TEACHING TWO CHILDREN WITH AUTISM TO FOLLOW A COMPUTER-MEDIATED ACTIVITY SCHEDULE UTILIZING MICROSOFT® POWERPOINT® PRESENTATION SOFTWARE

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Children with autism typically exhibit deficits in behavior and also in visual processing. Development and implementation of visually-cued instructional procedures, combined with electronic technology, have been used successfully to teach children with autism complex behavior chains. This study used photographic activity schedules on computer slideshow software to teach two children with autism to follow computer-mediated cues and engage in four play activities, and to transition between each activity in their homes without the presence of a trained behavior therapist. Results of this study demonstrated that these technologies can be utilized in children's homes to promote computer-mediated play behavior while eliminating the necessary cost of a home behavior therapist to prompt and supervise such activities.

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INTRODUCTION

Independent functioning is a research focus in the development of instructional strategies for children with autism (Dalrymple, 1995). Autism is characterized by dependence on adult cuing for staying on task, for completing activities and for transitioning between activities. Deficits in social cognition, abstract thinking, communication, cognitive processing (Quill, 1995) and auditory processing (Dettmer, 2000) result in fundamental differences in learning processes and performance across behavioral repertoires. Difficulties in sharing joint attention with others, shifting attention quickly and extracting the relevant features from a social context may contribute to the atypical patterns of social and play behaviors observed in children with autism (Quill, 1995). Individuals with autism have difficulty discriminating cues in their environment, which further interferes with their capacity to learn the independent skills necessary for successful functioning as adults (Bryan & Gast, 2000). Skills that have been learned are often not demonstrated unless the child is prompted by an adult.

Progress in independent daily living is inhibited by over-dependence on adult instruction. Even when prompts are systematically faded from instruction, transfer of stimulus control from adult initiated prompts to environmental stimuli often fails to occur (McClannahan & Krantz, 1997).

Therefore, continuous supervision and prompting are often necessary for persons with autism to enable them to be able to complete daily living and occupational tasks. This deficit may necessitate their long-term care and, in part, may be responsible for their low occupational achievements (Carothers & Taylor, 2004).

Current research strives to develop strategies for decreasing dependence on adult prompts and facilitating independence across life skills (Bryan & Gast, 2000). Despite these aforementioned deficits, individuals with autism are commonly reported to demonstrate strengths in the areas of concrete thinking and rote memory (Quill, 1995), sustained attention to stimuli (Miyashiro, 2001; Lincoln, Courchesne, Kilman, Elmasian & Allen, 1988), as well as superior abilities in integrating visuo-spatial information (Cafiero, 2001; Grandin, 1996; Lopez & Leekam, 2003; Mitchell & Ropar, 2004; Spencer, 2002) over auditory-temporal information (Hermelin & O'Conner, 1970).

An growing body of research has focused on designing teaching procedures incorporating visual cues that make use of these strengths in order to teach the child to respond to environmental stimuli without adult intervention and to facilitate independent behavior in a manner more consistent with typically functioning peers. Teaching procedures that decrease the continuous supervision needed to execute and complete daily activities also provide relief for adults in the child's environment, who, otherwise, are responsible for the daily care and supervision of the overdependent child (McClannahan & Krantz, 1997). Several types of instruction have been developed over the years to assist these children to gain more independent functioning. These types of instructional training are discussed below.

Visually-Cued Instruction

Visually-cued instruction uses representations of places, objects, and behaviors ranging from depictions (e.g., photographs) to abstract symbols such as textual language and line drawings (pictographs) as instructional prompts in the autistic child's living and learning environments. Because visual cues are spatial and tangible, visually-cued instruction may address the visuo-spatial strengths of children with autism in areas of attention, perception, information processing, memory and language by aiding the learner to process auditory and visual stimuli simultaneously (Quill, 1995; 1997). These cues may be used to illustrate sequences of behaviors necessary for any number of home, school, community, vocational and social behaviors. For example, visually-cued instruction has been reported to increase the acquisition, generalization and maintenance of daily living skills (Pierce & Schreibman, 1994), communication skills (Krantz & McClannahan, 1998; Miyashiro, 2001; Theiman, 2000), social skills (Kimball, Kinney, Taylor & Stromer, 2004), leisure and transitioning skills (MacDuff, Krantz & McClannahan, 1993), socio-dramatic play (Dauphin, Kinney & Stromer, 2004), transitioning skills during daily events (Dettmer, Simpson, Myles & Ganz, 2000), compliant behaviors (Hodgdon, 1995) as well as vocational skills for young and mature adults (Conis, 1979; Johnson & Miltenberger, 1996; Wacker & Berg, 1983; Wacker, Berg, Berrie & Swata, 1985). When behavioral sequences are taught using visual displays as cues, children with autism have acquired and maintained skills with less dependence on adult prompts than when behavioral sequences are taught without visual cues (Quill, 1995).

Written Scripts

Written scripts present textual words and sentences in script form to cue reciprocal language skills. Studies have shown that written scripts can be successfully implemented to promote social-communicative behaviors and independence in young learners with autism in their elementary school settings. Theiman (2000) used written scripts to teach initiating requests for information, initiating requests for objects/actions, and giving compliments to peers. Miyashiro (2001) implemented written scripts to teach echolalic children to engage in low-effort, reciprocal conversation exchanges with peers and adults in the school setting. Other research has investigated the effect of written scripts on language behavior in center-based programs.

Krantz and McClannahan (1993), in a center-based program, implemented visually-cued instruction in the form of script fading with 4 children with autism to teach communicative initiations with peers while attending a center-based program. While completing an art activity at their classroom desk, each child was manually prompted to read a script and orient their gaze to the child named in the scripted talk. The scripts included questions relevant to the ongoing activity (e.g., “Mike, do you want to use my crayons?”) and leisure activities recently completed or anticipated in the near future (e.g., “Mike, do you like to ride bikes?”). After manual prompts were faded, the instructors began to fade the social scripts from end to beginning, one word at time, then to the initial sound (e.g., “m”) and finally, the opening quotation mark only (“). Data were collected for 10 consecutive min using a continuous event recording system. Observers recorded when each child asked each question or made a response cued by their personal scripts. At baseline 2 of the 4 children never initiated. During the script condition these 2 children’s initiations increased to means of 13 and 15. The third child’s initiations increased from a mean of 0.1 during baseline to a mean of 17 during the script condition. The last child’s mean score increased from a mean of 2.0 during baseline to a mean of 14 during the second baseline condition. At a 2-month follow up probe, 3 children continued to engage in approximately the same number of initiations and responses. One child’s initiations decreased from 14 to 6, but responses remained high. While each child had only 10 scripted sentences, each one usually made more than 10 initiations/session. This behavior generalized to new settings, times and activities with new teachers using only the final two faded prompt steps. The children also combined different questions and statements into novel ones with no additional instruction. However, the new behaviors did not generalize in the absence of the textual prompt. The results of this study indicated that children with autism could successfully be taught social-communicative behaviors during school activities using visual cues with script-fading procedures. Script-fading procedures also eliminated the need for adult prompting and fostered social independence for these children. Further research is necessary to determine if more complex and varied communicative skills could also be taught using this procedure, as well as developing procedures that promote generalization in the absence of any textual prompts. While script fading has been successfully implemented in school settings, there have been few studies indicating this technology has been transferred successfully into the home setting.

Pictographs

Receptive language is a skill area that has gained the attention of researchers looking at application areas for visually-cued instruction. Preis (2002) used visually-cued instruction to teach direction-following skills to 5 young children with autism receiving therapy at a university speech-language pathology center. Preis compared effectiveness of verbal instructions vs. verbal instructions with visual cues, consisting of black and white line drawings (or pictographs), in an alternating treatments design. The combined verbal/visually-cued instructions involved simple commands such as, “Get the ball.” presented a picture of a ball. More complex commands—e.g., “Stand up and push the car”—were presented two or three line-drawing illustrations. From 1-6 commands, equally alternated, were taught/session. During intervention and maintenance conditions all participants achieved nearly equal levels of acquisition under both treatments. However, 3 participants required fewer trials to criterion in the picture prompt condition, and 4 participants' behavior generalized to novel instructions more successfully in the verbal instruction with picture prompts vs. the verbal instruction only condition. Retention probes at 10 and 20 weeks post-treatment revealed that every participant retained more instructions taught under verbal instructions with visual cues. These data suggested that while black and white line drawings may not be critical for acquiring receptive direction-following skills, visual cues do facilitate transfer of learning to new environments and long-term retention of receptive, direction-following skills.

Picture Activity Schedules

An increasingly widespread form of visual cue is the picture activity schedule. Often prepared in a 5-in. x 7-in. 3-ring binder, the picture schedule illustrates a specified sequence of events that occur across a day—getting dressed, eating breakfast, going to school, returning home, doing homework, going to bed—or a sequence of behaviors necessary to complete a particular task (e.g., getting dressed, setting a table). Picture schedules are useful in illustrating sequences necessary to enable effective behavior across various settings: in home, school, community, vocational and social environments.

Dettmer, Simpson, Myles and Ganz (2000) examined the effects of different types of common picture schedules on transitioning behavior for 2 children with autism. The picture schedule displaying pictographs in a small photo album illustrated the order of daily events for 1 participant. Another picture schedule using the identical illustrations was mounted on the dashboard of the parent's car. As one event ended the parent showed the corresponding picture and said, "Finished," and then showed the next picture corresponding to the next event and talked about it. A similar daily picture schedule was designed for the second participant. Additionally, the researchers designed a sub-schedule/finished box routine. This sub-schedule consisted of written instructions on index cards for work activities. When the participant completed a work activity, he placed the corresponding instruction card into a coffee can marked "Finished." A timer displaying a disappearing red section as time elapsed was used during preferred activity times. At the onset of preferred activity periods, the caregiver stated the contingency (e.g., "When red is gone, (preferred activity) is done"). Data for participant 1 indicated that physical prompts necessary for transitioning decreased from 14 prompts during baseline to 0 prompt during the final teaching phase. Latency between activities also decreased from a mean of 450 s to a mean of 96 s. For participant 2 data showed that physical prompts were not required to prompt this child to move from one scheduled activity to another. Latency between activities decreased from a mean average of 150 s during baseline to a mean average of 42 s during the final teaching phase. These results support the premise that visual supports in the form of picture schedules, sub-schedules, finished boxes and timers may not only reduce latency, but also, the need for physically prompting transitioning behavior between daily events in the lives of young children with autism.

MacDuff, Krantz and McClannahan (1993) employed picture schedules and graduated guidance procedures (most-to-least prompting) to teach 4 male adolescents with autism in a supervised group home setting to follow a photographic activity schedule that prompted them when to engage in leisure activities and when to transition between leisure and homework activities. Each participant engaged in high rates of stereotypical behavior and low rates of independent leisure and self-help behavior. These children learned to attend to 6 picture cards showing leisure and homework activities; they all learned to access, engage in, and complete each activity then to transition into the next activity in the sequence. Schedules consisted of six photographs displayed individually in a 3-ring binder. The activities depicted in these photographs were familiar to the child and available in the child's bedroom or the family room. The researchers measured on-task and on-schedule behavior in a multiple-baseline design across participants**.**

On-task behavior was defined as (a) visually attending to any appropriate play or work materials, (b) looking at their photographic schedules, (c) manipulating play or work materials appropriately, or (d) transitioning from one scheduled activity to another. They defined on-schedule behavior as engaging in the activity depicted on the page to which the schedule was open at the moment of observation. On-task but off-schedule was recorded if the child was engaged in an activity depicted in the schedule, but not on the page the currently opened schedule page. Off-schedule was recorded if the participant did not meet on-task criteria. Data were recorded using a 60-s momentary time-sampling procedure. Verbal, gestural and manual prompts were recorded using a 60-s partial-interval procedure.

Baseline consisted of a primary observer delivering initial instructions to all participants in the living room. In teaching conditions, the primary observer used graduated guidance procedures from standing behind the participant to guide him through taking the activity schedule to his bedroom, opening it, pointing to the picture, obtaining the requisite materials, manipulating those materials, putting the materials away and returning to the picture schedule to turn the page, then repeating that sequence. Graduated guidance (McClannahan & Krantz, 1999) began with full manual prompts that guided the child's body through the correct sequence of behaviors and systematically reduced these prompts as the child demonstrated the correct behavior. Then manual prompts were withdrawn as quickly as possible using spatial fading. Spatial fading consisted of the observer changing locations of physical prompts (e.g., fading up from the hand to the wrist), to physical shadowing during which the observer's hands followed the participant's movements without physically contacting the child, and finally, the observer faded back on physical proximity. Prompts were reinstated if the participant engaged in inappropriate behavior or stopped for an extended time period. The researcher ended teaching sessions when the participant remained on-task and on-schedule for 80% of time samples across 5 consecutive sessions after the teacher faded his physical proximity.

When training criteria were met, the researchers re-sequenced the first 4 activities on the schedule, leaving activities 5 (eating a snack) and 6 (watching TV) in their original positions. No prompts were delivered. This condition was followed by a generalization condition, in which two of the first four original activities were replaced by novel ones. All participants learned to complete the picture activity schedules in all conditions with 96%-100% on-task and on-schedule scores. Using picture activity schedules facilitated acquisition of complex chains of functional behavior, sustained engagement with leisure and homework materials, maintained independent transitioning between these activities and resulted in increased occurrence of independent (i.e., without immediate adult supervision and prompting) on-task and on-schedule behavior.

Video Modeling

With increasing availability and widespread use of technological equipment, research has focused on developing instructional procedures and programs involving digital photo/video cameras and computers. One teaching method that employs this technology is video modeling. Appropriate or desired behavior is videotaped using peer and adult models or the target child as a self-model to demonstrate desired target behavior. These types of instructional interventions decrease the learner's dependence on prompts and extend activity engagement without programmed prompting, correction and reinforcement procedures delivered by adults (Sturmey, 2003). When systematically compared to in-vivo modeling, videotaped modeling has led to more rapid acquisition of independent, cooperative interpersonal play, conversational speech, expressive labeling and self-help skills, as well as generalization of these skills across persons, settings and stimuli (Charlop-Christy, Le & Freeman, 2000). Video modeling has also been demonstrated successfully in teaching children with autism skills such as perspective taking; independent, cooperative and imaginative play, spontaneous language, academic skills (Sturmey, 2003), expressive labeling (Stoelb, 2004), reciprocal play with a sibling (Eastridge, 2003), social initiations (Nikopoulos & Keenan, 2003, Nikopoulos & Keenan, 2004), social reciprocity skills (Apple, Billingsly & Schwartz, 2005), as well as functional daily living skills (Shipley-Benamou, 2002). D'Ateno, Mangiapanello, and Taylor (2003) implemented video-modeling to teach solitary imaginative play behavior and play related conversation to a 3-year-old girl in a center-based program.

In that study, an adult model was used in three video vignettes to read a script and manipulate play materials accordingly. During intervention, the participant viewed a video presentation of one play scenario, then was given access to the corresponding play materials 1 hour later. No prompts, corrective procedures or reinforcement procedures were used. This study demonstrated that video modeling alone could be implemented to instruct solitary, imaginative play skills to a child with autism without any prompting, correcting and reinforcement procedures from adults.

As no adult interventions were necessary to teach the target responses, future investigations are needed to determine if such procedures would be effective in teaching solitary play behavior in the child's home setting without the stimulus control exerted by the presence of the therapist in the room. Such technology would be useful and beneficial for parents in that it could reduce therapy costs for families.

Computer-Mediated Instruction

Other behavior analysts (Bernard-Opitz, Sriram & Nakhoda-Sapaun, 2001; Bosseler & Massaro, 2003; Hetzroni & Tannous, 2004; Navarro, Marchena, Alcalde & Ruiz, 2004) have evaluated computer educational software designed to make use of behavioral procedures and reinforcement contingencies. This growing body of research suggests that computer-mediated, visually-cued instruction facilitates learning, is not difficult to train, attracts and maintains the learner's attention through its capacity to display interesting learning environments and to respond contingently with appealing, salient, visual features that capture and hold the learner's attention.

Moore and Calvert (2000) studied the effectiveness of computer instruction compared to teacher instruction in the area of vocabulary acquisition. They compared student attention, motivation and acquisition of vocabulary in vivo vs. via a computer educational software program. The behavioral contingencies in educational software were designed to be analogous to the in vivo program with additional features of sounds and object movement.

Fourteen children, ages 3 to 6 years, attending a school for children with autism, participated in this study. Each participant was assigned to one of two treatment conditions: in-vivo or a computer condition. In the in-vivo condition, children were taught to receptively identify simple objects using standard discrete trial procedures. Correct responding was followed with praise. In the computer condition, children were also taught to receptively identify simple objects using the computer mouse. Teaching procedures in this condition paralleled the procedures in the in-vivo condition. Correct responses were followed by sensory reinforcers, including color, animation, music and sounds. Attention was measured by recording total amount of time the participant's visual attention was directed toward the teacher and learning materials, or in the computer program, total amount of time the participant's visual attention was directed toward the computer.

Motivation was assessed periodically by asking each participant in both conditions whether they wished to continue working or go play. Participants indicated their choice verbally, by pointing to the drill materials, or by leaving their chair to approach play materials. If the participant chose the drill materials and continued to work, the condition was scored as motivating. If the participant left the work materials to go play, the condition was scored as less motivating.

Results demonstrated that the participants in the computer-led condition were attentive 97% of the time, while those in the teacher-led attended 62% of the time. Retention probe data showed that participants in the computer-led condition recalled 74% of target nouns compared to 41% for the teacher-led condition. Motivational data indicated that 57% of participants in the computer condition were motivated to continue working compared to 0% of those in the teacher condition. Inter-observer agreement (IOA) was 96% for duration of attention. The results of this study suggested that computer technology can be effective in teaching language skills to children with autism; furthermore, computers can evoke and maintain children's attention, interaction with learning materials, as well as promote learning.

Kimball, Kinney, Taylor and Stromer (2003) combined availability and convenience of technological tools and the picture activity schedule using digital cameras and Microsoft PowerPoint® presentation graphics program. They transferred the common 3-ring binder picture activity schedule to a computer-driven format. This transfer allowed the activity schedule to become more interactive, supporting photos and sound as well as short video clips. Using a computer mouse and keyboard, the child could "turn the page," view the photograph or video clip, then engage in the activity, and return to the computer to view the next instruction.

These researchers followed the methods described by MacDuff, et al., (1999). Using most-to-least prompting procedures and graduated guidance, they taught 2 children, aged 3 and 6 years, to independently access three or four play activities at a center-based program for children with autism. The participants were taught to advance the slide presentation and then go to the play center in the classroom illustrated in each photograph presented on the computer monitor. When the computer cued them to stop, these participants were taught to clean up and put away that activity and return to the computer for the next activity cue. The final photograph in each participant's schedule illustrated a preferred toy or activity that each could manipulate, thereby ending the session. Both participants learned to follow their schedules without adult prompts and engaged in play and transitioning activities for approximately 20-30 min.

All of the aforementioned studies investigated the use of visually-cued instruction in controlled educational and treatment settings. High costs of specialized educational programs and clinical therapies, limited or no insurance coverage, long waiting lists and lack of appropriate school programs for children with autism, as well as an emphasis on intensive early intervention, has created the impetus for parents to hire private therapists to deliver behavioral services in their home. The cost of home behavior therapy also places limits on the number of hours/week of treatment a family can afford. Further research is necessary to extend the benefits of visually-cued instruction on training unprompted behavior in the home environment to eliminate the need for behavior therapists to implement these procedures.

The current study was designed to teach 2 children with autism to follow a computer-mediated play activity schedule in their own homes, and to systematically transfer instructional control from the investigator to each child's parent (i.e., the mother). The goal of this study is to teach each child to follow his own activity schedule so that each can perform in-home activities without the support and additional expense of having a trained behavior therapist present to verbally or physically occasion these behaviors.

Experimental Question and Design

This study replicated Kimball, et al. (2003), in that it includes computer-mediated activities but extends Kimball et al.'s study in that this technology was implemented in each participant's home setting, and the goal was the ultimate transfer of stimulus control from the therapist to the parent (mother).

The experimental question addressed in this study is how will transferring and implementing the technology described in the Kimball, et al. study to the home setting affect unprompted play and transitioning behavior during leisure time in the family's environment?

METHOD

Participants and Setting

Two male children with autism participated in this study. Participant 1, aged 6, emitted limited vocal-verbal behavior with some spontaneous language. He could expressively and receptively identify photographs of common environmental objects and people and say 3- to 10-word sentences for preferred activities and objects. He had demonstrated deficits in self-directed play skills, completing activities and transitioning to new activities without adult prompts.

Participant 2, aged 10, also emitted limited vocal-verbal behavior with some spontaneous requests in 1- to 5-word sentences. He could receptively and expressively identify photographs of common environmental objects and people, and make requests for preferred activities and objects. His behavioral deficits included self-directed play skills, completing activities, transitioning to new activities, and engaging in appropriate play behavior without adult prompts or supervision. When unsupervised he emitted high rates of vocal and physical self-stimulatory behaviors. Both boys engaged in play skills that had been taught in their home behavior therapy sessions. Both could follow traditional picture activity schedules at home, and each had demonstrated basic computer skills (e.g., opening computer software, playing game programs using a mouse). All sessions occurred in each participant's bedroom in their homes.

Participant 1

Participant 1's assessment, baseline and teaching sessions occurred in a 12-ft by 11-ft bedroom containing a twin bunk bed, a dresser, a desk, an office chair, a 22-in. x 20-in. x 19-in. table with matching chair, a computer and video camera with a tripod stand.

Materials for Participant 1. An e-Machine® T2895 Desktop PC, with an Intel® Celeron® Processor and Microsoft® PowerPoint® presentation graphics program, version 2002, were used for all sessions. A 3-drawer storage caddy held necessary play materials for three activities. A 12-quart Sterilite® clearview storage box placed on top of this storage unit held materials for a fourth activity. Play materials included assorted children's coloring books, Crayola® washable markers, construction paper, Crayola® washable paint, spill-proof paint cups, assorted small, natural wood toys and boxes, interlocking wood puzzles, Spell Time™ educational toy, Play-Doh® modeling compound, assorted cookie cutters, assorted Play-Doh® plastic toys, Mr. PotatoHead® toy, children's scissors, Elmer's® glue, and children's paintbrushes.

Participant 2

For participant 2 assessment, baseline, training and retention sessions occur red in a 14-ft x 16-ft room containing a 60-in.x 36-in x 36-in table, 2 chairs, a computer desk, a dresser, 2 twin beds, a small bookshelf, 2 caddies on wheels, a computer and a video camera with a tripod stand. Play activities occurred at the table located next to the desk and caddy.

Materials for Participant 2. A Packard Bell® Pentium Desktop PC with a MMX™ Enhanced processor and Microsoft® PowerPoint® presentation graphics program, version 2000, was used for all sessions. A 4-drawer storage unit/caddy held play materials for 4 activities. Play materials included a wooden train set with wooden trains and a battery-powered Thomas the Tank Engine® battery-powered train, construction paper, Crayola® washable paint, spill-proof paint cups, paintbrushes, Play-Doh® modeling compound, assorted cookie cutters, assorted Play-Doh® plastic toys, children's scissors, children's assorted jigsaw puzzles, Lincoln Logs® real wooden logs, Leap Pad® learning system, an electronic piano, an electronic spelling toy and children 's books.

Digital Video Camera

A Sony® digital video camera recorder with a tripod stand was used to record sessions and a jWin® wireless camera with 5" black & white security monitor was used to observe the final 2 conditions and all retention probes from a remote location in each participant's home.

Pre-Assessment Procedures

Prior to baseline a pre-training assessment phase was conducted to assess the following skills and reinforcers: 1) the extent of each participant's basic computer skills, 2) what, if any, pre-training skills would be necessary to enable these children to execute the computer-driven activity schedule and 3) play activities and reinforcers to be included in each child 's activity schedule.

Computer skills assessment. Each participant was observed on two occasions left clicking the mouse to open a previously installed computer software game; maneuvering a computer mouse left, right, up, and down over the computer game display; and left-clicking once to make a selection within that game display.

Play materials. The play activities assessed were those that the participants previously had been taught during regularly scheduled home therapy sessions. These activities included building puzzles, painting objects or pictures, building a train track and running a train around the track, building a house with Lincoln Logs®, building a Mr. Potatohead®, coloring in a coloring book, playing with electronic toys and looking at books.

Play activities. Each participant was observed engaging in each activity to determine if he could start and complete each without prompts, as well as to determine the approximate time period spent in each activity or with each toy.

Activity schedule preparation. A slideshow, consisting of 5 slides, was prepared for each session. The first 4 slides were pictures of either an activity or toy (e.g., paints and paintbrushes) or a photograph of the participant playing in an activity or with a toy (e.g., the child building a Lincoln Log® house). Each picture slide included a text sentence typed above the photograph corresponding to the activity pictured (e.g., “This is cool!” and “I like trains!"). Each slide also included a voice recording of that sentence and a voice recording saying, "All done. Time to clean up." The 5th slide presented 4 photographs of highly preferred objects or activities (based on observations during home therapy sessions and in consultation with each participant's parents) from among which the participant could choose. These choices included television, computer games, preferred snacks and toys. A green sticker with the word "Go" was attached to the F5 computer key and a yellow sticker was attached to the computer spacebar to indicate the correct keys for slideshow presentation and advancement. A task analysis listing the component behaviors necessary to complete the schedule was also designed.

Procedure

Baseline Phase

Baseline sessions were conducted over 2 consecutive days in each participant's bedroom. The investigator and participant stood in the center of the bedroom several feet away from the desktop computer with the power on. A PowerPoint® slideshow icon labeled with the participant's name was located in the center of the computer screen. The investigator said, "Do your computer schedule," waited 5 s, and then recorded any responses that occurred thereafter. No consequences were delivered. The session was terminated when an incorrect response occurred. The investigator said "All done" at the conclusion of the session.

Training Phase

Condition 1. Training sessions began the day after baseline ended. All training sessions occurred in the participant's bedroom. The investigator and participant stood in the center of the bedroom several feet away from the computer. The first training session was conducted without error. The investigator said, "Do your computer schedule," while physically guiding the participant to approach the computer and double click on the PowerPoint® slideshow icon to open the slideshow. Then the investigator physically prompted the participant to press the green (F5) key to start the slideshow. As each slide appeared on the monitor screen, a pre-recorded vocal prompt, correlated with the activity presented, occurred. The investigator waited 3 s for the participant to imitate this voice prompt. If he did not, the investigator said the word on the screen and physically prompted the participant to point to each word on the screen as it was spoken. Then the investigator vocally prompted the participant to say the sentence. Then the investigator physically prompted the participant to retrieve the appropriate materials from the storage caddy, to put these materials on the table and to play with them. After 5 to 10 min of pre-determined playtime, a pre-recorded voice embedded in the slideshow prompted the participant to put away the materials. Then the investigator physically prompted the participant to put the materials back in the storage caddy and return to the computer.

Next the participant was physically prompted to press the yellow (spacebar) key to advance the slide to the second activity. The previous steps were repeated for activities 2, 3, and 4. The final slide presented 4 photographs of highly preferred objects. The voice recording and text prompted the participant to say, “I want….” If the participant did not imitate the vocal prompt within 3 s and did not make a choice from the selection, the investigator pointed to the text and verbally prompted the participant to say, “I want (choice).” After the participant made a choice the session was terminated, and the participant received his chosen object or activity.

Successive training conditions implemented prompt-fading procedures (see Table 1). In these sessions, the investigator did not intervene if the participant initiated correct responses in the behavior chain unprompted. The investigator observed in close proximity (1 to 5 ft away) until the participant initiated an incorrect response or made no response. When or if this occurred, the investigator physically prompted the correct response. If the next response in the behavior chain was initiated without prompts, the investigator did not intervene. The investigator continued to observe in close proximity and physically prompted only when an incorrect response was initiated or no response occurred.

Condition 2. When the participant accurately completed the activity schedule over 2 consecutive sessions with 90% correct responding and a maximum of 2 or fewer prompts, the next session was initiated with the investigator, the participant, and a parent standing just outside his bedroom in the hallway. The investigator delivered the instructions from the hallway, and then she and the parent observed the participant in his bedroom from just outside the doorway. If he made an incorrect response, the investigator entered the room and physically prompted the correct response. If the participant was off task, the investigator waited 15 s to allow the participant to return to the task on his own. If he did not, the investigator provided a proximity prompt by entering the room. If this action prompted the participant to return to the task the investigator returned to the hallway. If this action did not prompt task engagement, then the investigator approached the participant and physically prompted the correct on-task behavior. If a physical prompt was necessary, the investigator remained in the room within close proximity to the participant, and the next session was initiated and prompted with the investigator in close proximity until he again completed the behavior chain across 2 consecutive sessions with 90% correct responding and no more than 2 prompts. When this occurred, the sessions followed previously described, prompt-fading procedures.

Condition 3. When the participant completed the activity schedule correctly for 2 consecutive sessions with 90% correct responding and no more than 2 prompts while the investigator and parent observed from the hallway, the next session was initiated with the investigator, participant and the mother standing in the room closest to his bedroom. Then the mother delivered the instruction, and the investigator observed the participant from this room via a video monitor. If an incorrect response occurred, the investigator entered the room and gave a physical prompt for the correct response. If the participant was off-task, the investigator waited 15 s for the participant to return to the task. If he did not, the investigator provided a proximity prompt by entering the room. If the participant returned to the task, then the investigator returned to the monitor. If this action did not prompt the participant to re-engage with the task, the investigator approached the participant and physically prompted the correct on-task behavior. If a physical prompt was necessary, the investigator remained in the hallway just outside the doorway to the participant's bedroom observing his behavior. The following sessions were initiated and observed from the hallway outside the bedroom until the participant again completed the behavior chain at 90% correct responding over 2 consecutive sessions and with no more than 2 prompts. Once again, the following sessions were initiated by the mother, and the investigator remained in the room closest to the participant's bedroom and observed the session via the video monitor.

Condition 4. When the participant completed the activity schedule with 90% correct responding and no more than 2 prompts while the investigator observed from another room for 2 consecutive sessions, control was fully transferred to the mother. The parent and the participant stood in a central room of the house, and the parent delivered the instruction, "Do your computer schedule." Unbeknownst to the participant, the investigator observed from another room via the video monitor. If the participant initiated an incorrect response or did not remain on task, the investigator waited 15 s to allow the participant time to self-correct the error or return to the task. If the participant did neither, the investigator cued the mother to enter the room and prompt the participant. When he completed his activity schedule while following parental instructions across 2 consecutive sessions at 90% correct responding with no more than 2 prompts, mastery criterion was met and training conditions were terminated.

Procedural Revisions for Participant 1

After meeting mastery criterion (90% correct responding with no more than 2 prompts) in condition 1 and condition 2 correct responding scores for Participant 1's performance dropped below mastery criterion, and the total number of prompts increased for 3 consecutive sessions. A review of the data indicated that incorrect responses occurred most often when he was engaged in an open-ended activity (e.g., painting, drawing a picture and coloring). It was then that the experimenter most often had to prompt the participant to stop and clean up the materials. Refusal to get an activity that the slideshow presented or refusal to play with an activity once he placed it on the table was also observed. The participant would say "No!" when the slideshow advanced to an undesired activity or "All done, time to clean up" as soon as he placed the materials on the table.

At this time modifications were made. Before the next session began, all the activities that were rotated through the activity schedule were placed on the floor in the center of the bedroom. The experimenter asked Participant 1, "What do you want to play with today?" Participant 1 was allowed to scan the activities. When he picked one up the experimenter said "OK. Put it in the drawer. What do you want to put in the next drawer?" In this manner, Participant 1 selected the 4 activities that he would engage in during that session. When all 4 activities were chosen, the experimenter set up the slideshow to correctly reflect the choices and the session began. She also removed timings from the slideshow that had prompted the participant to stop playing with an activity. In the next session he was physically prompted to clean up and put away the materials when he determined he was finished with each activity (usually after 5-15 min).

Retention Probes

Retention probes were conducted 1, 2, and 3 weeks post-training. The same procedures as described above for the final (parent-only) training condition were followed. The investigator observed the session from a remote room without the participant aware of her presence.

Procedural Revisions for Participant 2

Data recorded during the first retention probe indicated that Participant's 2 previous performance at mastery criterion was not maintained one week after all training conditions were completed. Data indicated that transfer of stimulus control from the investigator to the mother did not occur. At this time, re-training conditions 5 through 9 were established.

In condition 5, the mother and investigator were present with Participant 2 in his bedroom. The mother gave the initial instruction "Do your computer schedule," and remained in close proximity to the child to physically prompt correct responding behavior. The investigator remained in close proximity to both the mother and child in order to cue the mother's prompting behavior. In condition 6, the mother remained in the bedroom in close proximity to the child while the investigator began fading her presence by observing from the hallway. In condition 7, the mother gave the initial instruction from the hallway and observed from this distance while the investigator observed from another room via the video monitor. In condition 8, the mother gave the initial instruction from a central area in the house and moved about the house while periodically ‘checking in’ to ensure the child remained on-schedule and on-task. The investigator observed the session via the video monitor in another room. If Participant 2 became off-shedule or off-task for more than 15 s, then the investigator cued the mother to enter the room and deliver a prompt to the child. Condition 9 was conducted in the same manner, except the presence of the investigator in house was unknown to the participant. A minimum of 3 consecutive sessions at 90% correct responding and with no more than 2 prompts was necessary to advance to the next condition.

Data Collection

Baseline data were collected on correct and incorrect responses. Training and retention probe data were collected on correct, incorrect and prompted responses. Correct responses were defined as unprompted responses necessary to initiate, perform and complete each component of the behavior chain. Prompts were defined as any physical contact used to guide the participant to orient towards, approach and handle materials. On-schedule and on-task data were also recorded using response definitions similar to those described by MacDuff, et al., (1993). On-task was defined as the participant (a) visually attending to play materials (b) looking at the computer monitor/using the keyboard as instructed (c) manipulating toy materials appropriately or (d) transitioning from one activity to the next. On-schedule was defined as the participant engaging in the set-up, play or clean-up of the activity depicted in the slideshow picture on the computer monitor (see Table 2). Interobserver agreement (IOA) data were independently recorded by a second individual. Agreement was calculated as (agreements/agreements + disagreements) X 100 (Sulzer-Azaroff & Mayer.

RESULTS

Participant 1

Prompting and correct responding. Figure 1 depicts this child's correct responding and investigated prompts. Figure 1 indicates the participant mastered the behavioral chain after 24 training sessions. He met criterion for condition 1 (investigator in the room in close proximity) after 12 training sessions. However, during condition 2 (investigator in the hall) his correct responding scores dropped to below 90%, and 7 physical prompts were required to complete the behavior chain. Although condition 1 was reinstated, his correct responding scores remained below criterion at 80% while the total number of prompts increased to 16 for session 15. Correct responding scores decreased to 63% correct responses with 4 prompts in session 16. The number of prompts does not correlate with the correct response score because Participant 2 refused to complete the activity schedule and the session was terminated after the third activity. After the procedural change was introduced (as described in *Procedural Revisions for Participant 1*), Participant 1's scores immediately returned to 92% correct, increased to 97% correct, and remained at this level, thus allowing him to advance through the training conditions quickly. Following 6 additional sessions, during which the investigator faded her presence completely, Participant 1 met mastery criterion for this study.

Weekly retention probes were conducted at 1, 2, and 3 weeks post-training intervals. Mean correct responding scores were 99% (range = 97-100%). One error occurred during the second weekly retention probe, involving advancement of the slideshow but was self-corrected. Number of prompts was 0.

O*n-schedule and on-task data.* Figure 2 shows on-schedule and on-task data. There are no data points for condition 1 because the investigator prompted all on-schedule and on-task responses. On-schedule performance was 100% across all independent sessions. Mean on-task performance was 97% (range = 88-100%) across all independent sessions. During the 3 weekly retention probes, mean on-schedule performance was 100%, and mean on-task performance was 98% (range = 97-100%).

Participant 2

Prompting and correct responding. Figure 3 illustrates this child's prompting and correct responding data. Initially, Participant 2 met mastery criterion after 22 training sessions. He was able to independently complete the behavior chain after 14 training sessions in condition 1 and maintained criterion level performance (mean score = 96%) throughout conditions 2 (investigator in the hall), 3 (investigator at the monitor), and 4 (investigator unseen). However, during the first retention probe (session 23), his correct responses fell to 77% correct and number of prompts increased to 8. Retention data indicated that in the absence of the investigator stimulus control had not transferred to the *mother*. To establish parental stimulus control retraining conditions were implemented (as described in *Procedural Revisions for Participant 2*) in the training area with the mother in close proximity to Participant 2 in order to deliver the initial instruction and to prompt correct responding while the investigator was in the room. Participant 2's mean correct responding in this condition (condition 5) was 94% (range = 89-97%) with a mean of 4 physical prompts/session (range = 1-11). After 4 training sessions the investigator moved to the hall while his mother remained with him in the bedroom (condition 6). Mean correct responding in this condition was 95% (range = 89-100%) with a mean of 3 physical prompts/session (range = 0-6). After 4 more training sessions the mother faded her presence to the hallway while the investigator observed via the monitor in another room (condition 7). Mean correct responding was 99% (range = 97-100%) with a mean of .25 physical prompts/session (range= 0 - 1). After 4 more sessions at this distance the parent gave the initial instruction and moved around the house completing household chores as would naturally occur in a family setting (condition 8). The investigator continued to observe via the monitor in another room. If the participant was off-schedule or off-task the investigator cued the parent to enter the bedroom and prompt him. Mean correct responding in this condition was 98% (range= 94 -100%) with a mean of 1 physical prompt/session (range= 0 -2). The final 3 sessions were conducted with the child unaware that the investigator was present in the house (condition 9). Mean correct responding in this condition was 99%

(range= 97 -100%) with a mean of .3 physical prompts/session (range= 0 -1). Mean on-schedule performance was 99% and mean on-task performance was 93% for all measured initial training sessions (sessions 15-22). Mean on-schedule performance was 98% and mean on-task performance was 96% for all measured re-training sessions (sessions 32-42).

Weekly retention probes were conducted at 1, 2 and 3 weeks post-training. Mean correct responding was 99% (range = 97-100%) with no physical prompts. During one retention probe Participant 2 advanced the slideshow two times instead of one time. He self-corrected this error by advancing to the end of the slideshow, restarting it, then advancing to the correct slide. Mean on-schedule scores were 100%. Mean on-task scores were 87% (range = 69-100%).

O*n-schedule and on-task data.* Figure 4 illustrates this child's on-schedule and on-task data. There are no data points for condition 1 because the the investigator prompted all on-schedule and on-task responses. On-schedule performance was 97% (range = 73-100) across independent sessions 15-22. Mean on-task performance was 91% (range = 67-100%) across independent sessions 15-22. Following re-training conditions 5 and 6 (mother in the room), his mean on-schedule performance was 98% (range = 91-100). His mean on-task performance was 94% (range = 69-100).

A second observer viewed the videotapes alone in her home and collected interobserver agreement (IOA) data on a cross section of 81% of all training and retention conditions. The mean IOA was 99% for correct responding data (range = 94-100%); 96% for number of prompts (range = 72-100%); and 100% for on-schedule and on-task data.

DISCUSSION

The results of the present study indicate that computer-mediated activity schedules can be used in the home environment to teach and maintain independent play skills and transitioning behaviors for young children with autism without the need for continuous adult supervision.

This study capitalized on the availability of electronic technology that is commonly available to parents today. These include home computers, digital cameras and factory-installed computer software. Using this technology to train new behavior is well suited to train children with autism and presents other advantages as well. First, computer slideshow software accommodates the visual strengths of children with autism. Second, computer-based activities have proven to be motivating for children with autism over other types of activities and instruction. Third, once trained, the computer-mediated schedule becomes cost efficient by using already available technology and eliminating need for and additional cost of a paid therapist to occasion and maintain the behavior.

This study extends the results reported by Kimball et al., (2003) in that computer-mediated play and transitioning behaviors were trained in two home settings, and stimulus control was transferred from the trainer to the mothers of both participants. This study further extends the previous research in that Participants 1 and 2 learned to operate the slideshow presentation without continued need for supervision and to complete their activity schedules with no adult in the room to occasion correct responding and on-task behaviors.

Two unpredicted issues were raised and addressed during the course of this study. The first was the effect of choice-making on task engagement. Initially, Participant 1 was motivated and interested in completing his activity schedule. After 14 sessions, however, he resisted playing with the activities depicted, although his parents, therapists and the investigator observed that he had previously demonstrated preference for those activities when these were rotated through his schedule. When allowed to choose the 4 activities that he would engage in each day and allowed the ability to play until he finished open-ended activities, his performance reached and maintained criterion scores. Watanabe and Sturmey (2003) analyzed the effect of choice-making on task engagement during activity schedules for adults with autism in their vocational environments. When these adults were allowed to choose the order of the work tasks that they were required to complete task engagement increased. The effect of choice-making on task engagement during leisure and/or chore activities for children with autism in their home environment warrants experimental attention.

The second issue raised by this study was that of stimulus control. Participant 2 reached criterion levels of performance quickly and advanced more rapidly through all training conditions than did Participant 1. However, Participant 2's on-task performance began to decrease when he thought the investigator had gone. During the first retention probe, his correct responding fell to below criterion levels. This observation is consistent with Stahmer and Schreibman (1992), who noted that children with autism will engage in functional play at the same rates as typically developing children in the presence of a supervisor; however, when that supervisor is removed, off-task and inappropriate behaviors associated with autism increase again. It is likely that appropriate behavior was initially under the stimulus control of the investigator's presence rather than the computer activity schedule or parental instruction. In the re-training phase with the investigator and parent present in the bedroom, his performance quickly returned to 89%, 94% and 97% correct responding. To develop independent responding in the absence of the investigator it was necessary to repeat all training conditions, replacing the investigator with the mother, as well as increase the number of sessions in each condition. In the final condition, the mother moved freely around the home and periodically "checked-in" quietly to observe if the child was on-schedule and on-task. Participant 2 continued to demonstrate high rates of correct responding and on-task behavior as the parent moved about the house. This observation is consistent with Dunlap and Johnson (1985), who examined the effects of unpredictable supervision on the task completion behavior of children with autism and found that independent on-task responding was maintained when supervision was random and intermittent.

After the re-training phase, Participant 2 maintained high performance scores in 3 weekly post-training retention probes. It would be interesting to systematically evaluate the effects of intermittent parental supervision on computer-mediated play and transitioning behavior in a future investigation.

Indications for Future Research

Systematic application of this technology to other daily living skills in the home environment could include daily living skills such as dressing and self-care, household chores, and basic meal preparation. Application of this technology to maintenance of mastered behavior programs is also warranted. After a skill is mastered, mediation may be transferred to the computer schedule for daily or weekly practice and maintenance of behavior after scheduled therapy hours. This would allow paid therapists to focus more therapy hours on training new behaviors and fewer therapy hours on retention of previously trained behavior.

This study may be extended in a future investigation to incorporate social interactions between family members. For example, upon completion of an activity the child may be prompted by slideshow cues to go find and talk with a family member about that activity. Inclusion of procedures to teach imaginative play and conversation skills with a sibling may also extend the current research.

Future investigation that examines the social validity of this study in terms of longitudinal cost efficiency is also needed. Therapy costs are often an out-of-pocket expense for the parent not covered by health insurance. Estimated annual household incomes for 2003 were $43,318 (DeNavas, Proctor & Milis, 2004). Estimated costs of intensive early behavioral intervention were $33,000, according to a study based on 1996 statistics (Jacobson, Mulick & Green, 1998). In that study, annual household income was reported at under $34,000. Furthermore, in a more recent survey study conducted, 106 families residing in the United States reported that they pay senior behavior therapists an average of $28.23 per hour based on a range of $0 - $110 hourly and pay assistant behavior therapists an average of $15.88 per hour based on a range of $0 - $100 hourly. These families reported that their child receives an average of 18.8 hours of behavioral intervention each week, based on a range of 5 - 45 weekly hours. Average total yearly program costs were reported at $48,026 (Scott & Oliver, 2004). For many children with autism, behavioral support continues through adulthood. Therefore, instructional strategies that can be implemented in the natural environment at low-cost to the parent and eliminate some out-of-pocket expenditures is a matter in need of development in behavioral research.

This study also suggests the value of future investigation to develop methods that will train parents to utilize the electronic technology described in this study and learn how to develop computer-mediated activity schedules without the need to hire a third party to develop and update the activity schedules as their child’s abilities and needs change. This may free the parent from dependence on trained therapists as well, while allowing them more control over individualizing their child’s programming to accurately correspond with the needs of the family. This may also further decrease overall expenditures for their child’s supervision and instruction.

Figure 1. Training data for Participant 1.

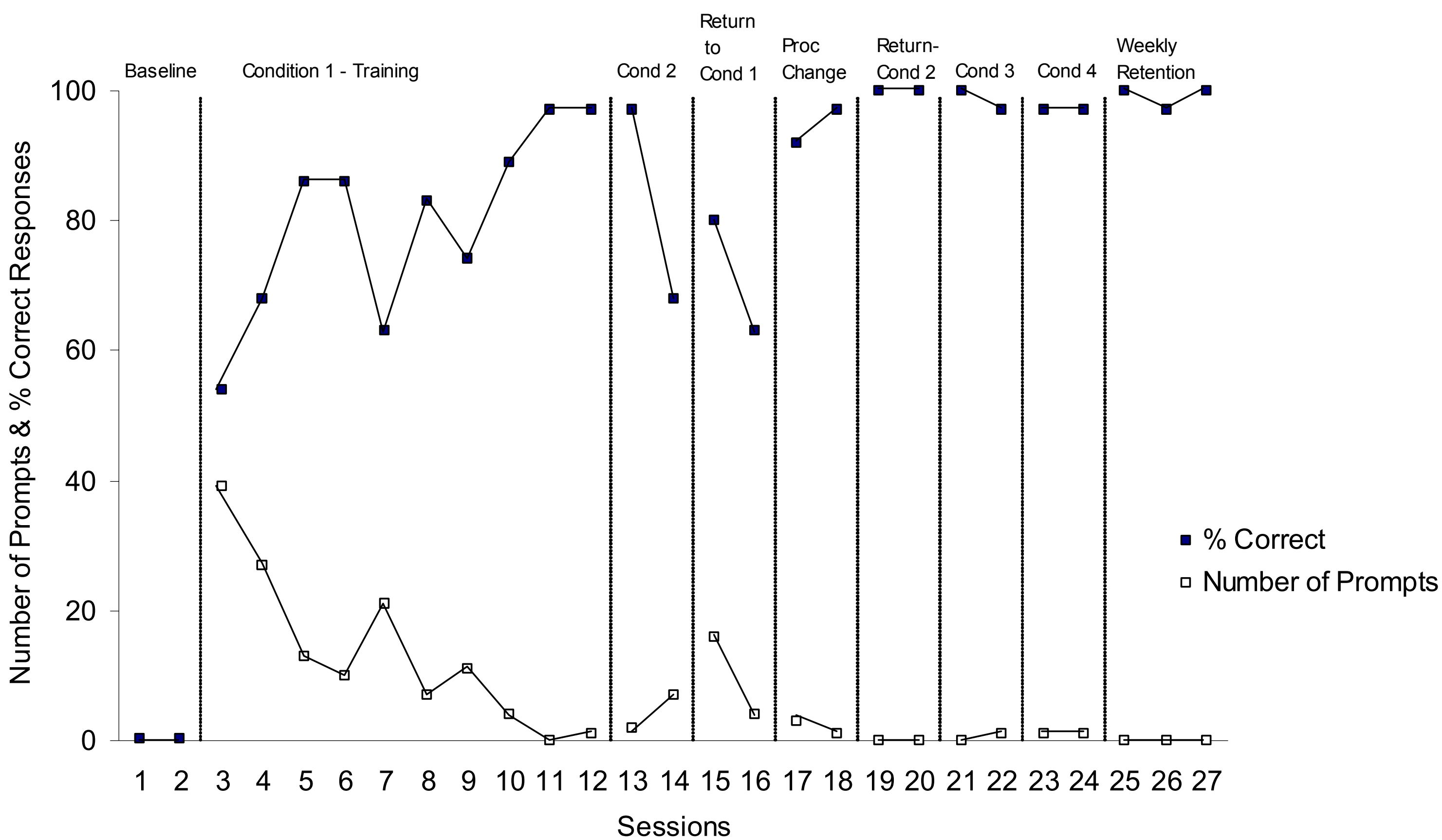


Figure 2. On-schedule and on-task data for Participant 1.

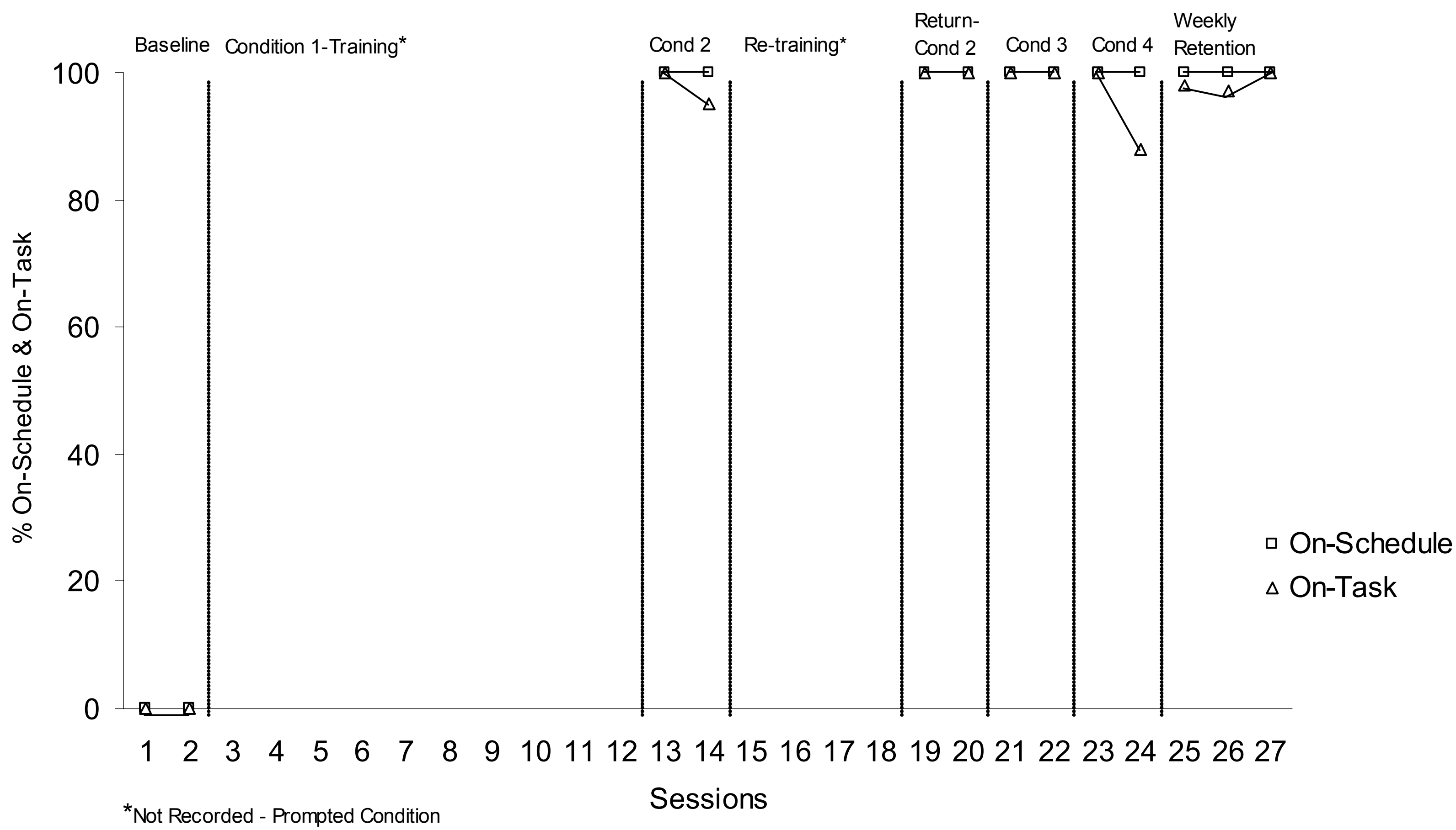
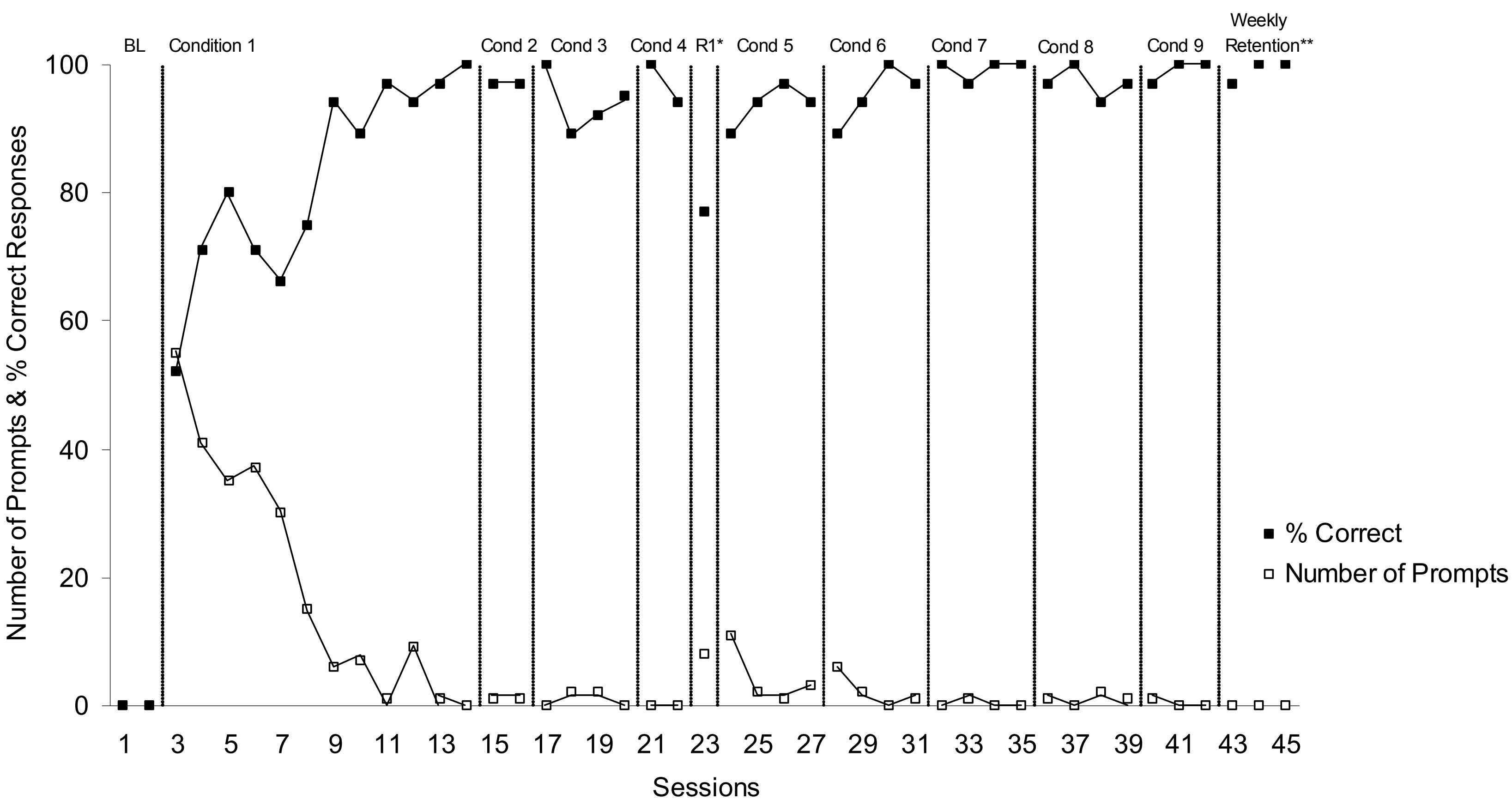


Figure 3. Training data for Participant 2.



*Weekly Retention Probe 1
**Weekly Retention Probes 1-2-3

Figure 4. On-schedule and on-task data for Participant 2.

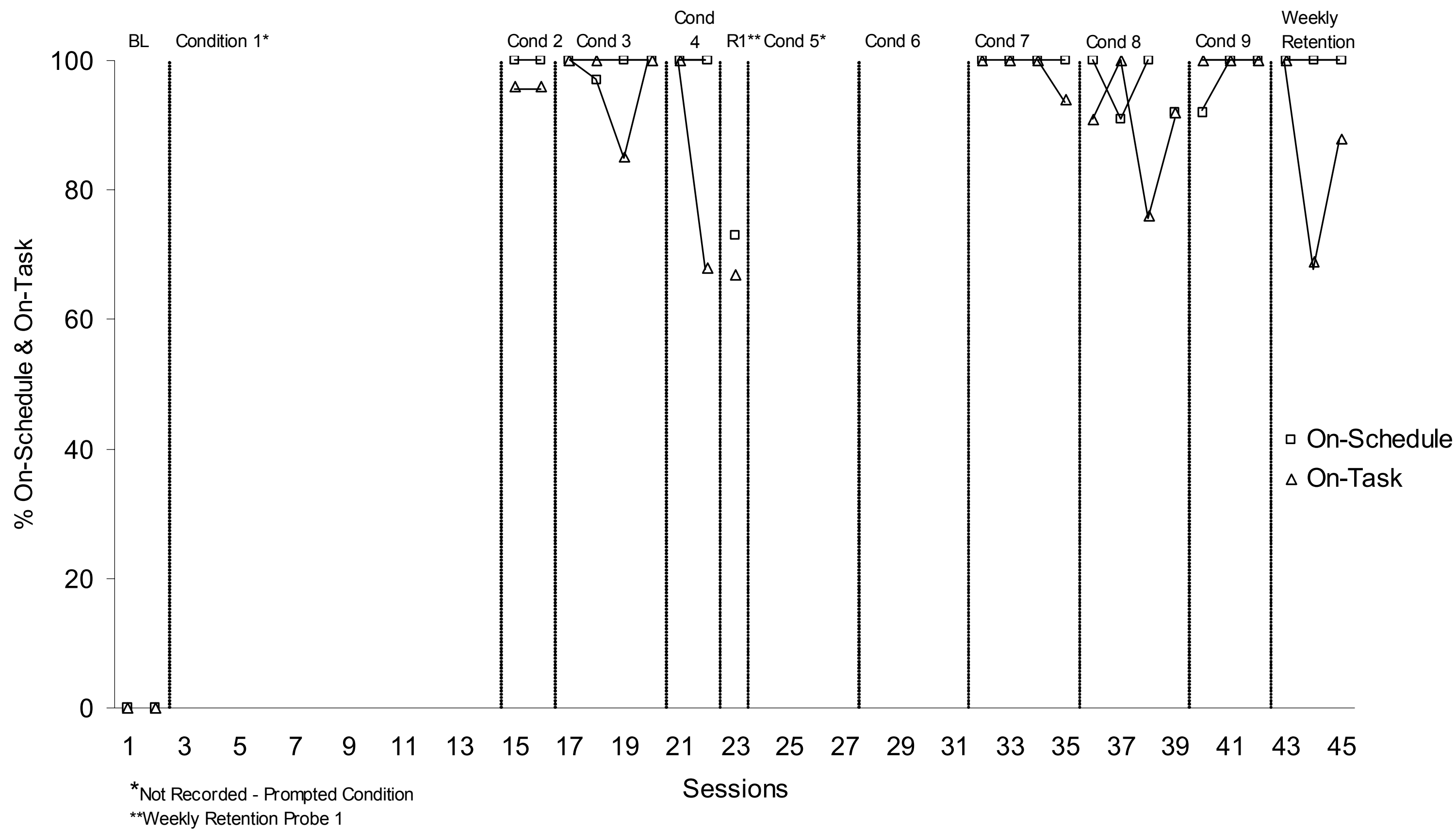


Table 1

Training Conditions

Condition 1	Investigator (I) and participant (P) in bedroom I gives initial instruction I remains in close proximity to P
Condition 2	I, P and mother (M) in hall I gives instruction I and M observe from hall
Condition 3	I, P and mother (M) in central room M delivers initial instruction M observes from hall I observes at monitor
Condition 4	I, P and M in central room M delivers initial instruction M moves about house & ‘checks in’ I observes at monitor video monitor I’s presence unknown to Participant
Condition 5 - Participant 2 only	I, M and P in hallway M gives initial instruction M remains in close proximity to P I remains in close proximity to M
Condition 6 - Participant 2 only	I, P and M in hallway M gives initial instruction M remains in close proximity to P I observes from hallway
Condition 7 - Participant 2 only	I, P and M in hallway M gives initial instruction M observes from hallway I observes via monitor
Condition 8 - Participant 2 only	I, P and M in central room M delivers initial instruction M moves about house & ‘checks in’ I observes at monitor video monitor
Condition 9 - Participant 2 only	P and M in central room M delivers initial instruction M moves about house & ‘checks in’ I observes at monitor video monitor I’s presence unknown to Participant

Table 2

On/Off-Schedule & On/Off-Task Descriptions

On-Schedule & On-Task	The materials that are currently depicted on the monitor are out on the table and the participant is appropriately manipulating these materials
On-Schedule & Off-Task	The materials that are currently depicted on the monitor are out on the table but the participant is not appropriately manipulating or attending to these materials.
Off-Schedule & On-Task	Other materials depicted in the schedule but not currently depicted on the monitor are out on the table and the participant is appropriately manipulating them.
Off-Schedule & Off-Task	Other materials depicted in the schedule but not currently depicted on the monitor are out on the table and the participant is not appropriately manipulating or attending to them.

Table 3

Trademark Owners

Product	Owner
Crayola® Washable Paint and Markers	Binney & Smith, Inc., Easton, PA
Elmer's® Glue	Elmer's Products, Inc. Columbus, OH
eMachine® T2895 Desktop PC	Gateway, Inc., Irvine, CA
Intel® Celeron® Processor	Intel Corporation, Santa Clara, CA
Leap Pad® Learning System	Leap Frog Enterprises, Inc., Emeryville, CA
Lincoln Logs® Real Wooden Logs, Mr. Potato Head® Toy, Play-Doh® Modeling Compound, & Play-Doh® plastic toys	Hasbro, Inc., Pawtucket, RI
jWin® Wireless Camara and Security Monitor	jWin Electronic Corporation, New York City, NY
Microsoft® Powerpoint® Presentation Graphics Program	Microsoft Corporation, Seattle, WA
MMX™ Enhanced Processor	Kingston Technology, Fountain Valley, CA
Packard Bell® Desktop PC	NEC Computers International BV, Wijchen, The Netherlands
Sony® Digital Camera	Sony Corporation, Tokyo, Japan
Spell Time™ Self-Correcting Learning Activities	Cadaco, Chicago, IL
Sterilite® Clearview Storage Box	Sterilite Corporation, Townsend, MA
Thomas the Tank Engine® battery operated train	TOMY Corporation, LTD., Newport Bch, CA

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