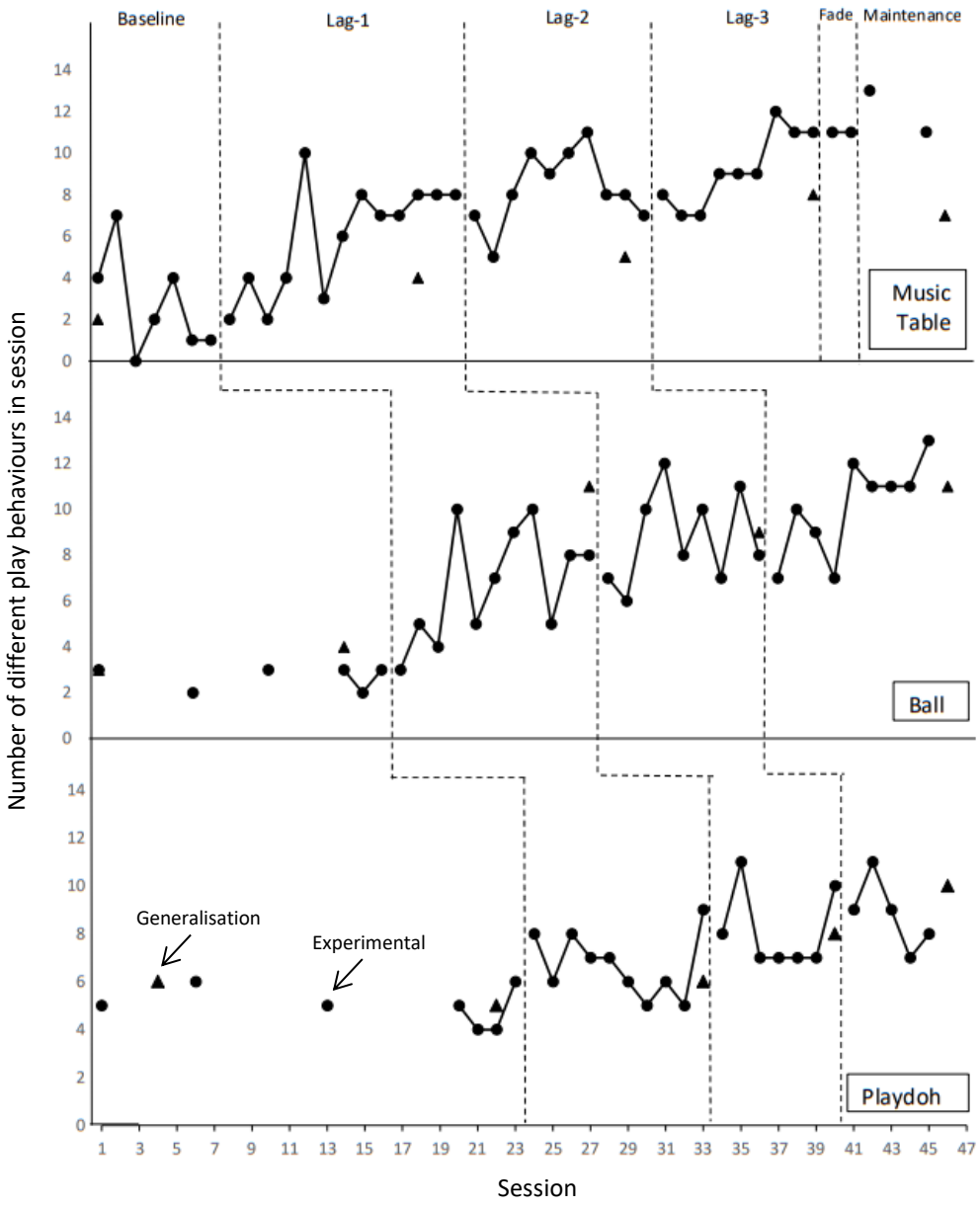
A decreasing trend is seen in baseline for the music table setting, followed by an increasing trend across all intervention conditions. Level was seen to increase in intervention conditions compared to baseline, with increases in level also being seen across each lag schedule condition. Responding was variable for lag 1 and lag 2. Data in lag 3 showed a more stable increasing trend. The variability observed influenced overlap, and overlap in data points was evident between each condition. The increases in number of different play behaviours in session that were seen across intervention conditions remained and increased in the maintenance condition. The highest number of different play behaviours seen in session occurred in the maintenance condition. Based on the limited number of data points collected in the fade and maintenance conditions, a trend and variability could not be identified.

A stable baseline was seen in the ball condition, followed by an increasing trend across all intervention conditions. Level increased between both baseline and intervention conditions, and between each lag schedule condition. Variable responding was evident across all three intervention conditions. High overlap in data points is evident between each condition.

In the playdoh setting stable responding is seen at baseline. An increasing trend is then seen with the introduction of the lag 1 condition. No clear trend was evident in the lag 2 condition and a decreasing trend was seen in the lag 3 condition. Despite this decreasing trend, increases in level are seen between both baseline and intervention conditions, and between each lag schedule condition. Variable responding is seen across all three intervention conditions, with high overlap of data points between each intervention condition.

Figure 5.

Number of Different Play Behaviours Occurring Within Session



Generalisation

The number of different play behaviours in session that occurred in generalisation probes is shown in Figure 5. Increases in the number of different play behaviours in session were seen for all three generalisation toys relative to baseline responding. Overall, higher lag schedules in place in the experimental condition led to higher number of different play behaviours in the generalisation probe. One exception to this was the ball setting, where the highest number of different play behaviours in session was seen for the generalisation probe conducted in lag 1. For the ball and playdoh setting, the number of different play behaviours in generalisation probes were similar, or in some cases higher, than the number of different play behaviours in the equivalent experimental sessions. This indicates that increases in the number of different play behaviours in session occurred at similar levels for the generalisation toys as it did for the experimental toys. In the music table setting, despite increases in the number of different play behaviours in session in generalisation probes, these increases did not occur at the same level as seen in the experimental conditions. Increases in number of different play behaviours occurring in session despite no intervention shows support for generalisation of variable play behaviours from the experimental toys to the generalisation toys.

Mean and range

Mean and range of number of different play behaviours in session are presented in Table 3. A visual representation of the mean and range is shown in Figure 6. An increase in the mean number of different play behaviours in session is seen as the lag schedule in place increases. Increases in the number of different play behaviours occurred across all three intervention conditions for all three settings. These increases across intervention sessions were maintained in the fade and maintenance condition for the music table. The mean number of different play behaviours in the fade condition was higher than in the lag 3

condition. The mean number of responses in the maintenance condition was the highest of all conditions. Fade and maintenance conditions were not conducted for the ball and playdoh settings. The highest mean number of different play behaviours occurred in the lag 3 condition for these settings. A large range was observed for lag 1, lag 2 and lag 3 intervention conditions. Low ranges were seen in baseline responding for the ball and playdoh setting, as well as in the fade and maintenance conditions for the music table. Low ranges evident in the fade and maintenance condition were influenced by limited data points in these conditions.

Table 3.

Mean and Range of Number of Different Play Behaviours in Session Across Conditions

Condition	Music table Setting		Ball Setting		Playdoh Setting	
	M	Range	M	Range	M	Range
Baseline	2.71	0-7	2.67	2-3	5.00	4-6
Lag-1	5.92	2-10	6.73	3-10	6.70	5-9
Lag-2	8.30	5-11	8.78	6-12	8.14	7-11
Lag-3	9.22	7-12	10.11	7-13	8.80	7-11
Fade	11.0	11-11	-	-	-	-
Maintenance	12.0	11-13	-	-	-	-

Note. Fade and maintenance conditions were not conducted for the ball and playdoh settings.

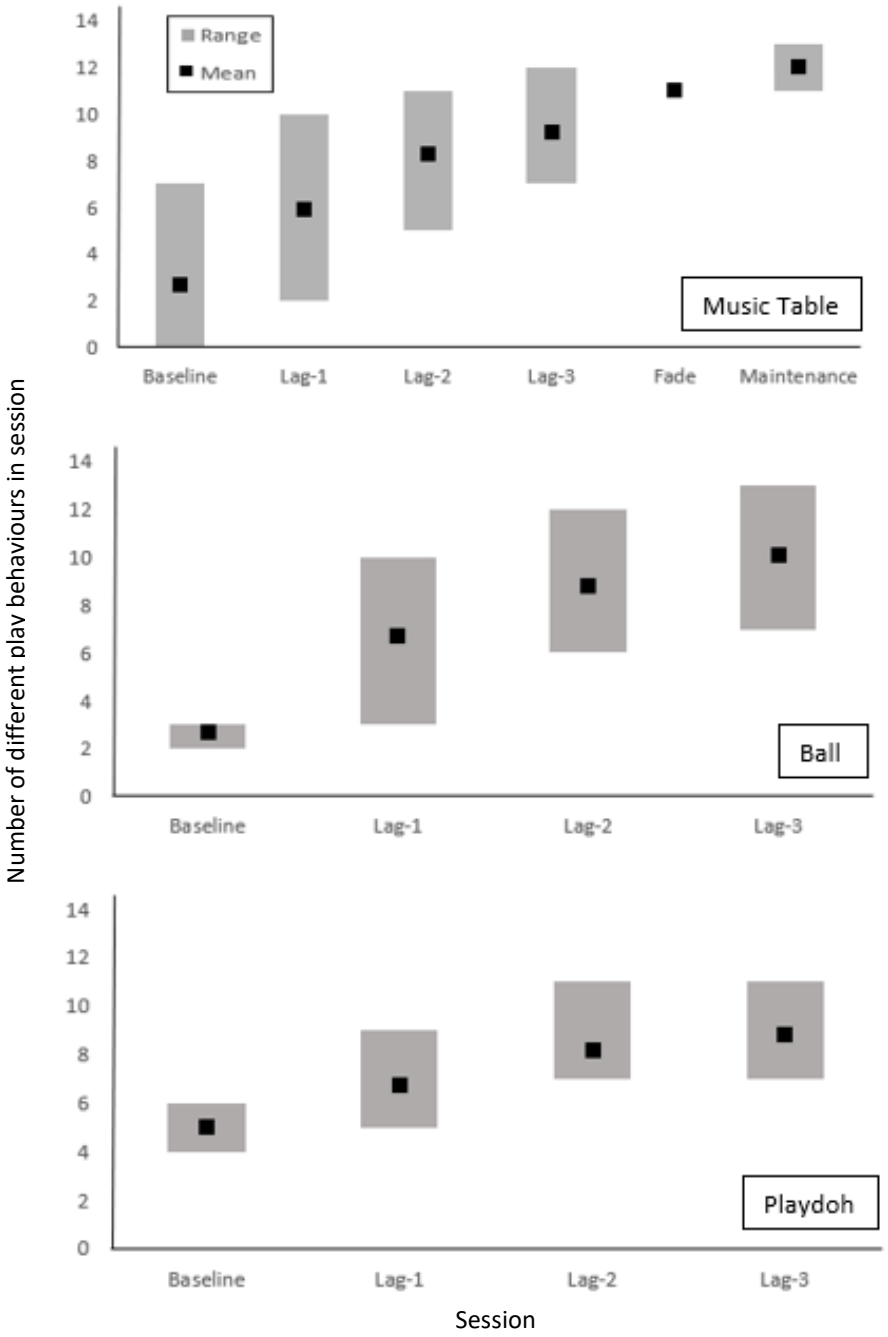
Effect size

PND was used to calculate the effect size of the number of different play behaviours in session between the lag 3 condition and baseline for each setting. PND was 78% for the music table setting, 100% for the ball setting and 100% for the playdoh setting. PND was also calculated between the maintenance condition and baseline for the music table setting, resulting in a PND of 100%.

When considered together, visual analysis, mean, range, and the effect size show support for a functional relationship between lag schedules of reinforcement and increases in the number of different play behaviours that occur in session. Support for this relationship is evident across the music table, ball and playdoh settings.

Figure 6.

Mean and Range of Number of Different Play Behaviours in Session Across Conditions



Cumulative number of novel play behaviours

The number of novel play behaviours observed varied greatly between settings. As a result, data from each setting has been presented individually. A novel behaviour was defined as a play behaviour that had not been observed in previous sessions. A list of all play behaviours observed in each setting is provided in Appendix F. Novel responding for the music table is presented in Figure 7. Nine of the 15 play behaviours observed for the music table occurred during baseline sessions. Another four novel behaviours then occurred under lag 1 conditions, another one under the lag 2 condition, and one final novel play behaviour during the maintenance condition. Altogether, 15 novel play behaviours occurred in the music table setting. Greater rates of novel play behaviours were observed for the ball and playdoh settings. Cumulative novel responses for the ball setting are presented in Figure 8. In the ball setting, five novel behaviours occurred in baseline, 25 in the lag 1, eight in the lag 2, and 10 in the lag 3. A total of 48 novel behaviours were observed in the ball setting. Cumulative novel responses for the playdoh setting are presented in Figure 9. In this setting, 11 novel behaviours were seen in baseline, 11 in lag 1, 3 in the lag 2 and 2 in lag 3. There were a total of 27 novel behaviours in the playdoh setting.

Figure 7.

Cumulative Number of Novel Play Behaviours Observed in Music Table Setting

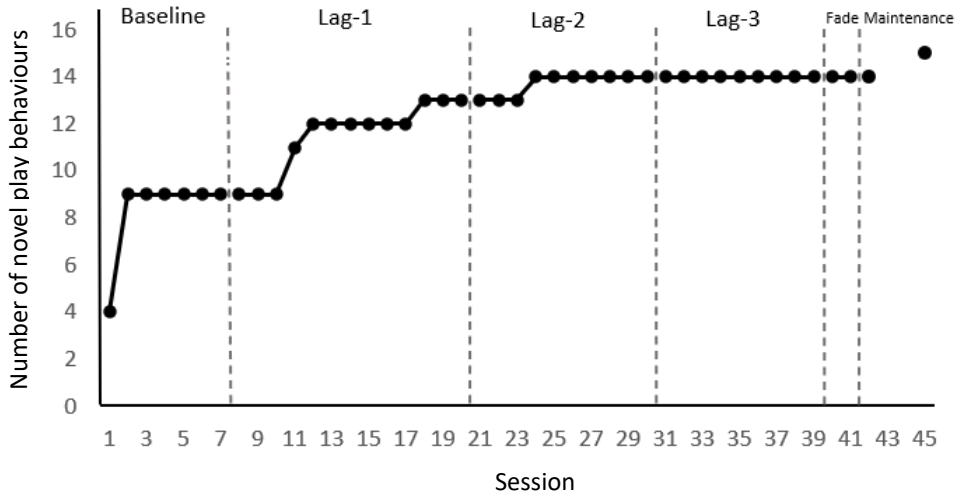


Figure 8.

Cumulative Number of Novel Play Behaviours Observed in Ball Setting

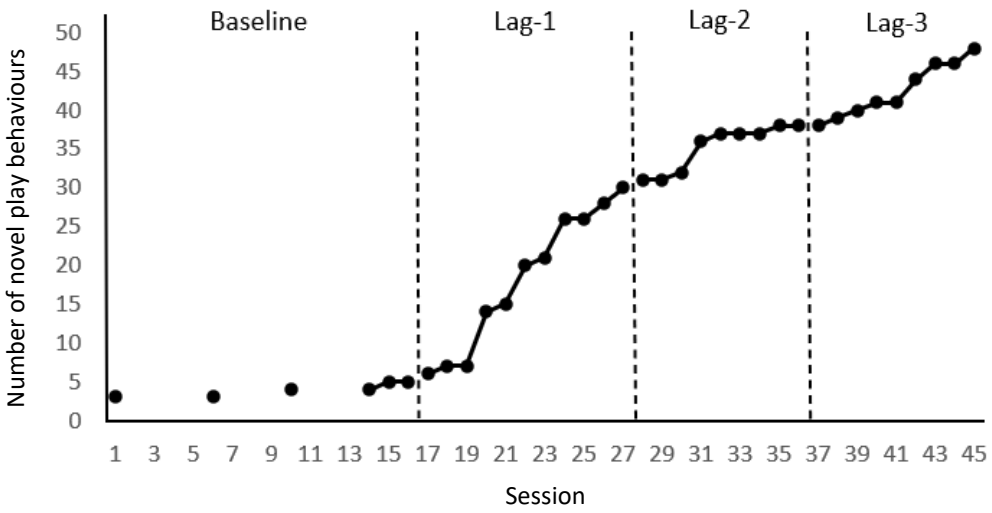
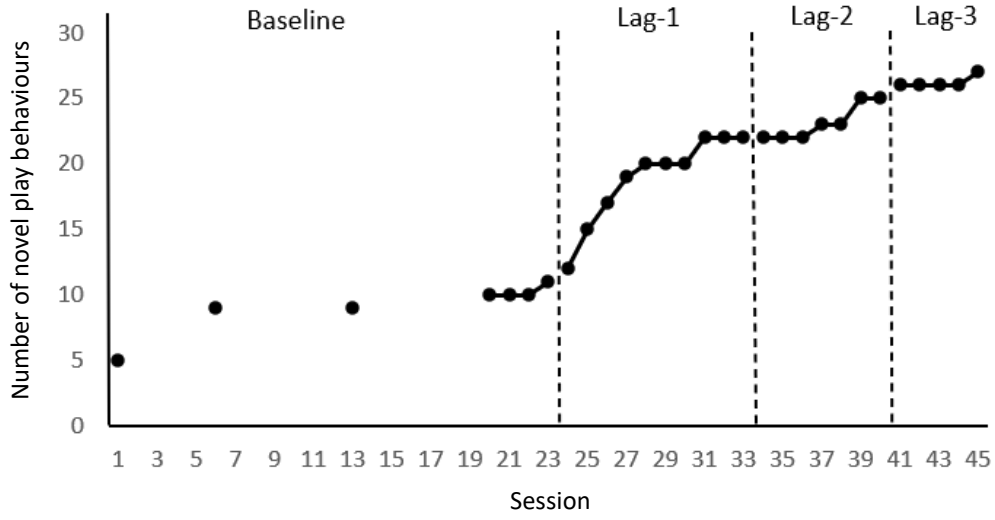


Figure 9.

Cumulative Number of Novel Play Behaviours Observed in Playdoh Setting



Interobserver agreement

Two methods were used to calculate interobserver agreement (IOA). Firstly, total count IOA and secondly an adaptation of exact count per interval IOA described previously. 25% of sessions were reviewed for inter-observer agreement. Total count IOA was used to assess agreement between the researcher and secondary observer for the number of reinforcers delivered. Total count IOA was 92.3% for the music table setting, 80% for the

ball setting and 64.7% for the playdoh setting. An adaptation of trial-by-trial IOA was used to measure agreement between the researcher and secondary observer on how behaviours were coded. Results showed 91% for the music table setting, 86% for the ball setting and 69% for the playdoh setting for this type of IOA.

Discussion

The purpose of this study was to investigate the effects of lag schedules of reinforcement on play variability in a young child with ASD. The study aimed to answer three key questions: 1) Does the use of lag schedules lead to increased play variability? 2) Does play variability generalise to similar toys? 3) Are increases in play variability maintained when lag schedules of reinforcement are removed?

Three measurements were used to assess changes in variability. These were average play variability, number of different play behaviours in session and novel responding. Average play variability and number of different play behaviours in session were used to assess response diversity, and novel responses across sessions was used to assess novel responding. When considered together, response diversity and novel responding reflected overall variability in play.

Play variability

Increases in average play variability and number of different play behaviours were evident between baseline and intervention for all three settings. An effect size of 100% between lag 3 and baseline was found for average play variability, across all three settings. This effect size demonstrates highly effective treatment (Alresheed et al., 2013). Intervention was also found to be highly effective for number of play behaviours in session for the ball and playdoh conditions, with an effect size of 100% found between lag 3 and baseline. For the music table setting an effect size of 78% was found between lag 3 and baseline for number of different behaviours in session, demonstrating fairly effective treatment

(Alresheed et al., 2013). This was heavily influenced by one session in baseline that displayed a high number of different play behaviours in session. When the effect size was calculated between maintenance and baseline sessions for the music table, highly effective treatment outcomes were found with a PND of 100%. These effect sizes demonstrate highly effective treatment outcomes and show strong support for the implementation of lag schedules leading to increased response diversity. Novel play behaviours were also found to increase with the introduction of lag schedules across the three settings. These findings therefore provide support for a functional relationship between lag schedules and play variability, suggesting that use of lag schedules produced increased play variability.

An interesting finding of these results is that increases were seen in the number of play behaviours in session and novel responses despite these behaviours not being directly targeted. Reinforcement occurred for any behaviour that differed from the previous behaviours in accordance with the lag schedule in place at the time. It was not required for a behaviour to be novel either within session or across sessions to receive reinforcement. The recording and measurement of novel responses across sessions and number of different play behaviours in session were included to give a better understanding of how play variability was presenting. The increases seen in number of different play behaviours in session and novel responding demonstrate that lag schedules of reinforcement produced increases in both response diversity and novel responding. Increases seen in all three measures of play variability demonstrate that lag schedules were effective at increasing over all play variability even though intervention did not target all areas of variability.

Another finding that requires further discussion is that the number of novel responses across sessions varied significantly between the three settings. Total number of novel play behaviours across sessions were 15 for the music table, 27 for the playdoh, and 48 for the ball. One likely explanation for this finding is that different toys encourage and allow for

different degrees of novel responding. A study by Harrison (2020) observed play variability that naturally occurred in five typically developing children across different play items. The findings showed that a higher number of variable play behaviours and novel responses occurred for toy playsets compared to single toys. These findings support the idea that different toys allow for and encourage different degrees of play variability. Harrison (2020) concluded that toys that have more components will likely allow for greater novel responding and generate the highest levels of variability and novelty.

The toys used for the three settings differed significantly in the level of novel responses, and therefore, also in the variability they allowed. When used alone, the playdoh allows for a high number of different play behaviours. Providing the four different playdoh tools significantly increased the number of possible play behaviours. The ball, although a single play item, allowed for a large number of different play behaviours. Opportunities for novel responses were increased further given that functional play was not a requirement, so any interaction with the ball that differed topographically was considered a different behaviour. The music table allowed for the lowest levels of novel responses and play variability as play behaviours were limited by the number of buttons on the music table. The music table only had 15 buttons, meaning that this was the total number of novel behaviours possible. The participant displayed all 15 of these possible novel behaviours across sessions. The limited number of novel responses possible in the music table created a ceiling effect and therefore explains why the total number of novel responses was significantly lower in this setting, relative to the other two settings.

Number of novel responses possible with each toy also influences novel responding across sessions. Number of novel play behaviours produced was seen to decrease as lag schedules in place increased. This was evident across all three settings, with the lowest levels of novel play behaviours occurring in the lag 3 conditions. These findings are similar to those

of Baruni et al. (2014) which found that when lag 2 intervention was introduced extremely small increases in novel play was seen in individuals with ASD with a train and car. A likely explanation to these findings is that each toy has a certain number of possible and likely play behaviours. Therefore, as novel responding occurs across sessions the number of novel play behaviours that are possible decreases. As a result of high levels of novel responding in baseline or lag 1 this reduces the number of novel responses possible in later sessions. It is therefore likely that it is not the higher lag schedules that produce lower novel responding, but rather when higher lag schedules are introduced the number of possible novel behaviours is lower. The inclusion of normative data in future research would be helpful to identify how much novel responding naturally occurs in the play of typically developing children with the play items included in the study.

Another notable finding was that the smallest increases in average play variability and number of different behaviours in session were observed in the playdoh setting. Based on Harrison's (2020) findings it would be expected that as playdoh has the most components it would allow for and generate the highest levels of variability. Interestingly, this was not the case for any of the three measurements of variability in lag 3. Rather a decreasing trend was seen for average play variability and number of different play behaviours in session in lag 3 for the playdoh condition. A number of possible factors may have influenced these outcomes including exposure, preference and fatigue.

Although toys used in the study were novel to the child, the participant had experienced exposure to similar toys in the past. Parents reported that the family had balls in the home and in the past had toys similar to the music table. They reported playdoh was not something they had in the home, but that the participant had exposure to this play item in the school setting. Therefore, degree of exposure may have influenced outcomes. Preference is another factor that may have influenced outcomes as lower preference for the playdoh may

result in less engagement and variability. However, baseline responding for playdoh was higher relative to the other settings for both average play variability and the number of different play behaviours in session. This demonstrates that the participant already had a number of play behaviours for playdoh in their repertoire and engaged with the playdoh, suggesting that other factors may better explain these results. Fatigue over time could offer an explanation for the decreasing trend seen in lag 3 and smaller increases in play variability seen in the playdoh setting. A large number of sessions had already been conducted when lag 3 intervention for playdoh started. The participant began to show disinterest in these later sessions and this may have contributed to the results seen especially the decreasing trend seen in lag 3.

Another factor that may have influenced the lower responding seen is that average responding in baseline was already high. As a result, in lag 1 the participant's average play variability was already above what was required for the lag schedule in place. This therefore did not offer an incentive for the participant to increase play diversity. Similar data was evident at the start of the lag 2 condition. The mean average play variability for this condition was above two, demonstrating that across the condition mean average variability occurred above the lag schedule in place. This again resulted in the participant not having a strong incentive to increase play diversity. This likely explains why increases in average play variability did not increase as much as expected. Responding was already occurring at the level required to gain regular reinforcement therefore there was little incentive to increase play diversity. Better outcomes may have been achieved for this setting if intervention had started with a lag 2 schedule. This would have required that play variability increase to gain reinforcement as soon as intervention was introduced.

In addition to the factors discussed above, complexity of play may also offer another explanation as to why novel responding and number of different play behaviours in session

was lower for playdoh than would be expected. Playdoh allows for a diverse range of play behaviours. Possible play behaviours include manipulation of the playdoh with hands (e.g., squishing, squeezing, pinching, rolling), combining tools and playdoh (e.g., rolling playdoh out with the roller, cutting playdoh, making shapes with the cutter), and imaginary play such as making pretend food items (e.g., – biscuits or pies) or making models out of the playdoh (e.g., a snake, other animals, a building, figurines). However, the ability to produce all of these play behaviours is dependent on the child's current play skills, given that a number of the possible behaviours require complex play skills (e.g., combining two objects in a functional way and imaginative and symbolic play). Looking at the participant's play behaviours across the three settings (see Appendix F) the majority of the play behaviours displayed across the three settings would be considered cause and effect play. Although some combining of the tools and playdoh occurred in the playdoh setting, the majority of the play seen involved manipulation of the playdoh with hands. This suggests that the participant may not have yet developed the more complex play skills that would allow for more novel responding and variability to occur with the playdoh. It is therefore likely that although it is expected that playdoh would allow for the highest level of play variability, the participant's current level of play skills meant that they could not yet do a number of the more complex play behaviours with the playdoh.

Generalisation

Increases seen in play variability for experimental toys were also seen to generalise to similar toys used in the generalisation probes. Increases in average play variability and number of different play behaviours in session were observed in generalisation probes for all three settings. Generalisation is "the occurrence of relevant behavior under different, nontraining conditions" (Stokes and Baer, 1977, p. 350). Generalisation is important for play behaviours as it is not practical to teach play variability with every individual toy. However,

it is important to note that although spontaneous generalisation did occur to generalisation toys, generalisation did not occur between intervention toys. This suggests that the use of lag schedules can produce generalisation for similar toys, but not necessarily for toys that are not similar in function or form. This therefore highlights the importance of training what Stokes and Baer (1977) describe as sufficient exemplars when teaching play skills to individuals with ASD, suggesting that training is required across a number of different categories and types of toy play for individuals with ASD.

Another finding of interest was that play variability in the music table generalisation probes was lower than what was seen in the ball and playdoh setting generalisation probes. Average play variability and number of different play behaviours in-session for music table generalisation probes was below the range of responding in the equivalent experimental condition. Differences in the degree of variability allowed for and encouraged discussed earlier may have also influenced this outcome. In the music table setting, although both music tables were similar, they differed in level of novel responding possible and likely also level of variability they encouraged. The generalisation music table only allowed for 12 novel behaviours to occur, and it also had more buttons that required movements other than pushing, such as sliding, spinning or flicking to one side. The generalisation toy was also slightly larger, meaning the participant had to reach further or move their position to reach the back buttons. Sound outputs from the buttons also differed across the two music tables. These factors likely encouraged different degrees of responding and combined with the lower number of possible novel responses, may explain why play variability in generalisation was lower for the music table. The ball and playdoh generalisation toys were very similar to the experimental toys and allowed for similar levels of play variability and novel responding. Therefore this likely explains why variability was similar in experimental and generalisation conditions for these settings.

Maintenance

Due to COVID-19 restrictions maintenance probes were only able to be completed for the music table setting. When compared to baseline, results demonstrated increases in play variability were maintained at follow up when lag schedules were withdrawn. Interestingly, during maintenance, the number of different play behaviours in session increased for one session, but average play variability decreased to the equivalent of lag 2 levels. One possible explanation for this decrease in average play variability is that different toys present with possible limitations on how naturally reinforcing variability is. This is difficult to conclude without normative data being collected for the toy play items used. It is hypothesised that what was observed in maintenance is what you may expect to see occurring in the play of typically developing children with this toy. This hypothesis is based upon the view that when using the music table, it would be unlikely that a child would rotate between every button on the music table in a set order, pressing each button once. Rather, it is more likely they would attempt to make a tune or a beat. To do this they might press piano keys a number of times or press the drum repeatedly to make a beat. This would likely result in them exploring the different buttons on the music table, but often repeating the same buttons or the same few buttons in a row to produce a tune or beat. Further research could benefit from having normative data for the play of children of similar ages without disabilities for the toys used in the study. The level of variability that naturally occurs and level to which variability is naturally reinforcing could then be considered and comparisons made.

Contributions to the literature

The results of this study are consistent with the findings of Baruni et al. (2014) and Napolitano et al. (2010), which also showed increases in play variability in children with ASD when lag schedules of reinforcement were implemented. The findings regarding generalisation of play variability are also consistent with the findings of Lang et al. (2014)

that demonstrated the use of lag schedules to produce generalisation of play variability. The findings of this current study build on the limited amount of past research in this area and add to the research in a number of ways.

Firstly, the highest lag schedule implemented in previous studies of play variability in individuals with ASD was a lag 2 schedule (Baruni et al, 2014; Lang et al, 2014; Napolitano et al, 2010). The use of lag 1, lag 2 and lag 3 schedules in this study addresses a limitation identified by Lee, McComas and Jawor (2002), that under lower lag schedules (such as a lag 1 schedule), the participant can receive reinforcement by rotating between two responses. By using lag schedules higher than a lag 1, the participant needed to expand their play behaviours beyond only two behaviours. The implementation of three different lag schedules also allowed for exploration of how play variability is influenced by higher lag schedules. Findings showed that overall higher lag schedules led to higher play diversity. However, there were a few exceptions to this. One exception was that mean average play variability in lag 3 remained at the same level as was seen in lag 2 for the playdoh condition. Novel responding was also seen to decrease as lag schedules increased. As discussed previously, this is likely a result of opportunities for novel responding being lower in later intervention sessions rather than as an outcome of higher lag schedules. Overall the findings support that higher lag schedules produce higher variability in play based on the lag schedules implemented in this study.

Measurement of variability used in this study also addressed some of the limitations identified in previous research. Baruni et al. (2014) suggested that not including a measurement for response diversity may result in important information about variability of behaviour being missed. Baruni et al. (2014) also highlighted that ceiling effects were possible when using novel responding as a measurement of variability. Therefore three different measures of play variability were used in this study. The use of multiple measures

allowed for a broader understanding of how variability was presenting and allowed for patterns in responding to be monitored. The use of average play variability and number of different play behaviours in session offered data on response diversity and reduced the sole reliance on novel responses, a measure that is more prone to ceiling effects. The use of average play variability gave an average of how many play behaviours the participant was performing before repeating a previously seen play behaviour. This gave an indication of how closely average responding was occurring, both in- session and across conditions, in relation to the lag schedule in place. The number of different play behaviours in session offered important information regarding how many different play behaviours the participant used to access reinforcement. This meant that it was possible to see if the participant was rotating through the minimum number of behaviours required to access reinforcement. This being two different behaviours for lag 1, three for lag 2 and four for lag 3. The findings demonstrate that the number of different play behaviours in sessions were significantly higher than the minimum number of different behaviours required to access reinforcement. The use of novel responding also gave an indication of what new play behaviours were being displayed and added to the participant's play repertoire. Overall, the use of three different measures of variability allowed for greater exploration of how variability in play was presenting. The findings that demonstrate increases across all three measures of variability strengthens the evidence for a functional relationship between lag schedules and play variability.

Limitations and future research

Although these results show support for the use of lag schedules to increase play variability, there are a number of limitations that need to be given consideration. One limitation of this study is limited external validity. External validity "refers to the degree in which a study's results are generalisable to other persons, settings and/or behaviors" (Cooper et al., 2019, p. 157). The use of a single case research design means that replication across

subjects was not possible. Further systematic replication by different research teams and with different populations is therefore required.

Differences in level of play variability possible across toys also presented another limitation. When selecting toys used in the study a number of factors were considered, including the child's interests, developmental appropriateness, and the practicality of the item. Attempts were also made to choose play items that would not significantly limit the variability allowed for. However, despite these attempts this was difficult to do while still also meeting the other requirements and the music table still displayed ceiling effects. The inclusion of normative data gathered from typically developing children could address this limitation in the future. This data could be helpful when selecting toys for research and also provide a comparison for naturally occurring rates of play variability.

Limited data and measurement regarding longer-term outcomes of the intervention is a further limitation of the study. Follow up probes were not able to be conducted and a maintenance condition was only possible for the music table setting. The result of this is that it is not known if these increases in play variability were maintained over time, or if increases in play variability would remain for the ball and playdoh conditions once reinforcement was removed. Therefore, little is known about the long-term outcomes of this intervention on play variability. Further research including maintenance and follow up conditions would be beneficial to further investigate if increases in play variability remain after the withdrawal of intervention and over time.

In addition to not knowing if changes in play variability remained over time, measures of play outcomes outside of the experimental condition or treatment acceptability were also not conducted. It would be interesting to know if increases in play variability achieved in this study influenced variability in the child's daily play in the home or school setting and more about treatment acceptability. Future research could strengthen findings by including a

measure for the social validity of intervention by having parents and/or teachers complete a questionnaire reporting if they feel the intervention was helpful and if it produced any noticeable change in the child's play behaviours in the home or school environment.

Low interobserver agreement (IOA) is another limitation of this study. Low IOA was found for the playdoh setting for both measures of IOA used. The coding of play behaviours in the playdoh setting was significantly more difficult than in the other two settings. Training sessions were conducted with the secondary observer before they began to analyse sessions. In these training sessions, 80% or higher agreement was achieved for both measures of IOA. The videos used for these training sessions were from baseline sessions. During baseline sessions, the number of different play behaviours was small with only five different behaviours presenting across the two training sessions used. As the participant was presenting with such a low numbers of different play behaviours this made behaviours much easier to code accurately in these videos. As new play behaviours emerged in intervention it became more difficult to code and differentiate these behaviours. In intervention sessions the participant's play behaviours commonly involved moving between behaviours such as pinching playdoh with fingers, squishing the playdoh with palm, squishing with fingers, squishing with a fist and manipulating with hands (which was defined as moving the playdoh around in space or rubbing or tapping the playdoh without making an indent). The similarity between the play behaviours made it difficult to discriminate between behaviours. This therefore may explain why IOA was so low in the playdoh setting. This could be addressed in future studies by including more training sessions, better defining play definitions and giving careful consideration to toys used and their developmental appropriateness.

In addition to addressing some of the limitations discussed future research could also explore if similar outcomes could be achieved when lag schedules of reinforcement are implemented by a range of different individuals. The current study produced changes in play

variability using easy to deliver reinforcers and did not require complex prompting or training procedures. Future research could therefore explore if similar outcomes could be achieved when lag schedules of reinforcement are implemented by individuals who commonly work with children with ASD. This may include individuals such as teachers, aides, or parents. The recent COVID-19 pandemic has highlighted the need for intervention procedures and programmes in which training and support can be given so that parents, teachers, and aides can then implement the interventions.

Conclusion

This study provides support for the use of lag schedules to increase play variability in individuals with ASD. The findings showed the following: firstly, lag schedules did produce increases in play variability in an individual with ASD. Secondly, increases in play variability in experimental toys generalised to similar toys. Thirdly, increases in play variability were maintained at maintenance once lag schedules were removed. This third conclusion is based upon findings in the music table setting only due to the inability to conduct maintenance sessions in the other two settings. This study addressed some of the limitations identified in past research and added to the research through the use of higher lag schedules and multiple measurements of play variability. Literature exploring the use of lag schedules to change play variability is still limited, therefore future research is still required. Future research should further strengthen the findings in this area by including, normative play data from typically developing children, maintenance and follow up conditions to explore long term outcomes and measures of treatment acceptability and social validity of outcomes.

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Appendix A

Data recording sheet

Date:	**Childs initials:**	**Setting:**
Lag schedule:	**Session #:**	**Reinforcer used:**

Response number	Behaviour	Behaviour code	reinforcer was delivered (X)	Comments
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				
21				
22				
23				
24				
25				
26				
27				
28				
29				
30				

Total # of responses:		# of novel responses:	
# of different responses:		Average response variability:	
Coded behaviours			
Novel behaviours			

Appendix B

Visuals used to indicate the start and end of sessions

Appendix C

Play behaviour descriptions and assigned code for each setting

Music Table

Music table: Experimental - Baby Einstein play table	
Code	Play behaviour
1	Drums
2	Guitar
3	French horn
4a	Blue square/violin/duck
4b	Yellow triangle/xylophone/cat
4c	Red circle/flute/dog
4d	Green star/harb
5a	Piano 1 – Red
5b	Piano 2 – Blue
5c	Piano 3 – Yellow
5d	Piano 4 – Green
5e	Piano 5 – Orange
6	Colours/numbers button
7	Flip book
8	English/French button
Music table: Generalization - Leap frog play table	
1	Guitar spinner
2	Cello push button
3	Trumpet slider
4	Spinner
5a	Yellow button
5b	Red button
5c	Green button
6a	Piano red
6b	Piano yellow
6c	Piano green
6d	Piano blue
7	Book flip

Ball

Ball: Spiderman and tennis ball	
Code	Play Behaviour
Feet	
1	Foot on top of ball (stagnant or manipulating it – eg – rolling it under foot)
2	Stand on ball (both feet on ball/full weight on ball)
3a	Kick with toes
3b	Kick with the inside of foot
3c	Kick with the outside of foot
3d	Kick with heal
3e	Kick with bottom of the foot
4	Foot roll over

5	Foot on top of ball while sitting or laying down
18c	Kick with knee
Hands	
7a	Manipulate with hands (hold in hands, tap etc)
7b	Push on ball/weight on ball through hands/arms
8a	Hit/bounce ball with open palm
8b	Hit either side of ball with open palm
8c	Tap ball with finger tips
9	Hit/bounce ball with fist
10	Dribble ball like in basketball
11a	Hit/swat ball across room
11b	Hit ball with elbow
12a	Drop ball from height
12b	Hold ball/lift ball up with one palm/hand
22	Rainbow movement
Throw	
13a	Throw ball up in the air
13b	Throw ball across the room (with deliberate throwing motion)
13c	Throw ball up and catch it
Roll	
14a	Roll ball away from self
14b	Roll ball towards self
14c	Roll ball back and forth between hands
14d	Roll ball under arm
14e	Roll ball under hand
Spin	
15a	Spin ball with 1 hand
15b	Spin ball with 2 hands
28	Spin with feet
Between feet/legs	
16a	Ball between feet
16b	Ball between legs
16c	Walk with ball between feet
16d	Walk with ball between legs
16e	Jump with ball between feet
16f	Jump with ball between legs
16g	Crawl with ball between legs
Body	
17a	Ball under 1 leg
17b	Ball under 2 legs
18a	1 knee on ball
18b	2 knees on ball
19a	Sit on ball
20a	Bounce up and down on ball while sitting on it
20b	Roll back and forth under bum while sitting on ball
21a	Lay on ball (tummy)
21b	Lay on ball (back)
23	Hold between thigh and calf
24	Hit with hip while lying down
25a	Roll down arms (like a slide)

25b	Roll down back of legs
26	Roll between arms (stacked)
27	Roll on body parts (eg – back, side, foot, face etc)
29	Lift ball up by holding between feet and lifting

Playdoh

Code	Behaviour
Playdoh and hands	
1	Manipulate with hands
2	Pull apart
3a	Squish in hands on table
3b	Squish in hand (lifted)
3c	Squish between hands/with two hands
3d	Playdoh on top of palm or stacked on each other or on top of hand
3e	Squish with palm
3f	Squish with fist
3g	Squish with fingers
3h	Squish between fingers
4a	Roll between hands
4b	Roll between fingers
4c	Roll on table
4d	Roll into a ball
5	Flip over
6	Drop
7	Throw
8	Fold in half/Push together playdoh
9	Pull/stretch apart playdoh
10	Pinch playdoh
11	Twill/twist in hands
12	Push finger through and wear playdoh like a ring
Roller	
13a	Pick up roller/manipulate roller
13b	Roll playdoh with roller
13c	Stick end of roller into playdoh
13d	
Duck cutter	
14a	Pick up/manipulate duck cutter
14b	Stick into playdoh in some way
14c	Stick into playdoh flat as intended
14d	Manipulate duck cut out
Spin cutter	
15a	Pick up/manipulate spinning cutter (includes MWH at some time)
15b	
15c	Stick spinning cutter into playdoh
15d	Cut playdoh with spinning cutter
Knife	
16a	Pick up/manipulate knife
16b	Stick knife into playdoh
16c	Cut playdoh with knife

Appendix D

Information sheet provided to parents

Emma Tutty

250-899-2651

eet1@students.waikato.ac.nz

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

Study Information Form

Study name: Use of lag schedules to increase play variability across settings for a young child with Autism.

Researchers: This research study will be carried out by Emma Tutty. I am a student at the University of Waikato, Hamilton, New Zealand and am conducting this research as part of my Master of Psychology. There will also be another individual who with your consent will be watching videos of the sessions to observe for interobserver agreement. However, this individual will not have any direct contact with your child at any time. As this study is part of my master's thesis, I will also be discussing information about the study and your child with my academic supervisor Angelika Anderson at the University of Waikato, Hamilton, New Zealand. She can be contact via email at angelika.anderson@waikato.ac.nz or phone on +64 7 8379209.

Purpose of the Research: The purpose of this research is to investigate if schedules of reinforcement (delivery of preferred items at specific points in time) can be used to increase variability and flexibility in your child's play.

What You Will Be Asked to Do in the Research: The study will be looking at increasing your child's play variability and flexibility across three different settings/play activities. We will be looking at increasing the number of different ways they play with, an individual toy (eg., plane, truck, doll), a play set (eg.,dolls house, farm yard, superhero playset) and what play equipment they try at a local playground. As part of this study your child would be required to participate in a number of 5-10minute sessions throughout the week for approximately 6-8 weeks. Sessions will be scheduled based upon your family's weekly schedule and availability. During these sessions your child will be presented with the individual toy, playset or the playground to play with. They will then receive reinforcers (eg., preferred items, food or social reward such as a high 5) when they display new ways to play with the toy or try new playground items.

Video recordings: Video recordings will be taken of sessions for review. These videos will be used to ensure that sessions are being delivered effectively and to assess for interobserver agreement. In order to assess for interobserver agreement another individual will review these videos. This individual will not have direct contact to your child at any time will only be reviewing the video recordings. They will sign a non-disclosure agreement in which they agree to not release any information about the study or your child to the public. Any videos taken of your child will be stored securely and password protected.

Risks and Discomforts: We do not foresee any risks or discomfort from your child's participation in the research. Should your child display signs of distress at any point, for example crying or showing two instances of escape behaviour such as running of in a session, that session will be terminated immediately. You are welcome and encouraged to directly observe sessions and interactions conducted with your child.

Potential benefits of this study for your child: Increases in play variability and flexibility have been shown to have many potential benefits, such as increased exposure to learning opportunities and gains in language and social skills. Higher play variability has been found to lead to increased exposure to

social interactions and therefore increased access to further learning opportunities and exposure to language. Therefore, over time the use of this method if successful may lead to potential benefits in learning, language and social interactions for your child.

Potential benefits of the Research: Findings from this study will add to what we currently know about the use of lag schedules to increase play variability. Further evidence regarding effective methods for children with Autism can help inform the use of these methods in day to day programming to bring benefits to children with Autism and their families.

Voluntary Participation: Your participation in the study is completely voluntary and you may choose to stop your child's participation in the study at any time, for any reason up until the final session. To withdraw inform Emma Tutty verbally that you wish to withdraw. In the event you withdraw from the study, all associated data collected will be immediately destroyed wherever possible.

Confidentiality: All information you supply during the research will be held in confidence and unless you specifically indicate your consent, your name or your child's name will not appear in any report or publication of the research. This research will be submitted as part of the course work requirement for the Masters of Psychology at the University of Waikato, in this work a different name will be used rather than your child's real name. Information and data will be collected in digital form and handwritten notes. Your data will be safely stored in a locked filing cabinet and digital copies will be password protected. Videos taken during the study will be uploaded to a secure cloud based program and be password protected. Videos will then be deleted off the device used to capture them.

Funding of the research: This research is conducted as part of the requirements for the Master of Psychology at the University of Waikato, Hamilton, New Zealand. It is not receiving funding from any groups or organizations.

Access to findings: Once the thesis is submitted and reviewed the public will have access to it via the University of Waikato thesis database. A copy of the published thesis and a summary of the findings will be provided directly to you. You will also have the opportunity to verbally discuss the findings face to face with Emma Tutty at the conclusion of the study if you wish.

Questions About the Research? If you have questions about the research in general or about your child's role in the study, please feel free to contact Emma Tutty either by phone at 250-899-2651 or email at eet1@students.waikato.ac.nz.

Further information on the researcher Emma Tutty, including recent child welfare and background checks are available on request.

This research project has been approved by the Human Research Ethics Committee (Health) of the University of Waikato under HREC(Health)2019#45. Any questions about the ethical conduct of this research may be addressed to the Secretary of the Committee, email humanethics@waikato.ac.nz, postal address, University of Waikato, Te Whare Wananga o Waikato, Private Bag 3105, Hamilton 3240.

Kind regards,

Emma Tutty

250-899-2651

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Appendix E

School of Psychology

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

CONSENT FORM

A completed copy of this form should be retained by both the researcher and the guardian of the participant.

Use of lag schedules to increase play variability across settings for a young child with Autism.

Please complete the following checklist. Tick (✓) the appropriate box for each point.	**YES**	**NO**
1. I have read the Participant Information Sheet (or it has been read to me) and I understand it.		
2. I am willing to give consent for (child's name) to participate in this study.		
3. I have been given sufficient time to consider whether or not to allow (child's name) to participate in this study		
4. I am satisfied with the answers I have been given regarding the study and I have a copy of this consent form and information sheet		
5. I understand that taking part in this study is voluntary (my choice) and that I may withdraw my child from the study at any time without penalty.		
6. I understand I have the right to decline for (child's name) to participate in any part of the research activity		
7. I know who to contact if I have any questions about the study in general.		
8. I understand that the information supplied by me could be used in future academic publications.		
9. I understand that as this study is part of a thesis that Emma will be discussing my child with her thesis supervisor		
10. I give consent for sessions to be videoed and for another individual to view these videos for interobserver agreement		
11. I understand that my participation in this study is confidential and that no material, which could identify me or my child personally, will be used in any reports on this study.		
12. I wish to receive a copy of the findings		

Declaration by participant:

I agree for (child's name) to participate in this research project and I understand that I may withdraw at any time. If I have any concerns about this project, I may contact the convenor of the Psychology Research and Ethics Committee (Professor Nicola Starkey, phone 07 837 9230, email: nicola.starkey@waikato.ac.nz)

Guardian's name (Please print):

Signature: Date:

Declaration by member of research team:

I have given a verbal explanation of the research project to the guardian of the participant and have answered any questions that arose. I believe that the guardian of the participant understands the study and has given informed consent to participate.

Researcher's name (Please print):

Signature: Date:

Appendix F

List of play behaviours observed across settings

Music table

Number of play behaviours	Play behaviour observed
1	Press drum
2	Push/pull Guitar
3	Spin French horn
4	Press blue square
5	Press yellow triangle
6	Press Red circle
7	Press green star
8	Press red piano key
9	Press Blue piano key
10	Press Yellow piano key
11	Press green piano key
12	Press Orange piano key
13	Press numbers/colours button
14	Flip book
15	Slide language options button

Ball

Number	Play behaviours observed
1	Foot on top of ball while standing (stagnant or manipulating it – eg – rolling it under foot)
2	Foot on top of the ball while sitting or lying (stagnant or manipulating ball)
3	Stand on top of ball (both feet on ball, weight on ball)
4	Kick with toes
5	Kick with inside of the foot
6	Kick with outside of the foot
7	Kick with heal
8	Kick bottom of foot
9	Roll foot over ball (foot on ground, roll over the top of ball and foot back to ground on the other side)
10	Manipulate ball with hands (hold in hands, turn, tap etc)
11	Push on ball (weight on ball through hands and arms)
12	Hit/bounce ball with palm
13	Hit ball with both hands at the same time (either side)
14	Tap with fingers
15	Hit/bounce ball with fist
16	Hit/swat ball across room
17	Hit/move with elbow
18	Hold up in air under one hand
19	Roll ball away from self
20	Roll ball towards self
21	Roll ball back and forth under hand/palm

22	Roll ball back and forth under arm
23	Spin ball with one hand
24	Spin ball with two hands
25	Spin with feet
26	Ball between two feet
27	Ball between legs
28	Hold ball between feet and lift ball in the air
29	Walk with ball between feet
30	Wall with ball between legs
31	Crawl with ball between legs
32	Ball under 1 leg lying down
33	Ball under 2 legs lying down
34	1 knee on ball
35	2 knees on ball
36	'kick' ball with knee
37	Sit on ball
38	Bounce up and down on ball while sitting on it
39	Roll ball back and forth underneath while sitting on it
40	Lay on ball (Tummy)
41	Lay on ball (Back)
42	Hold ball in hands and make rainbow movement back and forth
43	Ball between calf and thigh
44	Hit across room with hip
45	Roll down arms (like a slide)
46	Roll on back on legs (like a slide)
47	Roll between arms stacked (one arm under ball, one arm on top)
48	Use hands to roll ball on body (tummy, hips, back etc)

Playdoh

Number of play behaviours	Play behaviours observed
1	Manipulate with hands (interactions that move the playdoh but don't make an indent into the playdoh – eg - tap, rub, move around in space)
2	Pull apart
3	Squish with hand/hands on table
4	Squish in one hand (lifted)
5	Squish between hands/with two hands (lifted)
6	Playdoh on top of palm or stacked between hands
7	Squish with palm
8	Squish with fist
9	Squish with fingers
10	Roll on table
11	Flip
12	Fold in half/Push together playdoh
13	Pull/stretch apart playdoh
14	Pinch playdoh
15	Twirl/spin in hands
16	Push finger through playdoh and wear like a ring
17	Roller - Pick up/manipulate roller alone
18	Roll playdoh with roller

19	Stick end of roller into playdoh
20	Pick up/manipulate duck cutter alone
21	Stick duck cutter into playdoh flat intended to make duck shape
22	Stick duck cutter into playdoh some other way (eg – standing upright)
23	Pick up/manipulate spinning cutter alone
24	Jab spinning cutter into playdoh
25	Cut playdoh with spinning cutter as intended to be used
26	Pick up/manipulate knife alone
27	Stick knife into playdoh