THE EFFECTS OF MATRIX TRAINING WITHIN ACTIVITY SCHEDULES ON THEMATIC PLAY SKILL FOR CHILDREN WITH AUTISM SPECTRUM DISORDER

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The undersigned, approved by the dean of the Graduate School, have examined the thesis entitled

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a candidate for the degree of Master of Science, and hereby certify that, in their opinion, it is worthy of acceptance.

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THE EFFECTS OF MATRIX TRAINING WITHIN ACTIVITY SCHEDULES ON THEMATIC PLAY SKILL FOR CHILDREN WITH AUTISM SPECTRUM DISORDER

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ABSTRACT

Photographic activity schedules have been demonstrated to teach functional and social play to individuals with autism spectrum disorder (ASD). Matrix training is an instructional format that teaches a subset of targets, additional targets in the matrix are then acquired without direct teaching. Dauphine et al. (2004) has demonstrated that matrix training delivered within an activity schedules format was effective at increasing schedule following behavior and promoted recombinative generalization of sociodramatic play skills. The present study extends previous literature by assessing the effects of matrix training within activity schedules on thematic play skills for two children with ASD. Researchers used an alternating treatment design embedded in a concurrent multiple baseline design to assess the percentage of correct schedule following, engagement, and frequency of varied play. Researchers found that the use of matrix training embedded in an activity schedule was effective for teaching thematic play skills as well as promoting recombinative generalization in all participants.

Introduction

Autism spectrum disorder (ASD) characteristics may include deficits in social-emotional reciprocity, non-verbal communication, and difficulties in developing and maintaining relations with peers (American Psychiatric Association; APA, 2013). ASD is also categorized by restrictive and repetitive behaviors, fixated interests, or activities, demonstrated by stereotyped motor movements, ritualistic behaviors, and inflexible routines (APA, 2013). The cumulative deficits across social skills, communication, and restrictive behaviors can impede an individual's development of functional play skills (Thorp et al., 1995).

Functional play is categorized by two different levels beginning with simple functional play, which encompass the use of only one object in the manner it was intended and the child's engagement in play actions that relate similar objects (Williams et al., 2001). The process of appropriate associations between objects has also been termed as relation play (Fenson et al., 1976). The second level is elaborated functional play which encompasses the use of multiple objects as the manufacturers intended, paring appropriate vocalization, and engaging in functional acts carried out by a doll (Williams et al., 2001). Within the second category of symbolic play is the process of children engaging in actions such as imitating the action of eating a meal (Fenson et al., 1976). Common themes across the literature describe functional play skills as a child's engagement with various items, how they relate those items to other items, how the actions they engage in are symbolic for actions in everyday life, and the order in which these various acts are carried out (Fenson et al., 1976; Williams et al., 2001).

Functional play skills can promote social interactions with peers (Akers et al., 2018), increase independent leisure activities, and increase the opportunity for naturalistic learning (Ashiabi, 2007). In addition, functional play skills have been linked to a child's increased accuracy to categorize various objects and stimuli, development of cause and effect relations, and increased play diversity (Fenson et al., 1976). Throughout a child's development they can engage in various forms of functional play, including parallel play, cooperative group play, thematic play, and figurine play. Parallel play is the actions of two children playing side-by-side with separate activities, however not engaging with one another in communications or actions (Bakeman & Brownlee, 1980). Cooperative or group play is when at least two children play using the same materials and interact with one another (Ashiabi, 2007). Sociodramatic play is the use of multiple objects which all convey the same theme (Dauphine et al., 2004). Finally, figurine play is the use of multiple objects to engage in various acts which convey a common theme, typically the child engaging in this play is taking the perspective of a character within the environmental arrangement (Pellegrino, 2018). The development of both thematic play and figurine play begins from a child demonstration to engage in second-ordered representation which is often impaired in children with ASD (Williams et al., 2018).

The engagement in figurine play demonstrates a child's advanced interactions with their environment and overall social development. Figurine play allows individuals to an opportunity to engage in many types of functional play, such as using multiple related objects together, accompanying play behavior with an appropriate vocalization, or carrying out an act with the use of a figurine (Williams et al., 2001). Williams et al. (2001) categorized functional play in accordance to children of typical development's

play. The researchers conducted observations across individuals with ASD, down syndrome, and children of typical development. Throughout their observations the researcher collected data on the duration of play, as well as frequency, diversity, and integration of play actions. The results of the present study demonstrated that individuals with ASD engaged in less elaborated play with dolls, integrated, and varied play in comparison to their counterparts of typical development and children with down syndrome.

Some individuals with ASD demonstrate repetitive patterns of behavior within their play actions (APA, 2013). These repetitive actions may be idiosyncratic behaviors that affect a child's development of joint attention with their peer's preferred toys which develop thematic or symbolic play (Thorp et al., 1995). One method to reduce engagement in repetitive behaviors is to teach the child variability across different play behaviors to access new sources of reinforcement (Rodriguez & Thompson, 2015). Increasing access to novel reinforcers may lead to increasing their social engagement with their peers and ability to develop joint attention.

Variability within play is the novel responding or responding that differs for previous responses made. Galizio et al. (2020) defined varied figure play as the participant's engagement with the activity that changed from the previous responses across three different dimensions including a different character, engagement in a different action, and in a different location. Variability of responding during play has been taught using positive reinforcement contingencies (Rodriguez & Thompson, 2015). One method of increasing variable play in children with ASD is by implementing matrix training (Dauphin et al., 2004) in which recombinative generalization or novel

responding of untaught targets is demonstrated through direct teaching of specific combinations (Curiel et al., 2016). Recombinative generalization of play skills promotes novel responding of functional play skills by teaching two play behaviors (e.g., walking a dog figurine and hoping a cat figurine) within a matrix. After which a generalization of those mastered skills across the untaught combinations of responses within the matrix is demonstrated (e.g., walking a cat figurine).

Dauphin et al. (2004) assessed the use of matrix training delivered via video-enhanced activity schedules to increase sociodramatic play skills of a 3-year-old child with ASD. The researchers taught combinations of actions and statements within a matrix (e.g., girl in dollhouse saying "the girl is waking up") within an activity schedule. Dauphine et al. showed the utility of a combined intervention of matrix training and activity schedule were effective at increasing recombinative generalization and independent play. These results are consistent with previous literature demonstrating that activity schedules have been effective to promote interactive and independent play skills such as relational play (Akers et al., 2016; Macduff et al., 1993), social play with peers (Akers et al., 2018; Betz et al., 2008; Gadaire et al., 2018), and figurine play (Dauphine et al., 2004; Jimenez-Gomez et al., 2020). Duphine et al. further extends research by demonstrating that the addition of the matrix training delivered within the activity schedule format increased recombinative generalization (Hatzenbuhler et al., 2019; Wilson et al., 2017). To assess the extent to which matrix training can enhance the delivery activity schedules to promote play, a literature review of the current status of activity schedules is warranted, especially related to the production of untaught varied play responses.

Literature Review

To investigate the extent to which photographic activity schedules promote variability within play for individuals with ASD, we conducted an informal literature review that described photographic activity schedules aimed to increase play skills for individuals with ASD. The review was conducted using, Academic Search Premier, PsycINFO, and PsycARTICALS. The search terms included: activity schedule + play skills. These search terms were limited to the abstract and titles of the articles. Articles were limited to those that were per reviewed and published in English. This search produced 40 articles, after further examinations of procedures to assess if the articles meet the inclusion criteria of (a) used activity schedules as an independent variable, and (b) observed play behavior as the dependent variable. This produced 10 articles which meet our inclusion criteria.

Activity Schedules and Functional Play

The utility of activity schedules to promote play skills has been demonstrated across multiple forms of play such as close ended play (Jimenez-Gomez et al., 2020; MacDuff et al., 1993), functional play on the playground (Akers et al., 2016), increasing social play among peers without scrips (Betz et al., 2008; Gadaire et al., 2018), and with scripts to increase commenting (Akers et al., 2018) when engaging in games. Furthermore, activity schedules have been assessed to the extent they promote variability within play skills (Brodhead et al., 2018; Dauphin et al., 2004).

MacDuff et al. (1993) first examined the effects of picture-based activity schedules and graduated guidance to teach individuals with developmental disabilities to acquire the behavior of following complex response chains. MacDuff and colleagues

demonstrated complex chains included engaging with various toys, leisure activates, or academic work which all were located in different areas of their home. Four children participated in the study who were between the ages of 9- to 14- years and who had a diagnosis of ASD. The researchers investigated three target behaviors which included visual attending, manipulating play or work materials, and off-task/on-schedule behavior. The researchers used a multiple baseline design to assess the effect of activity schedules on complex chains. Across all conditions, the researcher presented the instruction "everyone look at me; find something to do" at the beginning of every session. The activity schedules consisted of playing with blocks/games, writing tasks, snack, puzzle, and TV time. All sessions were terminated after 60 min had elapsed. During the teaching phase researchers presented the instruction and then waited 10 s for correct responding. If the participant did not engage in the correct response a researcher then physically prompted the next step in the schedule. For all subsequent sessions graduated guidance was implemented in which the least intrusive prompt to evoke the correct response was delivered by the instructor. The teaching condition was mastered if participants were on-task and on-schedule 80% of the time across five consecutive sessions after physical proximity of the researchers had been removed. MacDuff et al. found that all participants maintained high levels of responding during the teaching, maintenance, and generalization conditions. However, within this study MacDuff et al. only assessed two novel tasks that were similar to the tasks that were already present in the activity schedule. Therefore, it is unclear as to how many novel targets would generalize and future researchers could extend the number of novel actions by recombining similar responses in previous play activities.

Similar to MacDuff et al. (1993), Jimenez-Gomez et al. (2020) demonstrated the utility of activity schedules in teaching closed ended play by assessed the effects of activity schedules on independent responding for participants' engagement in functional play with cars, blocks, and coloring during experiment two. Activity schedules were presented in the form of a digital watch which was presented during all no-prompt, vocal-prompt, and watch prompt conditions. Researchers used most-to-least prompting procedures to teach completion of functional play activities. The researchers found that the use of an activity schedule in the form of a watch decreased the number of vocal prompts that were presented by researchers for independent play. However, researchers did not assess the maintenance or generalizations of the complex behavior chains.

In addition to closed ended play, activity schedules can promote functional play on playgrounds. Akers et al. (2016) extend previous literature on activity schedules and functional play by teaching three participants, diagnosed with ASD, playground activities in a novel environment. All participants had previous experience with activity schedules. Akers and colleagues used graduated guidance to teach close ended functional play activities which were defined as activities that had a clear beginning and end to them (e.g., riding a bike, climbing a rock wall, hitting a t-ball). The primary dependent variables were number of activities completed, percentage of independently completed schedule components, and engagement. The current researchers found that after training was implemented all participants engaged in more activities and percentage of independently completed activity schedule following steps. Despite the participant's previous training with activity schedules, independent schedule following only generalized to a novel setting after additional teaching. More researcher should be

conducted to assess the extent to which activity schedules can generalize across settings and functional play skills without explicitly having to teach novel skills.

Activity Schedules and Social Play

Not only have activity schedules been shown to be effective at teaching closed ended play with toys in novel environments, they have been shown to also promote social play (Betz et al., 2008). Betz et al. (2008) examined the effects of joint activity schedules on peer engagement during interactive games with three dyads of preschoolers with ASD using a nonconcurrent multiple baseline design. Prior to the study, all participants demonstrated the prerequisite skills to independently complete activity schedules with the inclusion of a choice page. The choice page consisted of a picture of one of the children within a dyad and an open piece of Velcro on which the participant placed their chosen activity. The joint activity schedule consisted of two prechosen activities and two choice activities. Each participant in the dyads were responsible for initiating engagement with one prechosen activity and a choice activity. All participants were taught to complete the schedules via graduated guidance. Betz et al. found that all participants learned to follow the joint activity schedules and increase the percentage of engagement when the schedule was present. These levels persisted during the maintenance, resequencing, and generalization for two of the three dyads. More research should be conducted in the area of activity schedules and maintenance and generalization. Future research should assess the extent to which play engagement persists when the schedule is no longer available.

Similar to Betz et al. (2008), Gadaire et al. (2018) examined the utility of activity schedules to teach social play skills and extended previous literature by assessing the different components aiding in schedule following. Gadaire et al. conducted two studies

with participants with ASD and attention deficit and hyper activity (ADHD). Within the first study, researchers assessed the use of group activity schedules and most-to-least prompting procedures on on-task and on-schedule behavior. Gadaire et al. conducted baseline sessions where the schedule was present but prompting was not provided. During the teaching condition, researchers used most-to-least prompting to teach the participants how to follow the schedule. During the first study, the researchers found that participants were on-schedule and on-task during the group activity schedule condition more frequently in comparison to the baseline condition. During the second study, researchers compared the use of group activity schedules to most-to-least prompting alone. Group one received training with group activity schedule and group two only received most-to-least prompting. The researchers found that both the group activity schedules and most-to-least prompting alone increased the level of on-task behavior. However, the group activity schedule showed a larger differentiation from baseline levels compared to most-to-least prompting only. A limitation of the present study was the inconsistency in prompting due to extraneous variables. Future researcher should look at the effects of activity schedules with a consistent prompting procedure.

Activity schedules are well known for increasing independent play and on task work. However, there has been an increase in research being conducted assessing the effects of activity schedules to teach individuals with ASD social play skills. A notable study that aided in this research was Akers et al. (2018) by embedding scripts with in the activity schedule to promote communication of peers. The researchers assessed whether individuals with ASD could learn complex group play using activity schedules with embedded scripts. In addition, to incorporating typically developing peers to the groups

and systematically fading the activity schedules and scripts. The experimenters observed the percentage of independent hide-and-seek behaviors using a nonconcurrent multiple baseline design across play groups. The target participants were three preschool aged children diagnosed with ASD. Additionally, researchers included 12 preschoolers of typical development and taught a seeker and a hider schedule. Results of the present study showed that the use of activity schedules with embedded scripts were effective at teaching preschoolers with ASD complex group play. Akers and colleagues also successfully removed the activity schedules to be less intrusive while still maintaining high responding. Once the activity schedules were complexity removed, the participants were seen engaging in novel hiding and seeking behaviors which suggests generative play. It is possible that systematically removing an activity schedule allows for novel behaviors to occur which promoted more variability within an individual's play. However, since the present study did not specifically track variability of these behavior, it is unknown to the extent at which schedule fading promoted variability. Future research should assess variability of play behaviors when activity schedules are removed.

Activity Schedules and Variable Play

Two studies measured variability in play skills while implementing activity schedules (Brodhead et al., 2018; Dauphin et al., 2004). Even though individuals might learn play skills they still maybe restrictive or repetitive in nature even if they are deemed functional. Brodhead et al. (2018) examined the use of activity schedules embedded with in an iPad and the extent to which it promoted varied application use in children with ASD. Researchers included three participants ranging from 4-to-9-years with a diagnosis of ASD. Brodhead et al. assessed the number of varied application usage and the

percentage of correct responding for the activity schedule using a nonconcurrent multiple baseline across participants with an embedded reversal design. Activity schedules were presented using an iPad and consisted of six pages which included the participants name (first page) and three different iPad application and a timer application (across pages two through four). The fifth page only included one application, YouTube, and a timer application and the last page had the words "the end." Researchers taught participants to engage in schedule following using manual guidance and did not provided any vocal prompts. The researchers found that the use of an activity schedule embedded with in an iPad increased the varied application use and percent of correct responding. However, it is unknow to the extent at which participants within the study engaged in ridged behaviors with in the use of each application and should be further addressed. Additionally, the present study did not assess participants preference of the applications utilized with in the schedule. This is problematic in that it is unknown how participants would vary their responding if applications were preferred or not preferred.

Dauphin et al. (2004) assessed the utility of video-enhanced activity schedules and matrix training on sociodramatic play skills of a three-year-old child with ASD. The experimenters conducted three phases using a multiple probe design across matrixes. During phase one, researchers assessed the use of computer activity schedules and matrix training. A three-by-three matrix format consisted of three scrips and three figurine and play set combinations presented on a script and one figure and playset combinations were combined to create teaching targets. During phase two, researchers assessed the use of activity schedules in a book format. During phase three, researchers assessed if initial teaching of a matrix using a video activity schedule would maintain to cue the participant

to play. Dauphin et al. demonstrated that using video enhanced activity schedules to teach components of a matrix was effective at maintaining correct responding picture notebook schedule. However, the result within this study should be interpreted with caution because phase three was unsystematically conducted due to using three different matrixes. In addition, they did not compare the effects of video enhanced activity schedule to an alternative teaching procedure. Despite these limitations the present study demonstrates promising results of a combined teaching package of activity schedules and matrix training to promote variability by providing choice.

Activity schedules have shown to be a beneficial intervention not only for increasing engagement during complex response chains, but with increasing independent and peer play engagement. However, there is still a lack of research that assesses the use of activity schedules and their effects on varied play behaviors in individuals with ASD. Only a few studies briefly addressed variability within the constructs of their study. Future researchers should assess how the activity schedule technology can be utilized to teach variability across play activities using matrix training.

Purpose Statement and Research Questions

Research in which play has been assessed in regards to the varied play actions emitted by individuals with ASD is needed to further determine efficient methods to teach these more complex skills. The purpose of the present study was to extend previous literature by assessing the effects of matrix training embedded within a photographic activity schedule on the occurrence of varied play skills for individuals with ASD. Specifically, research questions are as follows.

1. To what extent did matrix training embedded in a photographic activity schedule promote functionally appropriate varied play skills as measured by a frequency count of novel play behaviors?
2. How independently do the participants complete the activity schedule as measured by the percentage of correctly completed components?
3. To what extent did the participants independent activity schedule following increase during generalization conditions as measured by the percentage of correctly completed components?
4. To what extent were percentage of correctly completed components persisted and are participants observed to have varied play skills during maintenance?

Methods

Participants and Setting

The participants in the present study included two children who were diagnosed with ASD. Ana and Weston were five and seven years old, respectively, and had been receiving services from a university-affiliated early intensive behavioral intervention (EIBI) clinic where they received behavior analytic services. Both participants had previous exposure to activity schedules. To be included within the study participants were recommended by their Board-Certified Behavior Analyst (BCBA) to ensure that the participants demonstrated the necessary prerequisite skills. Participants were referred for the study if they had demonstrated engagement in restrictive or repetitive behaviors during unstructured play in the form of stereotyped motor movements, ritualistic behaviors, fixated interests, and inflexible routines (APA, 2013). In addition, all participants met the minimum criteria which included the demonstration to imitate eight gross motor movements, two of which involve objects (Sundberg, 2008). Researchers conducted sessions within individual therapy rooms 10 m by 15 m within the university affiliated clinic. Each room contained a table and two chairs.

Materials

Researchers included five different playsets and their corresponding three figurines. One high preferred playset was selected via a multiple stimulus without replacement (MSWO) preference assessment (DeLeon et al., 1996) for each participant and used across all sessions. The five playsets (see appendix A) included a farm (with a cow, pig, and chicken), a blue house (with a women, man, and baby), a school (with a baby, girl, and women), a pink house (with a girl, man, and dog), and an arcade planet (with an alien, man, and astronaut).

Researchers used two different activity schedules consisting of a small binder (22 cm by 17 cm) for the teaching and generalization conditions. Within each schedule, researchers placed four to seven 7 cm by 10 cm laminated pages. The pictures depicted one figurine, action, and location of where the action will be performed (see appendix B). Each figurine and location combination were displayed in a semi-random sequence across all research sessions using an online number generator. Within the teaching and generalization schedules, researchers used red and green pages, respectively. Researchers wore colored shirts to aid discriminated responding between reversals to baseline conditions when the activity schedule is not present. Researchers wore a blue shirt during the baseline sessions when activity schedules are not present and a black shirt when the teaching or generalization schedule is present.

Researchers selected the play combinations that were included in the teaching and generalization schedule using a matrix specifically designed for each play set and corresponding characters (see Appendix C). The combinations for the teaching schedule were the targets that appear grey within the matrix (e.g., Pink House the man will hop in the kitchen). The targets used in the generalization schedule included those combinations remaining white within the matrix (e.g., Pink House the girl will hop in the kitchen). Researchers placed a picture of a high preferred edible reinforcer on the last page of the schedule to function as reinforcement for engaging in the play chain sequence. A high preferred edible was identified through an MSWO preference assessment. Researchers also included data sheets, writing utensils, and video recording devices.

Response Measurement

Target Behavior

Trained observers collected primary data across all sessions by watching video recordings. The primary dependent variable was percentage of correct schedule following behaviors (See Appendix D), which was calculated by totaling the frequency of correct responses and dividing the sum by correct responses plus incorrect response. Correct responses included (a) opening the schedule, (b) attending to the pictures of the figure and location, (c) obtaining the correct materials, (d) completes play skill/consumes edible, (e) returns to schedule, (f) turns page, and (g) closes schedule. Completing the play skill was scored as correct if the participant's manipulation of the figure matches the location and figurine photo that was presented in the activity schedule, and each location and figurine combination are completed in the order in which they are presented in the schedule.

Researchers collected data on two secondary depended variables, varied play and percentage of toy engagement. The frequency of varied play was scored as occurring if the participants' play actions differed from the previous action by either the figurine or location on the play set (Galizio et al., 2020). For example, if the participant manipulated a girl figurine to hop in the kitchen of the house then manipulated a boy to hop on the bed, the participant would have engaged in two different actions. The percentage of toy engagement was defined as continuously attending to the play materials by: (a) holding at least one figurine, (b) and making physical contact with the playset using another play item, (c) touching the activity schedule, or (d) touching reinforcer materials, including

consuming the reinforcer. A momentary time sampling (5 s) procedure was used to measure engagement during all conditions (Betz et al., 2008).

Interobserver Agreement and Procedural Fidelity

Researchers assessed exact count-per-interval interobserver agreement (IOA; Cooper et al., 2019) for 35% of sessions across all conditions and participants. A trained secondary independent observer collected exact count-per-interval IOA for varied play, percentage of correct schedule following, and percentage of toy engagement via video-recorded sessions. IOA was collected by dividing the number of intervals of agreement by the total number of intervals and then multiplied by 100 to produce a percentage. Ana's mean IOA for varied play, schedule following, and engagement were 98% (range, 96% to 100%), 97% (range, 92% to100%), and 91% (range, 72% to 100%), respectively. Weston's IOA for varied play, schedule following, and engagement were 65% (range, 53% to 90%), 97% (range, 92% to 100%), and 82% (range, 70% to 97%), respectively.

Trained observers collected treatment integrity on the primary researcher's correct implementation of the intervention via video recorded sessions on 29% of sessions across all conditions and participants. Researchers selected sessions for which treatment integrity was collected using an online random number generator. A researcher calculated the percentage of treatment integrity (see appendix E) by adding the number of yeses that are tallied divided by the number of yeses plus the number of no's multiplied by 100 (Cooper et al., 2019). Treatment integrity included (a) the therapist wearing the correct colored shirt that corresponds with the condition, (b) presenting the high preferred playset and figurines on the floor, (c) present the activity schedule within 1 m of the playset in the room with the correct targets in the specified order, (d) provided the discriminative

stimulus “go play” at the beginning of a session, (e) if participant engaged in incorrect behaviors, then the researcher used a non-vocal most-to-least prompt, (f) the high-preferred edible reinforcer was available on the last page of the activity schedule, and (g) verbal praise was delivered after the completion of the activity schedule. Mean treatment integrity for Ana was 95% (range, 83% to 100%) and Weston’s was 100%.

Experimental Design

Researchers used an alternating treatment embedded in a concurrent multiple baseline design to assess the effects of picture activity schedules and matrix training on schedule following, engagement, and varied play across participants (Cooper et al., 2019).

Procedures

Preference Assessment

Researchers conducted an MSWO preference assessment (DeLeon & Iwata, 1996) prior to baseline sessions to identify the participants' high-preferred playset that was used throughout the study. The MSWO preference assessment procedures began when the researchers presents an array of five playsets equal distance from the participant and said, "pick one." The participant was allowed 30 s access to the playset that they touched first. Then, the playset was marked on the data sheet as chosen first and removed from subsequent presentations of the array. Researchers then represented the array and the process repeated until all items had been chosen. A minimum of three assessments were conducted using the same playsets. Before the results were analyzed and a playset was selected for inclusion in the participants research sessions. The MSWO results were calculated by dividing the number of times a play set was selected by the number of times it was presented in an array and then multiply the product by 100 to receive a percentage. The play set with the highest percentage was selected for inclusion in the study. A second MSWO preference assessment using the same procedures described for the playsets was conducted to identify a high preferred edible item, and tangible item for Jami, that was include at the end of the activity schedule.

Pretraining

Prior to the start of sessions, researchers taught participants to engage in picture activity correspondence. This skill was demonstrated by teaching the participant to match pictures of the figurines and playset locations. The matching skill was taught using discrete trial training (DTT) and most-to-least prompting (MacDuff et al., 1993) with a

time delay. After all correct independent responses, researchers delivered reinforcement in the form of specific praise statements.

Each pretraining sessions began with researchers presenting the instruction, "match." With no time delay (0 s) the researchers immediately physically prompted the participant's behavior to engage in the response and then provided praise. On a 5 s delay, the researchers presented the relevant instruction and waited 5 s before providing a model or gestural prompt. If the participant engaged in a correct response, praise was delivered. If the participant did not engage in a response, then the instruction was represented while a model or gestural prompt was given.

If a participant engaged in an error, the researcher blocked the response and implemented an error correction procedure. The error correction procedure consisted of the researcher removing the materials for 3 s, then represented the instruction while giving a model prompt. Next the researcher removed the stimuli for 3 s and then represented the trial, if the participant engaged in the correct independent response praise was delivered.

The researchers taught the figurines by presenting a picture array of three figurines and presented the instruction "match" while handing the participant the figurine. Playset locations were taught by presenting the corresponding playset and handing the participant a picture of the location and presenting the instruction "point to the same." The action was taught by presenting the participant with a figurine and handing them a picture of that figurine engaging in the action and presenting the instruction "do this." Once participants had either two consecutive correct probes for a target or had three

consecutive trials with correct responding, the target was considered mastered. Once all targets were mastered participants started the baseline condition.

General Procedures

Sessions were conducted during the participant's regularly scheduled EIBI sessions by a trained research assistant for a maximum of five sessions during a therapy session visit across a maximum of five days a week. Each session began when the researcher walked the participant within 1 m of the play set and delivered the instruction "go play." All sessions were terminated after the participant completed the activity schedule or after 5 min has elapsed, whichever occurred first. The high preferred playset was presented across all sessions. Researchers wore a corresponding shirt for teaching and baseline conditions. If problem behavior occurred, the researchers followed the participant's specific behavior plan outlined in their treatment plan by their board-certified behavior analyst (BCBA). Only Weston engaged in problem behavior during sessions 13 and 18.

Baseline

The purpose of this condition was to measure the percentage of engagement with play materials and frequency of varied play prior to the implementation of the activity schedule. The sessions began after the researcher presented the playset and figurines to the participant and the researcher delivered the instruction "go play." The researcher did not provide any prompts for incorrect responding or challenging behaviors. The preferred reinforcer was not available during this condition. Sessions were 5 min in duration, termination was signaled by the researcher saying "good job playing with your toy's." Baseline sessions continued until a minimum of five sessions or until stable responding

was achieved across three consecutive sessions. Researchers identified stable responding using visual analysis of the graphs or after three data points in a decreasing trend or stabilized (within 15%).

Activity Schedule Probe

The purpose of this condition was to assess if the presentation of the activity schedule without prompting procedures increased the percentage of schedule following and engagement behaviors. The researchers implemented the procedures as described in the baseline session. During this condition researchers did not prompt incorrect responses or challenging behaviors. The picture icons presented in the schedule on blue pages consisted of each teaching targets from the matrix. The reinforcer was available in ether a open container (Weston) or paper cup (Ana). Sessions were 5 min in duration or until the schedule had been completed. Only one session was conducted during this phase.

Generalization Probe

The purpose of this condition was to assess if the presentation of the activity schedule with the untaught targets increased the percent of correct responding without the presentation of prompts. A second generalization probe was conducted after each participant meet mastery criterion during the teaching phase. All procedures remained the same as the activity schedule probe except the activity schedule consisted of the six play combinations that were untaught during the teaching phase (see Appendix C). Similar to the schedule probe session, during this condition the researcher did not deliver any prompts for incorrect responding or challenging behaviors. The reinforcer was available for the participant to obtain after completing the activity schedule. Researchers terminated sessions after 5 min in duration or until the schedule has been completed.

Activity Schedule Teaching

The purpose of this condition was to assess if the presentation of the activity schedule with graduated guidance prompting increased participants' independent schedule following. Researchers terminated sessions after 5 min in duration or until the schedule had been completed. Mastery criterion for this condition was three consecutive teaching sessions with a percentage of schedule following above 90%. Sessions during the teaching condition alternated between the activity schedule teaching sessions and an extended baseline where the activity schedule will not be present. For Weston two consecutive baseline sessions were conducted during sessions 16 and 17 of the teaching condition due to a video recording error.

Researchers designed a three-by-three instructional matrix (Dauphin et al., 2004) to teach schedule play targets. The matrix consisted of three figurines and three locations on a play set. An example of a matrix would include (a) boy, girl, and dog, and (b) on the couch, in the kitchen, and on the bed. Appendix C displays the matrices that were used for each participant dependent on their preferred play set. Each target consisted of one figurine, one location, and an action (e.g., jump). Diagonal training (Frampton et al., 2016) was used to teach three targets within the matrix. The sequence of the three targets were presented in a semi-randomized order during each session across all presentations of the schedule.

Participants were taught to follow the schedule using graduated guidance prompting procedures (MacDuff et al., 1993). The researchers used the following prompt sequence: hand over hand, hand on the participant's upper arm, light touch, and shadowing of the arm. Hand over hand was the most intrusive and shadowing of the arm

was the least intrusive. Each step in the activity schedule first began with hand over hand prompting, once the participant engaged in two consecutive correct responses for a specific step the next lowest prompt was implemented. Researchers removed prompts contingent on the participant's independent responding. If the participant made an error or remained on a step for longer than 5 s, researchers prompted the correct step. Steps in the schedule are presented in appendix D as described by Akers et al. (2016). The therapist presented the instruction "go play," after which the participant (1) opened the schedule, (2) turned to the first page, (3) pointed to the pictures of the figurine, location, and action, (4) obtained the materials, (5) completed the action with the corresponding figurine and in the corresponding location, (6) replaced materials, and (7) returned to schedule and flip the page. Steps three through seven were repeated until the last target was completed. Finally, the schedule ended with the participant (8) pointing to the edible picture in the schedule, (9) consuming the edible, (10) turning the page, and (11) closing the schedule. The researchers conducted teaching sessions until the participant achieved 90% independent responding across three consecutive sessions (Akers et al., 2018).

The researchers alternated teaching sessions with extended baseline sessions on a fixed sequence schedule. Sessions were conducted identical to baseline. Specifically, the playset and figurines were presented; however, the researchers only provide the participants with prompts if they moved a distance of 5 ft or more from the camera and the initial instruction "go play." Sessions were terminated after 5 min had elapsed for the baseline sessions.

Maintenance

Researchers conducted the maintenance probes two weeks after the last schedule probe. The maintenance probe was conducted in the same manner as the teaching condition. During the teaching probe, where the schedule was present, researchers provided the high preferred playset, figurines, and reinforcer. Researchers also implemented graduated guidance. The sessions were terminated once the schedule was completed or after 5 min had elapsed, whichever occurred first. During the baseline probe, when the schedule was not present, researchers provide the high preferred playset and figurines. Graduated guidance was not implemented during this probe. The sessions ended after 5 min had elapsed. The purpose of this conditioned was to identify if correct responding and varied play skills maintain during both the teaching schedule and baseline schedule sessions.

Results

Depicted in Figure 1 are the results of the play set MSWO preference assessment for Ana and Weston. Ana's high preferred play set was the pink and purple house which was chosen 57% across all opportunities. The remaining playsets included pizza planet, farm, school, and white and blue house were chosen 51%, 48%, 39%, and 33% respectively. Similarly, Weston's high preferred play set was the pink and purple house which was chosen 100 % of the time. The remaining playsets included the farm, school, pizza planet, and white and blue house which were chosen 40%, 36%, 29%, and 23% respectively.

Figure 2 demonstrates the results from the edible MSWO preference assessment for Ana and Weston. Ana's data showed that her high preferred edible item was starburst which was chosen 83% opportunities. The remaining edibles included nerds, peppermint patty, smarties, M&M's, pretzels, and red hots were chosen 51%, 30%, 29%, 28%, 18%, and 15% respectively. Weston's high preferred edible item was popcorn, which was chosen 71% of the opportunities. The remaining edibles included cheese, veggie straw, gold fish, fruit strips, animal cracker, and granola bar were chosen 56%, 43%, 35%, 13%, 0%, and 0% respectively.

Depicted in Figures 3 and 4 are the results of engagement, schedule correct, and variability for Ana and Weston. During initial baseline sessions Ana engaged in near zero levels of responding for toy engagement (range, 1 to 11) and varied play actions (range, 1 to 15) with the exception of sessions two, where Ana had 11% engagement and 15 varied play actions. Weston engaged in moderate levels of varied play (range, 14 to 50) and engagement (range, 20 to 66) during the first several sessions of the initial baseline phase.

However, a decreasing trend in both varied play actions and engagement was observed during the end of the baseline condition.

During the initial schedule probe, researchers observed low levels of schedule following for both Ana and Weston. Additionally, low levels of engagement for Ana and moderate levels of engagement for Weston (56%) were observed. During the following generalization schedule probe, researchers saw a slight increase in schedule following and engagement for Ana. During this condition, Weston engaged in slightly lower levels of schedule following (0%) and engagement (45%). Mastery criteria was not meet during the schedule probe or the generalization probe sessions for either participant.

During the teaching condition both participants reached mastery criteria. Ana reached mastery in 12 sessions (range, 15% to 96%) and Weston in seven sessions. Ana averaged 83% for engagement (range, 71% to 94%) when the schedule was present. Ana showed significantly lower levels of engagement when the schedule was not present averaging 2% (range, 0% to 15%). During teaching sessions when the schedule was not present researchers observed low levels of variability averaging 1 response (range, 0 to 8). Weston averaged 77% of schedule following (range, 36% to 92%) and averaged 75% for engagement (range, 64% to 88%) when the schedule was present. Weston showed slightly lower levels of engagement when the schedule was not present averaging 57% of intervals (range, 31% to 76%). During teaching sessions when the schedule was not present researchers observed low levels of variability averaging 36 responses (range, 17 to 53).

Because Weston engaged in high levels of engagement during the initial baseline condition, a subsequent baseline condition was conducted following mastery of the

teaching condition until stability was demonstrated. Across the three sessions during the return to baseline sessions, a decreasing trend was observed for engagement which averaged 46% (range, 18% to 76%). Additionally, researchers observed lower levels of varied responding averaging 19 (range, 16 to 26) when compared to the initial baseline levels.

Both Ana and Weston demonstrated similar responding during the second schedule probe and generalization probes. Ana followed 100% of the schedule components and engaged in 93% of the intervals during the schedule probe. Weston followed 92% of the schedule components and engagement of 88% of the intervals. Two generalization probes were conducted for both participants due to an error in the activity schedule materials. Both participants engaged in the error of turning two pages at one time, which prevented the engagement of a series of responses. Ana engaged in 86% and 100% schedule followed for the first and second generalization probes, respectively. Similarly, Weston engaged in 84% and 95% of intervals during the first and second generalization probes, respectively.

Discussion

The present study is the first to evaluate the utility of matrix training embedded in a photographic activity schedule for thematic play actions for individuals with ASD. The current study extends Dauphin et al. (2004) by assessing thematic play skills, using a photographic activity schedule, and collecting data on varied play actions when an activity schedule is not present. ASD is associated with impaired social skills, communication, and restrictive behaviors which can impede an individual's development of functional play skills (Thorp et al., 1995). The use of matrix training embedded in activity schedules provided an efficient method to teaching individuals with ASD functional play skills.

Matrix training embedded in an activity schedule was effective at teaching Ana and Weston three play actions during the teaching condition that combined three characters with three different locations on the play sets using one play action (jump). Efficient learning was demonstrated when the participants were presented with six novel play actions that included novel combinations of the three character and location combinations during the generalization probes. Ana and Weston demonstrated high levels of schedule following indicating the occurrence of independent recombinative generalization of the taught play action combinations. Therefore, using matrix training was an efficient method to teach the participant three play actions that systematically combined three characters with three different locations on the play set. Using the teaching from each of those combinations, the participants then engaged in following all novel variations of those combinations. Therefore, matrix training embedded in

photographic activity schedules was an efficient method for teaching varied play responses.

The present study was consistent with the current activity schedule research in that both participants engaged in higher levels of engagement during sessions where the activity schedule was present in comparison to the no schedule conditions where engagement occurred at decreased levels. Although Weston demonstrated moderate levels of engagement throughout baseline conditions and decreased across time. The decreasing trend in engagement was consistent during the reversal to baseline after the teaching condition concluded.

Finally, during the conditions in which the schedule was not present, Ana engaged in relatively low levels of variability. Weston engaged in moderate levels of variability that decreased at the end of each condition. Anecdotally, researchers observed that Weston engaged in repetitive play in which he placed various figurines on different areas of the playset, tilting the playset forward, and watching the figurine drop during baseline conditions. These data suggest that despite the increase in acquisition of play skills, the participants' variability did not increase during conditions when the schedules were not present. One reason decreasing engagement may have occurred across time was because of an increase in more stereotypic play. Future research should explore methods to promote generalization of the play actions when activity schedules were not present by assessing participants engagement and varied play actions during sessions the schedule is not presented. Furthermore, systematically removing the activity schedule while maintaining the play actions may reduce the stigmatization activity schedules may present (Jimenez-Gomez et al., 2020). Alternative formats that may be more discrete and

increase play actions could include wearable activity schedules (Jimenez-Gomez et al., 2020) or activity schedules presented in Keynote on a hand healed device (Brodhead et al., 2018).

When comparing Ana's results to Weston's, researchers noted that although the individuals responding during sessions when the schedule was present were similar, their baseline sessions differed. Ana showed low levels of engagement and varied play actions where Weston engaged in moderate to high levels of engagement and varied paly actions. The difference in responding could be in part due to the inclusion criteria for participants demonstrating repetitive play. Anecdotally, Weston engaged in repetitive play with the figurines and the playset where Ana engaged in repetitive paly with only the figurines. Because Ana predominantly engaged with only the figurines during sessions when the schedule was not present she did not meet the definition of engagement or varied play actions within this study. Another, difference in the data is Weston achieved mastery criteria in fewer sessions than Ana. This difference could potentially be accounted for, by a procedure fidelity error with implementing graduated guidance during the first few teaching sessions with Ana.

The present study extends the current activity schedule literature in several areas. First, Dauphin et al. (2004) used matrix training and video enhanced activity schedules to teach sociodramatic play skills. The present study assessed matrix training with a book activity schedule. Similar to the findings of Dauphine et al. The paper book format of the activity schedule showed to be an effective modality to present the schedule. By assigning a book, activity schedule researchers found an alternative format which is more accessible and affordable for schools, families, and clinicians. Second, activity schedule

litterateur (Akers et al., 2018; Dauphine et al., 2004) has demonstrated the need to assess the extent to which individuals engage in generative and novel responding when activity schedules are present. Akers et al. (2018) found that when they systematically faded the activity schedule, participants showed emergence of generative play behaviors. The presents study however did not see an increase in varied play actions during sessions when the schedule was not presents. This potentially indicates the need to systematically fade out activity schedules in order to promote generative paly. Third, increasing engagement is a primary goal of activity schedules. Similar to Betz et al. (2008), activity schedule literature assesses engagement only when the schedule is present. The present study provides interesting data in that high levels of engagement did not persist during conditions when the schedule was not present even after participants meet mastery criteria. These findings demon straight a need for activity schedule fading procedures to be developed.

Although matrix training embedded in activity schedules was effective at increasing engagement, schedule following and recombinative generalization in children with ASD, there were several limitations that should be noted. First, a technology error occurred during Weston's session 17 denoted by an asterisk above the data point. During this teaching session was not recorded preventing researchers to collect data. Due to this, his two baseline sessions are depicted consecutively. Researchers have concluded however that these data are still representative of Weston's skill set in that the two subsequent teaching sessions depicted a consistent level of responding. A second limitation is that during the generalization probes following the teaching conditions both Ana and Weston turned two pages at the same time. This resulted in steps during the

missed page to be marked as an error. Due to this a second generalization probe was conducted for both participants. Future studies should consider adding tabs to the activity schedule pages that allow for easier turning or other naturalistic formats.

A third limitation is the present study did not include a social validity measure to demonstrate participants' preference for play with activity schedules or without (i.e., baseline conditions). Future research should conduct a choice assessment (Dauphin et al., 2004) as to whether participants enjoy playing with the figurines with or without the schedule being presented. This will also assist in answering whether participants ritualistic or stereotypic behaviors effected their development of play skills (Thorp et al., 1995), or in other words, the ritualistic play was due to a skill deficit versus whether the participants engaged in the ritualist behavior because they preferred it. A final limitation is the number of participants included in the study. Future research should demonstrate the effectiveness and generalization of these procedures with a larger population.

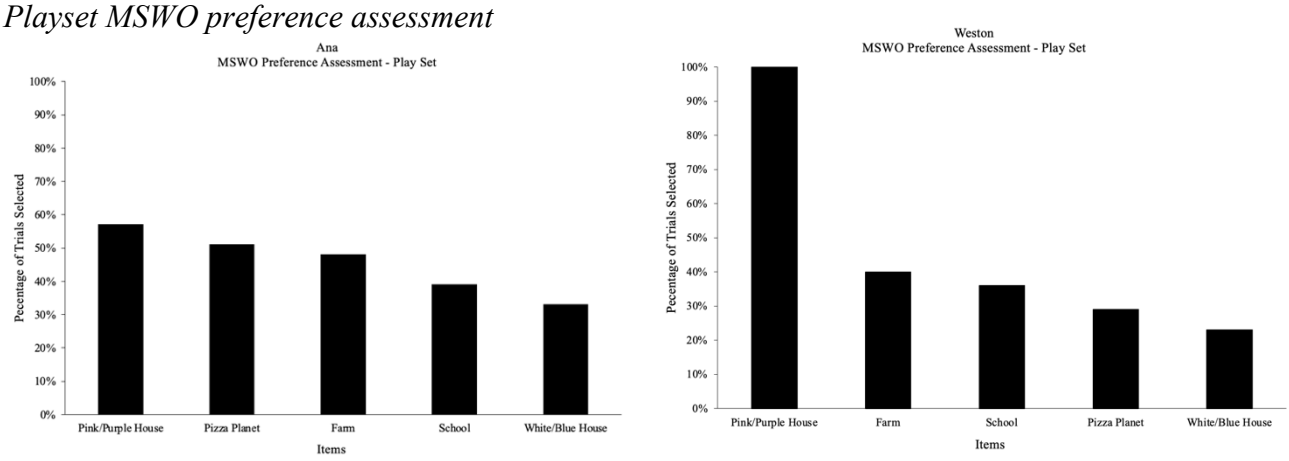
Functional play skills are important for individuals with ASD to establish because developed play skills aid in promoting social interactions with peers (Akers et al., 2018), increase independent leisure activities, and increase the opportunity for naturalistic learning (Ashiabi, 2007). Because of the gains that will be provided to children with ASD teachers, clinicians, and parents should continue to promote the development of play skills. The present study provides an instructional method that allows for more skill acquisition without direct teaching by incorporating matrix raining into an activity schedule to teach thematic play. The data in the present study suggest that matrix training embedded in activity schedules are effective at teaching children with ASD to accurately

follow a picture activity schedule, increase engagement with toys, and promote recombinative generalization.

Figures

Figure 1

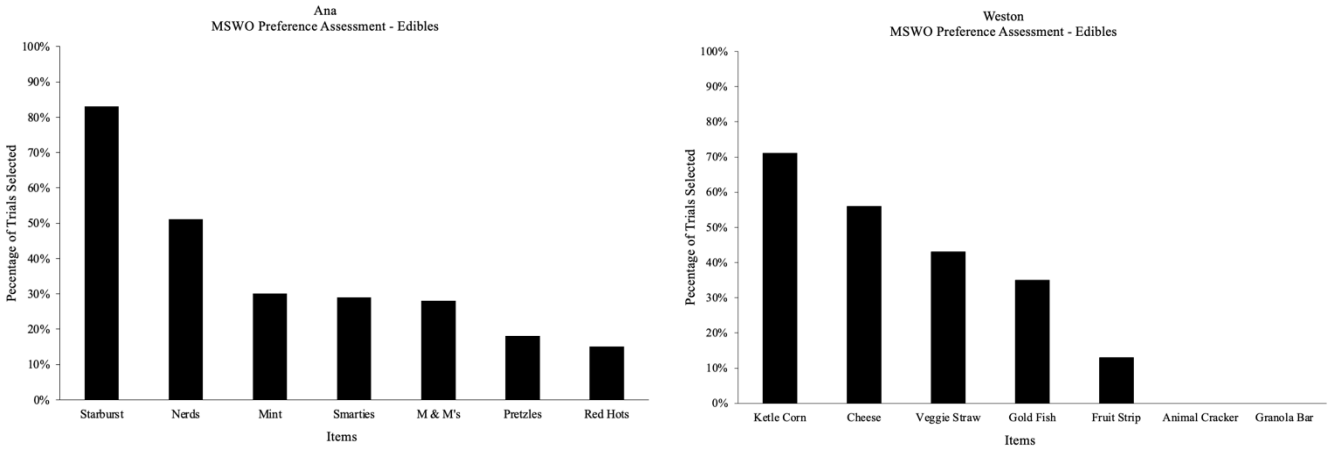
Playset MSWO preference assessment



Note. These represent the results of the MSWO preference assessments for playsets.

Figure 2

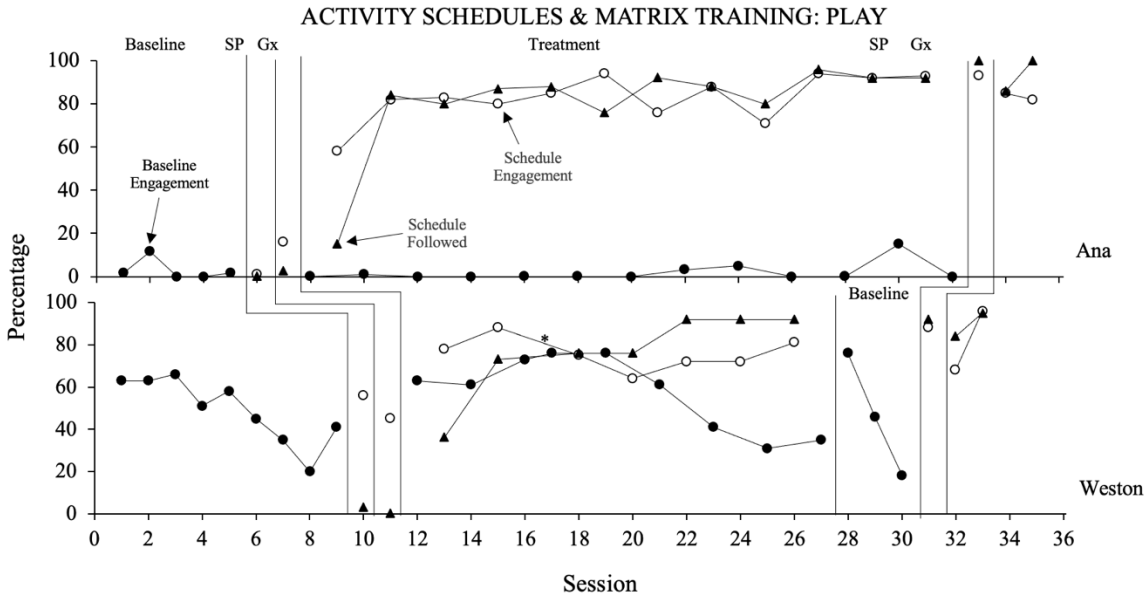
Edible MSWO preference assessment



Note. These data represent the results of the MSWO preference assessment for edibles.

Figure 3

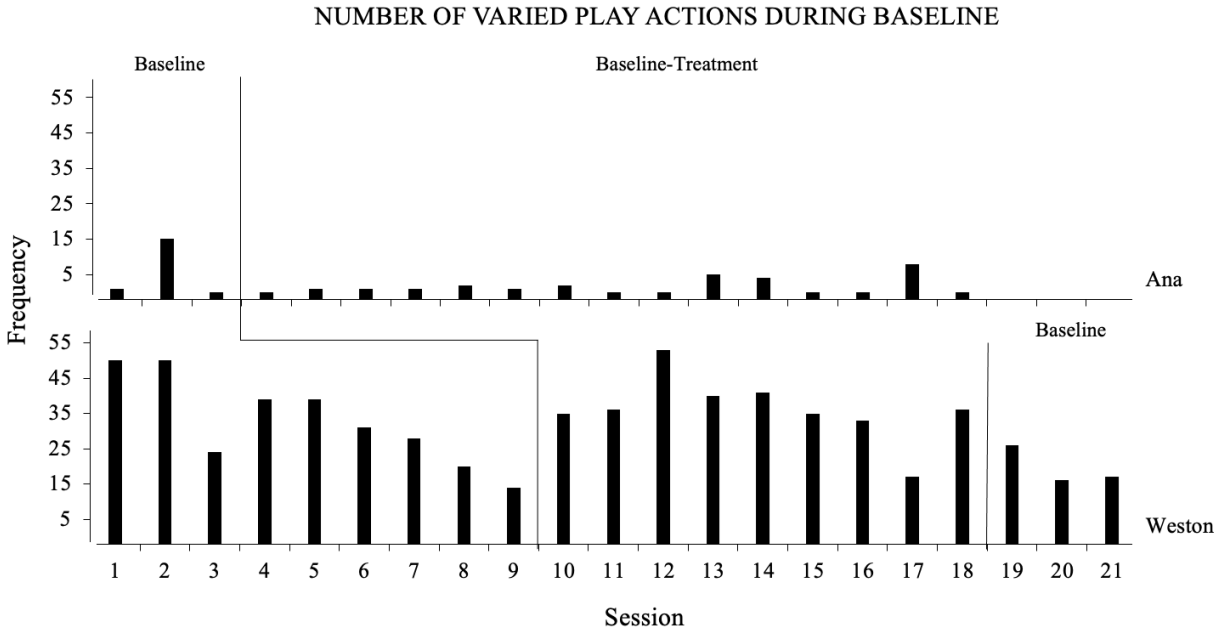
Results for Engagement & Schedule following



Note. These are the data for two participants. The close circles denote percentage of play engagement during baseline (BL). The open circles denote percentage of play engagement when the schedule is present. The closed triangles note percentage of schedule followed Schedule probes are denoted by (SP) and generalization probes are denoted by (Gx).

Figure 4

Results for Varied Play Actions



Note. These are the data for two participants varied play actions during baseline sessions.

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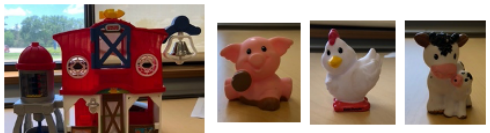
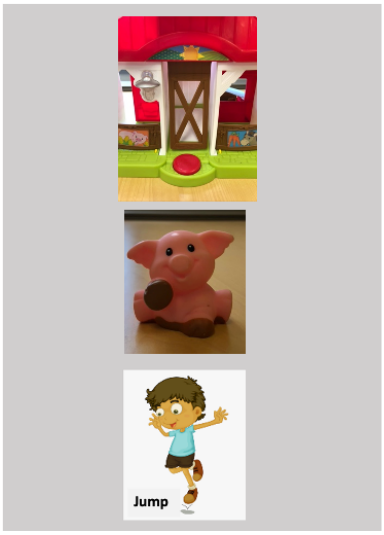
Appendix A.

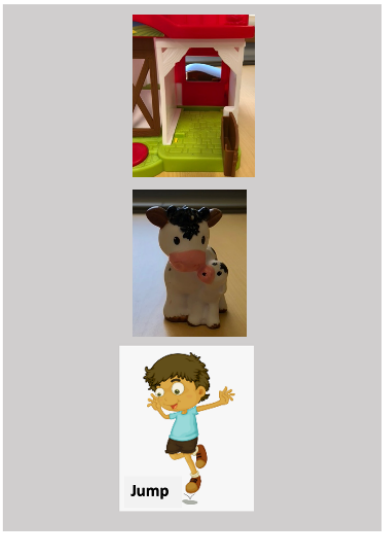
Playsets and figurines for preference assessment.

Playset	Figurines	Pictures
School	boy, older women, girl	
Pizza Planet	buzz light year, alien, tall boy	
Pink/white house	girl, baby, boy	
Farm	pig, chicken, cow	
Pink/purple house	girl, dog, man	

Appendix B.

Depicted below is an example of what the activity schedule will look like for the three taught targets and the edible reinforcer page.





Appendix C.

Depicted below is a 3-by-3 matrix. The shaded squares represent the targets that will be taught. The white squares represent untaught targets that will appear in the generalization schedule.

	Dog	Boy	Girl
Bed	Dog jump on bed	Boy jump on bed	Girl jump on bed
Kitchen	Dog jump in kitchen	Boy jump in kitchen	Girl jump in kitchen
Couch	Dog jump on couch	Boy jump on couch	Girl jump on couch

Appendix D.

Activity schedule data collection sheet.

Activity Schedule Data Sheet

Participent:					
Date:			Observer:		
Opens Schedule			Closes Schedule		
Play Skill/ Edible	Points/ attends	Obtaines Materials	Compleats Play Skill/ Consumes Edible	Returns to Schedule	Turns Page
# of components completed coreectly/Total # of components ____ / ____ x 100 =					

Appendix E.

Treatment integrity data collection sheet.

TREATMENT INTEGRITY

Client: Session #: Date: Condition:			
Therapist Behavior	**YES**	**NO**	**N/A**
Therapist is wearing the correct collored T-shirt. - Baseline: Black - Schedule Probe/Teaching/Generalization: Blue			
Correct schedules are present in the room for each condition - Baseline: no schedule - Schedule Probe/Teaching: teaching schedule (green) - Generalizaton: generalization schedule (red)			
Therapist present's high prefered playset & figuriens on the floor			
Activity schedule is present within 1-m of the playset with the correct targets in the specified order			
Therapist gives the instruction "go play" at the start of session			
Therapist delivers prompts appropriate for the condition - Baseline: no prompts - Schedule Probe/Generalization: no Prompts - Teaching: most-to-least prompts			
Therapist makes the reinforcer avalible for all conditions			
Session is terminated after 5 minutes or compleation of the schedule			
# of YES's/ # of YES's + NO's =	_____%		