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ORIGINAL PAPER

Effects of an Individual Work System on the Independent Functioning of Students with Autism

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Abstract This study examined the effects of a work system on the independent work and play skills of students with autism. Work systems, an element of structured teaching developed by Division TEACCH, are organized sets of visual information that inform a student about participation in work or play areas. A single subject withdrawal of treatment design, with replications across three participants, was used to assess the on-task behavior and work completion skills of the students in classroom and employment settings as a result of the intervention. Observational data indicated that all students showed increases in on-task behavior, increases in the number of tasks completed or play materials utilized, and reduction of teacher prompts. The results were maintained through the 1-month follow-up.

Keywords Independence · On task behavior · Teacher prompting · Structured teaching

Introduction

Students with autism require a curriculum that promotes independence and skills needed for adult functioning. Curricular goals should focus on assisting students in working and playing independently, managing their own behavior, and motivating students through meaning and natural consequences, over unrelated contingencies and artificial reinforcers (Olley, 1999). Despite these curricular goals, students with autism often have difficulty independently initiating tasks and/or independently remaining engaged with materials (Pelios, MacDuff, & Axelrod, 2003). Though students may have previously demonstrated mastery of a task or material, they may continue to rely on the presence of an adult or treatment contingency to remain engaged or to complete activities (Stahmer & Schreibman, 1992). The removal of close supervision, adult prompting, or contingencies may lead to reoccurrence of off-task behaviors, and to a decline in appropriate responding and productivity (Dunlap & Johnson, 1985; Marholin & Steinman, 1977).

Independent functioning is defined in this study as on-task engagement in an activity in the absence of adult prompting. The deficit in independent functioning may be related to prompt dependency due to the reliance on the constant presence of a treatment provider (Giangreco & Broer, 2005), difficulty with organization and sequencing due to executive function deficits (Mesibov, Shea, & Schopler, 2005), limited ability to generalize skills to new settings (Dunlap & Johnson, 1985), problems with processing and understanding auditory directives (Dettmer, Simpson, Myles, & Ganz, 2000), and/or lack of initiation (Koegel, Carter, & Koegel, 2003). The deficiency in independent functioning has grave implications for students with autism, as it is a significant impediment to classroom and community inclusion (Dunlap, Koegel, Johnson, & O'Neill, 1987) and limits one's potential to thrive in educational, vocational, and domestic settings (Pierce & Schreibman, 1994).

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A number of studies have focused on teaching students with autism to work or play independent of adult support. Several interventions include contingency and supervision packages (Dunlap & Johnson, 1985; Dunlap et al., 1987; Pelios et al., 2003). In an effort to address stimulus control, such as adult presence or predictable reinforcement, Dunlap and Johnson (1985) successfully used a random schedule of adult supervision and reprimands to increase on-task behavior in students with autism. Similarly, Dunlap et al. (1987) used infrequent and delayed contingencies along with the removal of the primary therapist in an effort to increase the maintenance of independent behavior in generalized settings. Pelios et al. (2003) evaluated the effectiveness of a treatment package, which included delayed reinforcement, fading of instructional prompts and instructor presence, unpredictable supervision, and response cost for off-task responding, in producing independent work. The intervention package resulted in higher levels of on-task and on-schedule responding when supervising adults were present briefly and intermittently.

Other researchers have effectively utilized self-management strategies to increase independent play skills (Stahmer & Schreibman, 1992), and a combination of videotaped self-modeling and self-monitoring to increase on-task, independent work skills (Coyle & Cole, 2004). In addition, a number of studies have demonstrated the effectiveness of visual or textual cues combined with prompting or fading procedures to teach students with autism to initiate tasks independently (Johnson & Cuvo, 1981; Krantz, MacDuff, & McClannahan, 1993; MacDuff, Krantz, & McClannahan, 1993; Pierce & Schreibman, 1994). These studies have primarily addressed daily living skills, and frequently included the use of primary reinforcers, such as food and toys, upon successful completion of the independent routine. Extending this research on prompting, Tabor, Seltzer, Heflin, and Alberto (1999) found that auditory prompts can also promote on-task behavior for some children with autism. To promote independent behavior in novel activities, Ivey, Heflin, and Alberto (2004) used a social story intervention for children with autism.

The recent emphasis on independence, and the priority of inclusive placements and communities, highlights the immediate need for research and intervention in this area. However, the specific learning characteristics of students with autism, which includes difficulty with organization, distractibility, sequencing, and generalization, require that an intervention be designed around the particular strengths (e.g., visuo-spatial organization) and needs (e.g., structure and predictability) of students on the autism spectrum (Mesibov, Shea, & Schopler, 2005).

Structured teaching, as defined by Division TEACCH (Treatment and Education of Autistic and related Communication handicapped CHildren) is an instructional strategy that emphasizes visual supports, and its aims are to increase and maximize independent functioning and reduce the frequent need for teacher correction and reprimand (Schopler, Mesibov, & Hearsey, 1995). The four major components of structured teaching are physical structure (the organization of the classroom), schedules (visual information depicting where/when/what the activity will be), work systems (visual information informing a student what to do while in a work or play area), and task organization (visually clear information on what the learning task is about) (Schopler et al., 1995). Children with autism respond more favorably to structured than unstructured settings (Schopler, 1971). Studies have shown the effectiveness of the structured teaching methods for promoting the independent performance of children with autism and severe intellectual disability during work sessions and transitions (Panerai, Ferrante, & Caputo, 1997; Panerai, Ferrante, Caputo, & Impellizzeri, 1998), reducing self-injurious behavior (Norgate, 1998), and increasing the vocational skills in individuals entering the job market (Keel, 1997). Several studies have compared the TEACCH program with other interventions (Ozonoff & Cathcart, 1998; Paneri, Ferrante, & Zingale, 2002) showing statistically significant gains in all areas on the Psychoeducational Profile-Revised (PEP-R, Schopler, Reichler, Bashford, Lansing, & Marcus, 1990).

While the need for independent work skills may be well recognized, the importance of independent play skills is also well documented in the literature (Wehman, 1977). Though play skills are defined and addressed in the literature in a number of ways, in this study play skills are defined as the appropriate and functional use of toys (Stone, Lemanek, Fishel, Fernandez, & Altemeier, 1990). Students with autism spend less time using toys appropriately and functionally (in a manner consistent with their conventional functions) than their typically developing peers (Stone et al., 1990; Williams, Reddy, & Costall, 2001), which can negatively affect peer relationships and adaptation to typical environments (Lewis & Boucher, 1988). This study will address independent toy use and maintenance of those previously mastered play skills, which is an important recreation and leisure skill for young children with autism (Terpstra, Higgins, & Pierce, 2002) and can lead to an increase in spontaneous play (Lewis & Boucher, 1995).

Independence was also addressed in this study without reprimands (Dunlap et al., 1987) or response-cost strategies (Pelios et al., 2003) as an element of the independent variable, and without additional or specifically directed adult supervision (only existing classroom or program staff was used for prompting during intervention). This study evaluated the effectiveness of the intervention in the traditional classroom or employment setting. By placing interventions in settings in which children naturally participate, the eventual likelihood of supporting independent performance of skills in natural settings may be enhanced. Finally, there are no published studies, to date, that have demonstrated the effectiveness of the individual work system as an element of structured teaching. To reduce transition time and adult promoting, Dettmer, Simpson, Myles, and Ganz (2000) incorporated several elements of an individual work system (finished box, pictorial cues) in a study involving three children with autism. The supports were successful in reducing latency between instruction and student response and decreasing adult prompting, however on-task behavior and independent completion of tasks were not measured.

This study was designed to assess the effects of an individual work system on the independent work and play skills in students with autism. The following research questions were addressed:

1. Does an individual work system produce increases in on-task behavior, work completion, and number of play materials utilized for students with autism?
2. Does an individual work system result in a decrease in adult prompting of students with autism?
3. Does the individual work system result in socially important outcomes for participants, as assessed through measurement of social validity?

Method

Participants

Three students with autism participated in this study. Each was selected on the recommendation of school district special education personnel. Students were selected according to the following criteria: formal diagnosis of autism, teacher report of difficulty completing tasks independently (confirmed by researcher observation), familiarity with visual schedules and/or following visual sequences of information, and no prior experience with the use of work systems. Diagnoses were made by an independent clinical or school psychologist. Additional testing and anecdotal information was provided by the parents or program teacher.

Mark was a 20-year-old Caucasian adult with autism and intellectual disabilities. He scored in the severely autistic range on the Childhood Autism Rating Scale (Schopler, Reichler, & Renner, 1988) and received a full scale IQ score of 64 as measured by the Leiter-R (Roid & Miller, 1997). Mark's adaptive functioning was assessed on the Scales of Independent Behavior-Revised (SIB-R, Bruininks, Woodcock, Weatherman, & Hill, 1984) and the Vineland Adaptive Behavior Scales- Interview Edition (VABS, Sparrow, Balla, & Cicchetti, 1984). In each area of the SIB-R, motor skills, social/communication, personal living, and community living, he scored in the very limited range. His composite score on the VABS was 23, placing his skills in the 2-to-3 year old range.

Mark participated in the school district's Community Transitions program, which assisted students in locating and maintaining employment, accessing public transportation, and participating in social, recreational, and educational opportunities. Mark was nonverbal yet was able to communicate his wants, needs, and emotions through the use of a Dynavox communication device. He was able to type words with visual prompts, compose simple e-mails, utilize the Internet, and travel to the local library independently on a community shuttle. His reading was limited to basic sight words but he was able to listen to books through the use of a computer assisted software program. Mark had a history of aggressive behavior and received Tegretol and Risperdal daily. He lived in an apartment setting with full-time care provided by a local agency.

Scott, a 6-year-old Caucasian boy, was diagnosed with autism at age 2 through the use of clinical observation, developmental history, and criteria from the Diagnostic and Statistical Manual of Mental Disorders-Fourth Edition (DSM-IV, American Psychiatric Association, 1994). At age 5, the school district conducted an evaluation using the Differential Abilities Scales-Upper Preschool Level (DAS, Eliott, 1990) and the Behavior Assessment Scale for Children-Clinical and Adaptive Skills (BASC, Reynolds & Kamphaus, 1992). No composite score was attained on the DAS, as Scott was only able to complete the Picture Similarities portion, scoring below the first percentile. He received clinically significant scores on the BASC adaptive skills measures, including at-risk score related to anxiety, attention, social skills, and self-injurious behaviors. The Sensory Profile (Dunn, 1999) indicated definite differences in touch processing, modulation of input, and behavioral and emotional response.

Scott was in kindergarten in a self-contained multi-categorical classroom for students in grades K-2 with moderate to severe disabilities. He was nonverbal and had mastered Phases 1–3 of the Picture Exchange Communication System (Bondy & Frost, 2001). He frequently engaged in sensory seeking and self-stimulatory behavior, such as spinning, hand flapping, climbing, and chewing, and demonstrated challenging behaviors (tantrums, hitting others, falling to the floor) several times per day. He received Risperdal daily. He was able to match colors and shapes, order numbers 1–5, orient and turn pages in a book, and operate several beginning level computer programs. He was not yet reading, appropriately using writing utensils, or demonstrating 1:1 correspondence. Dressing and toileting were emerging independent skills.

Chris was a 7-year-old Caucasian boy, who received the autism diagnosis at age 4. The Autism Diagnostic Observation Schedule-Module 1(ADOS, Lord, Rutter, DiLavore & Risi, 1999) was utilized, although an overall score is not reported. The clinician reported that no verbalization or gestures were used, and that Chris did not respond to his name or a touch used to gain his attention. The DAS was also attempted and Chris was unresponsive. Chris received a 54 on the VABS Parent Interview communication scale, 67 on daily living, 54 on socialization, 62 on motor, and a composite score of 54. Criteria from the DSM-IV was also used in the diagnosis. The BASC was administered by school personnel at age 6, and elevated scores were noted in adaptability, atypical behavior, and withdrawal. The SIB-R indicated adaptive behavior delays in all areas—motor skills at a 3-year-old level, social skills at 0–11 months, personal living skills at 2 years and 11 months, and community living skills at 1 year and 2 months.

Chris was a kindergarten student served primarily in a self-contained, multi-categorical classroom for students in grades K-2 with moderate to severe disabilities. He was also served in a general education kindergarten classroom for up to 30% of his educational day. He was beginning to use verbal language supported by visual cues (8–12 words consistently). Chris was able to identify numbers 1–10, letters, and count objects through five. He also recognized several sight words, such as days of the week and schedule words. He engaged in repetitive, self stimulatory, and sensory seeking behavior, such as repeating the same phrases frequently, running his hands through sand or water, and high pitched vocalizations. Chris demonstrated refusal and resistive behavior (flopping to the floor, verbal protests) when transitioning from one activity to the next. He was independent in toileting, feeding, and dressing.

Setting

Mark's intervention took place at his employment site, the library at the School of Optometry on the campus of a large mid-western university. All sessions occurred in his small office in the rear of the library. Prior to the initiation of the study, program staff covered the windows of the office, which faced a large study area, to eliminate visual distractions. The office contained a table with a computer and scanner, two chairs, a large cart with work materials, and several boxes of old books stacked in the corner. Mark followed a full day written schedule with small picture cues.

Scott and Chris' intervention occurred in the play area of their classroom at their elementary school, which served 350 students in grades K-2. Five students with varying disabilities were served in their classroom, which was staffed with a special education teacher and three instructional assistants. The classroom had centers that the students rotated through during the day, including 1:1 teaching areas, an independent work area, a play area, computer stations, group areas, and several other leisure skills centers (i.e., books, sensory materials, art). Each area was defined through the use of furniture or visual markings, such as numbers, labels, or materials to assist students in navigating throughout the classroom. Both Scott and Chris used a partial day visual schedule with icons.

Materials

Mark's job and intervention required a desk, chair, computer, scanner, pen, and highlighter. The work system consisted of 2 three-shelf trays, a small file box with a laminated ''finished'' icon, a $1' \times 1'$ piece of laminated poster board with 8 Velcro squares, 16 $2'' \times 2''$ laminated squares numbered 1–8 with pictures of classic Disney lithographs, two $2'' \times 2''$ laminated ''break'' cards, and one laminated $2'' \times 2''$ card with the ''library'' icon.

Scott's and Chris' intervention required one desk and one chair, two small plastic shelves, and one laundry basket with a laminated ''finished'' icon. Functional classroom toys were used, including Mr. Potato Head, interactive Dr. Seuss books, Thomas the Train magnet boards, inset puzzles, dot paints, and play food and utensils. Additional structure was added to toys as needed with Velcro, plastic trays, Ziploc bags, and cookie sheets.

Design

This study employed an ABAB withdrawal of treatment design across three participants (Kazdin, 1982). This design alternated the baseline condition (A = no work system) and the intervention condition (B = use of a work system). These phases were repeated again to complete the study.

Procedure

Baseline 1

During Baseline 1, participants were observed in their employment or school settings during times when independent work or play was expected. No changes were made to the students' schedules or expectations of performance, and teachers were not told to alter current level of prompting (frequency or type) during this phase. Sessions were videotaped and data were collected for the first ten minutes of each session across participants.

Participant 1

Mark was observed in his office at his job setting. His job was to scan library documents, which required operating the scanner software, titling each page, and scanning each page. Mark had been trained in each step of the scanning process prior to the start of this study and had been in his current job for over 6 months. Materials to scan were located in a large basket in front of Mark, and Mark was to replace the documents when scanning was completed. No clear time frame or number of scans required was observed, and no visual cues were provided to Mark. He was assisted by Community Transitions staff members. Data collection began when Mark was instructed to begin scanning.

Participant 2 and 3

Scott and Chris were observed in the large play area in their classroom. Each day staff members introduced functional play materials (i.e., books, Mr. Potato Head, trains) to the students in a structured teaching session. After the guided play session, the students were to independently select from a large field of play materials, such as cause and effect manipulative toys and one-step functional toys (that had previously been taught and mastered), and encouraged to use the materials appropriately. The play area had one table that students used when sitting on the floor and a closed storage area with play materials. Participants were to play with materials until directed to transition by teacher cue. Data collection began when students were instructed to play independently.

In baseline and subsequent phases, decisions to change phase were based on visual inspection that revealed changes in trends and/or levels of student performance.

Individual Work System 1 (IWS1)

The *individual work system* was defined as a visually organized space where children practice or perform work previously mastered under the direct supervision of an adult (Schopler et al., 1995). The work systems in this study visually communicated four pieces of information to the participant: (a) the tasks, (b) the amount of work to be completed, (c) a signal that the work is finished, and (d) instructions for the next activity in their schedule. An individual work system was established for each participant. Mark used a number matching work system. On the desk in front of him were numbered cards, and on his left there were trays with the corresponding numbers. In each tray were all of the materials required for the task. Scott and Chris used a left-right work system, which did not require number matching or sequencing skills. All of the play materials to be used were placed on a shelf to the left of the student. After each work/play activity was completed (per previous description), the participant placed the finished material into the box to his right. When all activities were completed and placed in the finished box, a visual cue directed each participant to their next scheduled activity, which varied each day depending on the student schedules (see Figs. 1 and 2). All other classroom components (including the physical structure of the classroom and the use of visual schedules) were held constant throughout each phase of the study.

During the intervention sessions, the participants' schedules directed them to their individual work systems during independent work and play time. Mark's schedule remained the same (''Work at library'') and Scott and Chris's schedule directed them to a desk and toys set up in the play area. The work systems, as described previously, were set up for each participant, and all required materials (scanning documents and mastered play items) were provided. Teachers were not told to alter their prompting levels at any time throughout the intervention and were not told that data would be collected on prompting behavior as to avoid influencing the frequency or type of prompts given.

The intervention phase consisted of two stages—the training stage and the intervention stage. All

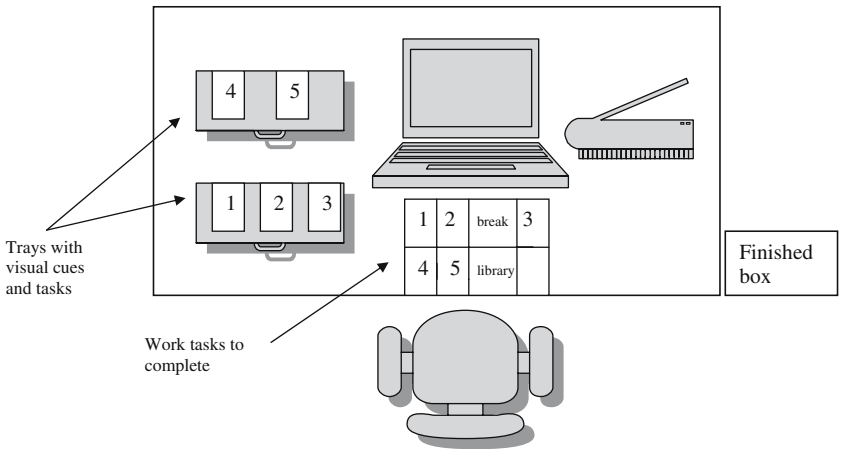

Fig. 1 The independent work system for Mark. In the depiction, squares on the left represent trays with mastered tasks and materials. Visual cues on the desk will be matched to the cues on the trays. Completed tasks will be placed in the finished box

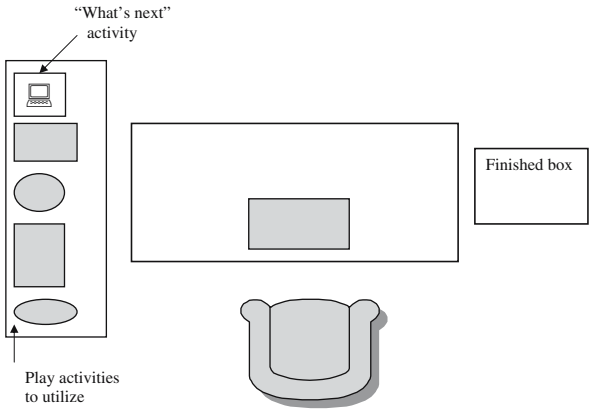

Fig. 2 The independent work system for Scott and Chris. In the depiction, shaded shapes on the left represent mastered play materials. The visual cue representing the next scheduled activity is placed at the end of the sequence of materials. Completed play activities will be placed in the finished box

participants were instructed by the investigator in the use of work systems during the training phase. This consisted of teaching (1) the establishment of a left-to-right work routine, (2) the use of visual instructions to sequence activities (numbers for Mark, play materials on the left for Scott and Chris), (3) the matching component (for Mark only), (4) the transfer of materials to the desk, (5) the completion of each task, (6) the concept of finished, (7) attention to the visual cue of ''what's next,'' and (8) the independent transition to the next activity. The investigator provided prompting related to the use of the work system, while the staff members continued to provide prompts to encourage attention to task or task completion when deemed necessary. Data were collected on the dependent variables, as well as the number of prompts required specifically related to the manipulation of the work system (i.e., getting a task from the left, putting a task in the finished box, matching a visual cue). When 90% accuracy was met in the use of the work system (7 of the 8 steps listed above were completed independently), the training phase was completed and the investigator no longer provided prompts to the participants. Chris required three training sessions, Mark required five, and Scott required six before the 90% criterion was met.

Baseline 2 (BL2)

A return to baseline conditions occurred after IWS1 to establish experimental control of the use of individual work systems. Participants did not have access to their work system, work trays, finished box, or visual cues related to the ''what's next'' element of the work system during BL2.

Individual Work System 2 (IWS2)

The IWS2 phase was a direct replication of IWS1, but without the training phase.

Maintenance Session

A 1-month follow-up session was conducted after the IWS2 phase was completed in order to assess whether behavior change was maintained with the use of the individual work system.

Procedural Integrity

Treatment integrity consisted of operationally defining each step in the set-up of the individual work systems, the assessment of skills to determine mastery prior to use in the work system, and the direct observation of those steps throughout the study to ensure that the procedure is implemented in the manner in which it was intended. An eight-question checklist with a Yes/

No format was used to ensure that treatment fidelity was intact (see Appendix A). Observers collected data on 100% of the sessions and indicated that prior to and after independent work/play times the teacher or graduate student completed all of the individually listed procedures in setting up the work system and that the skills had been mastered prior to assignment during independent work/play sessions.

Dependent Variables

The dependent variables for this study were on/off-task responding, teacher prompting, and task completion (Mark) and/or number of play materials utilized (Scott and Chris). Definitions were similar to those used by Pelios et al. (2003). *On-task* was recorded if the participant was visually attending to work/play materials, manipulating work/play materials or work system appropriately (i.e., as they were designed to be used), or moving from one work/play activity to another. *Off-task* was scored if the participant used materials in a manner other than that for which they were designed, manipulated but did not visually attend to the materials, engaged in inappropriate behavior (e.g., aggression, tantrums, stereotypies), or did not engage in activities or use materials. *Teacher prompting* was defined as a physical, verbal, visual, or proximal cue used to redirect student's attention to task. Prompting included hand-over-hand or other manual prompts, gestural prompts such as pointing or motioning, calling student's name or giving verbal reminders, presenting student or redirecting student to a visual reminder or directive, and use of shadowing or close proximity to alter student behavior (if adult appeared in the video screen).

Task completion was defined as completing assigned tasks during work sessions. Task completion was measured by counting the number of tasks completed during the work session. *Number of play materials utilized* was defined as the number of different toys the participants engaged with and/or completed during the independent play session. This was measured by counting the number of play materials the students used/finished during the session. Play materials were deemed finished when all parts or pieces were manipulated and/or placed in the appropriate location (e.g., puzzle pieces put in puzzle, magnets placed magnet board, play food cut and/or decorated, paint sheets painted, book pages manipulated).

Observational Procedures

A video camera recorded all sessions and a 10-minute sample of on/off-task behavior and teacher prompting was collected daily for each participant. Data were collected in 10 s intervals, followed by 10 s to record behavior. This resulted in 30 intervals for each day of data collection. Momentary time sampling was used to record on/off-task behavior, with the data collection "moment" occurring at the end of each observation interval. Partial interval recording was used to document any type of teacher prompting provided during the observation period. Event recording was used to document task completion data for Mark and the number of play materials Scott and Chris used.

Interobserver Agreement

Observers were graduate special education and school psychology students who had prior experience working in school and clinic settings with students on the autism spectrum. Pre-baseline training consisted of a brief overview of the observation system and training sessions using video tapes during actual work/play sessions. During this training period, data collectors reached 90% agreement criterion on all categories. All work and play sessions were video recorded. Data collectors listened to a prerecorded cassette tape of audio prompts signaling when to record data. Throughout formal data collection observers independently viewed and recorded behaviors of the same child during 27% of total sessions distributed evenly across conditions and participants.

Percentage of interobserver agreement was calculated by dividing the number of agreements by the number of agreements plus disagreements and multiplying by 100. Mean percentage interobserver agreement for Mark across each phase was 99% for on/off task behavior (range 93–100%), 98% for teacher prompting (range 93–100%), and 100% for task completion. Mean percentage interobserver agreement for Scott across each phase was 98% for on/off task behavior (range 96–100%), 91% for teacher prompting (range 80–100%), and 100% for task completion. Mean percentage interobserver agreement for Chris across each phase was 98% for on/off task behavior (range 93–100%), 94% for teacher prompting (range 86–100%), and 100% for task completion.

Social Validity

Neisworth and Wolfe (2004) defined social validity as the perceived worth of an intervention and they recommended appraisal of the social worth of educational outcomes through consumer ratings. The social importance of treatment effects can be measured

through subjective evaluation, which involves the use of questionnaires to solicit opinions about an intervention (Kazdin, 1977). A pre-and post-treatment questionnaire was developed for six service providers (2 staff members working with Mark, 4 staff members working with Scott and Chris) that addressed three areas: goals of treatment, treatment procedures, and treatment outcomes. Pre-treatment questionnaires had eight statements about the intervention goals (e.g., My student demonstrates off-task behavior, The ability to work/play independently is an important goal for my student) and treatment procedures (e.g., My student can be taught a way to work more independently). Post-treatment questionnaires had similar items, with the addition of treatment outcome statements (e.g., My student's independence increased with his participation in this study). Staff members selected from a five response choices—agree (point value of 5), slightly agree (point value of 4), neutral (point value of 3), slightly disagree (point value of 2), and disagree (point value of 1). Information obtained from student IEPs was also used to ensure that the goals of the intervention matched the needs of each participant.

Results

The use of an individual work system was effective in increasing independent work or play functioning for all three subjects and maintaining performance during the 1-month follow-up. Positive changes occurred in independent performance when the work system was implemented after the initial baseline; performance decreased when the work system was withdrawn; and participants subsequently increased independent performance when the work system was implemented again. These changes in performance, coinciding with the manipulation of the independent variable, demonstrated experimental control, as defined by Horner et al. (2005).

Independent functioning, as measured by on-task behavior and reduction of teacher prompting, improved for all participants (see Fig. 3).

During the initial baseline phase, Mark's mean on-task behavior was 68% of intervals (range 43–97%) and he received prompting from staff an average of 99% of intervals (range 97–100%). During intervention his rate of on-task behavior rose to 75% (range 47–93%), while teacher prompting decreased to 3% (range 0–33%) of the intervals. In the withdrawal phase, Mark's average on-task behavior dropped to 40% (range 30–43%) and teacher prompting rose to 28% (range 17–40%). The second introduction of the work system increased his on-task behavior to 84% (range 77–91%) and teacher prompting decreased to 1% of intervals (range 0–6%). Those levels were maintained at the 1 month follow-up, where Mark demonstrated on-task behavior an average of 83% of intervals and teacher prompting occurred 0% of intervals.

Scott initially demonstrated on-task behavior 54% of independent play time intervals during baseline conditions (range 43–60%), and was prompted by staff during 53% of intervals (range 37–80%). During use of the work system, his on-task behavior increased to 96% of intervals (range 90–100%), while prompt levels decreased to 43% (range 12–100%). His on-task behavior returned to baseline levels during the reversal phase, as Scott was on-task 50% of intervals (range 46–53%) and was prompted 48% of intervals (47–53%). When reintroduced to the work system, Scott returned to high levels of on-task behavior, 97% of intervals (range 95–100%), and lower levels of teacher prompting, 17% of intervals (range 10–21%). These levels of behavior were maintained, as Scott's mean on-task behavior was 100% of intervals during the 1 month follow-up probe and he was prompted 19% of intervals.

During the initial baseline phase, Chris exhibited on-task behavior 38% of intervals (range 23–48%) and received prompting from staff 59% of intervals (range 30–93%). Throughout the intervention phase, Chris was on-task an average of 95% of the intervals (range 83–100%), and was prompted 22% of intervals (range 0–87%). When the work system was removed, Chris's on-task behavior declined to below baseline level, an average of 39% of intervals (range 30–48%). He received prompts 58% of intervals (range 53–62%). When reintroduced to the work system, Chris's on-task behavior returned to higher levels, 86% of intervals (range 67–96%), and staff prompts fell to the lowest level, 7% of intervals (range 6–14%). His on-task behavior increased to 97% during the 1 month follow-up phase, while the level of adult prompting continued to decrease to 3% of intervals.

Mark's task completion rate also increased with the use of an individual work system (see Fig. 4).

He scanned a mean number of 5.4 pages during the baseline observation sessions (range 3–8), which increased to 6.2 pages (range 5–7) during intervention. His work completion rate dropped to a mean number of 3.3 pages (range3–4) during the second baseline phase. Productivity reached its highest level, with a

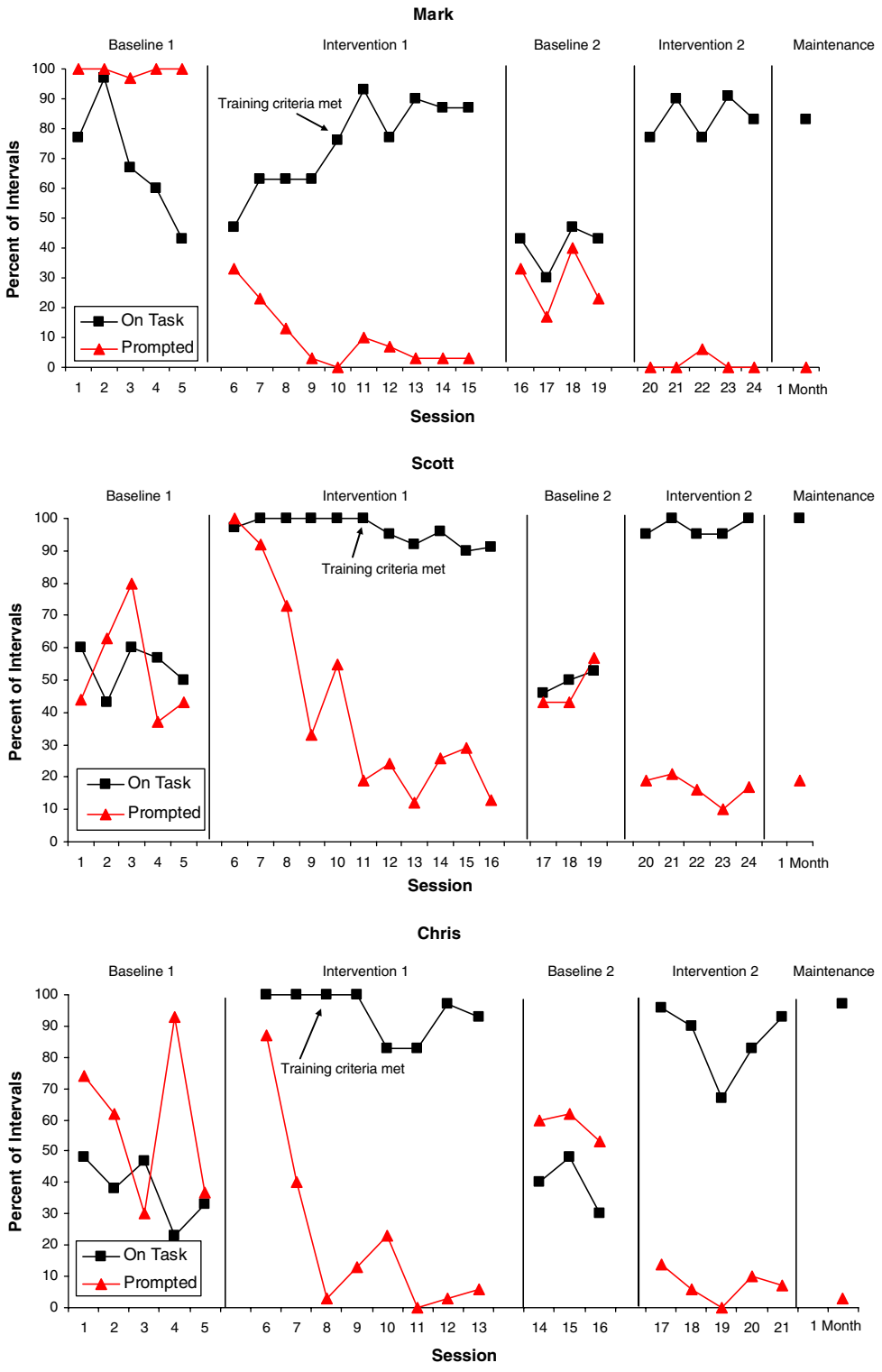

Fig. 3 Percentage of time on task and percentage of intervals prompted for Mark, Scott, and Chris across baseline, intervention, and maintenance conditions

mean number of 7 pages scanned (range 5–8) during the final intervention phase. This rate (7 pages) was maintained at the one-month follow-up observation.

Scott and Chris increased the number of play materials utilized during a play session as well (see Fig. 5).

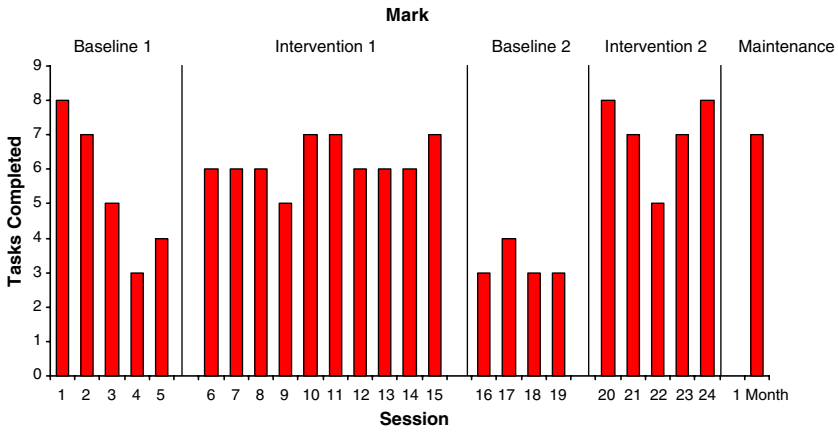

Fig. 4 Number of tasks completed for Mark across baseline, intervention, and maintenance conditions

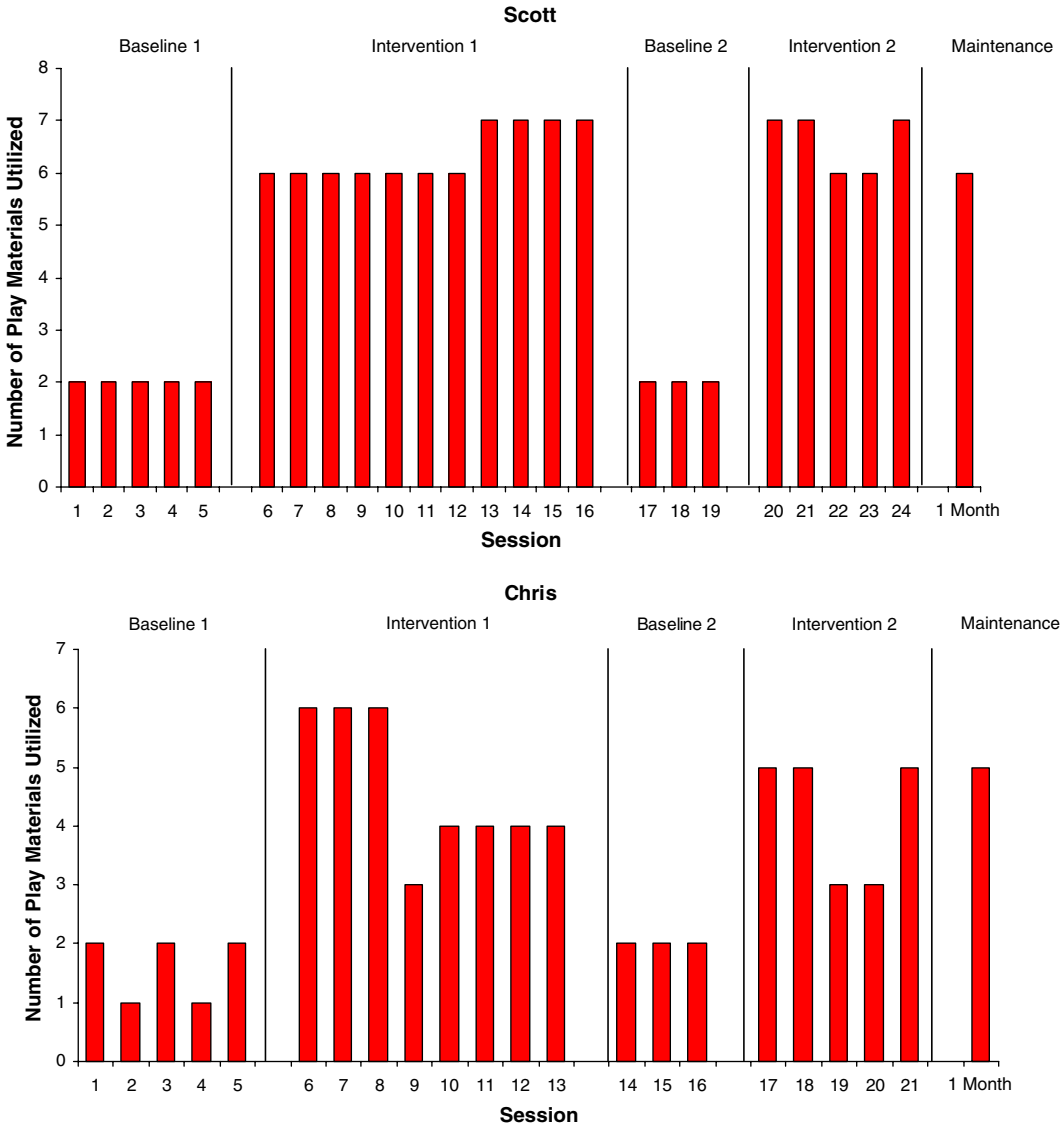

Fig. 5 Number of play materials utilized for Scott and Chris across baseline, intervention, and maintenance conditions

During baseline, Scott used 2 play materials (both cause and effect manipulative toys) during each observation session. Throughout the intervention phase, Scott utilized 6.3 toys (range 6–7) per play session (all one-step functional play materials such as dot paint and Thomas the Tank Engine magnet boards). In the reversal phase, he selected the identical 2 play materials as those selected in the initial baseline phase. When reintroduced to the work system, he interacted with/finished an average of 6.6 play materials or activities (range 6–7) (all one-step functional play materials such as puzzles, play food, interactive books). This maintained during the follow-up observation period (6 toys used) (all one-step functional play materials). Chris played with 2 play materials (both cause and effect manipulative toys) during each baseline observation session. His average rose to 3.6 toys used during intervention intervals (range 3–6) (all one-step functional play materials such as Mr. Potato Head, decorating pretend cakes/pizza, interactive books). Throughout the withdrawal phase Chris played with the identical 2 cause and effect manipulative materials utilized in the initial baseline phase. His average number of play materials utilized continued to rise in the second intervention phase, to 4.2 play materials (range 3–5), and Chris interacted with 5 functional play materials during the maintenance phase.

Procedural integrity

The observers completed the fidelity checklist after all the intervention sessions. The intervention was implemented with 100% accuracy.

Social validity

The evidence of the social validity of the work system intervention was based on the student's IEP goals and the social validity questionnaire.

Goals

The goal of independent functioning was identified by the school special education staff (teacher, assistants, district autism consultants, case coordinator) as a priority prior to the beginning of this research study. All participants had current goals addressing independent functioning in their Individualized Education Plan (IEP) or Individualized Transition Plan (ITP).

Six staff members completed the social validity instrument, and each agreed prior to the intervention that independent functioning was an important area for intervention (mean rating of 4.4), that the participants demonstrated off-task behavior (mean rating of 5.0), and that the participants often required prompts when working or playing (mean rating of 4.3). Mark's staff agreed that increasing productivity was an important goal (mean rating of 5.0) and Scott and Chris' staff members agreed that increasing play repertoire was an important goal as well (mean rating of 4.9).

Treatment procedures

Prior to intervention, all respondents agreed that their students could be taught to work or play more independently (mean rating of 5.0). Post intervention, all respondents agreed teaching their student to use a work system was a good idea (mean rating of 5.0). The intervention took place in natural settings (job site and classroom) and was implemented by program staff. At both sites, staff members continued to use the independent work system between the intervention phase and follow-up, and beyond the scope of the study.

Outcomes of treatment

Across participants, all staff members agreed that the independence of the participants increased as a result of their participation (mean rating of 4.2), and off-task behavior was reduced (mean rating of 4.0). All respondents agreed that teacher prompting reduced as a result of the intervention (mean rating of 4.5). Mark's staff noted that he was taught to complete more tasks (mean rating of 4.5) and Scott and Chris' staff indicated that they increased the number of play materials utilized (mean rating of 4.4). All respondents indicated that the participants ''often'' worked or played more independently (mean rating of 5.0). Mark's staff noted an important outcome to the investigator—an additional job offer, with a competitive salary, scanning documents for the city utility department.

Discussion

This study demonstrated that the use of individual work systems resulted in higher levels of on-task behavior and task participation and/or completion for all three participants. A decreased rate of adult prompting was noted for all participants, as was an increase in the number of play materials utilized for Scott and Chris. Both on-task behavior and task completion rates were maintained above baseline performance. Overall response gains, as indicated by comparing baseline to treatment and maintenance

measures, were substantial. Several studies have investigated different interventions to promote independent academic or employment skills (Brooks, Todd, Tofflemoyer, & Horner, 2003; Tabor et al., 1999) or independent play skills (Stahmer & Schreibamn, 1992), but no study to date utilizes the same intervention to address both independent work and play skills. The use of the same intervention across skills and settings may assist with implementation integrity for service providers, and may demonstrate the applicability, utility, and efficacy of the structured teaching approach for promoting independence across a range of skills. This investigation also supports and extends the research related to TEACCH-based interventions as effective learning and teaching tools, and as potential efficacious components of classroom interventions.

The use of individual work systems is supported both by the findings in this study, and the stress in the literature for interventions that reduce emphasis on unrelated contingencies, extrinsic rewards, or response-cost strategies as a consequence for off-task behavior and/or low productivity, as utilized in past studies (Horner, Carr, Strain, Todd, & Reed, 2002; NRC, 2001). Pelios et al. (2003) also identified the importance of identifying natural contingences (such as the ''what's next'' component of the work system) when addressing independent functioning with students with autism, and recommended future research in this area. The field has called for supports that modify or alter environments to match the behavioral needs of students with autism, as the work system does (Horner et al., 2002). The work system was designed specifically to address the organizational and sequencing limitations of students on the autism spectrum, as well as the reduction of extraneous information (visual or auditory) that may be distracting (Mesibov et al., 2005). A work system also provides concrete information to assist in demonstrating the passage of time, often another challenging skill for students with autism (Heflin & Alberto, 2001). Additionally, work systems incorporate structure, which has proven to be effective with students on the spectrum (Rutter & Barak, 1973), and visual information, which capitalizes on the visual-spatial strengths often found in students with autism. This antecedent based, preventative intervention is also well supported by recent literature indicating the need for comprehensible, structured learning environments for students with autism (Heflin & Alberto, 2001; Iovannone, Dunlap, Huber, & Kincaid, 2003).

While the work system in this study clearly affected on-task behavior, work productivity, and teacher prompting for Mark, this study also illustrates how a work system was used to promote the independent use of play materials for Scott and Chris. In baseline conditions, Scott and Chris consistently chose the same two play materials (i.e., cause and effect manipulative toys) during independent play time. These materials were not similar to toys their peers would be using in kindergarten, and their use resulted in increased off-task behavior (primarily stereotypy). Though child choice is a well documented strategy in increasing student engagement and motivation (Reinharsten, Garfinkle, & Wolery, 2002), the restricted and rigid choice making limited these students' ability to practice more purposeful, functional, and age-appropriate play skills that could be used with peers or in more inclusive settings. A question for future research may be whether students' independent use of a wider range of play materials may generalize to the choice of these materials in a naturalistic play activity with peers.

Several limitations in this study should be addressed. First, there was no protocol guiding the frequency or type of adult prompting. Staff members were told to prompt as they would typically prompt throughout all phases of the study. While this may increase the social validity of the intervention (implemented by program staff) and intervention feasibility, it is difficult to assess how the presence of the intervention, investigator, or video camera influenced adult behavior, and caused more or less prompting that would typically occur. The prompting level by Mark's staff never returned to the very high levels seen in Baseline 1 (i.e., the staff member used to sit less than a foot away from Mark and she never returned to that position after the initial baseline phase). Prompting provided to Scott and Chris was similar across baseline phases, and dramatically reduced across all three participants in the training phase, suggesting that the intervention was responsible for the decline in prompts, rather than the presence of the video camera or research staff.

Second, though Mark's initial on-task performance and productivity were quite high, there was a clear and substantial negative trend observed in the initial baseline. The high rates of behavior initially may have been influenced by high rates of adult prompting, however, the efficacy of the adult prompting faded during the phase. In subsequent sessions during baseline, Mark no longer responded to the constant prompting, evidenced by his reduction in on-task behavior and productivity.

Finally, an individual work system consists of a number of components that may have affected the

increase in time on-task and work completion. These include minimizing visual and auditory distractions, reducing mobility throughout the classroom, organizing materials, using visual cues, reducing the field of choices, as well as introducing the ideas of ''finished'' and ''what's next.'' It is impossible to identify which specific variables were responsible for behavioral gains, and indeed the independent work system might be seen as an intervention package. Such an intervention package might be implemented as a single instructional technique in a classroom or as one component of a comprehensive instructional model, as is the basis for the TEACCH program.

Future research should extend these findings to additional students and variable settings as well as to investigate whether all of the components used in the individual work system are necessary to replicate these outcomes. Also, future research needs to investigate the use of a work system to expand independent skills in people with autism in all domains, including academic skills, self-help skills, job skills, and leisure skills. The efficacy of structured teaching methodology should continue to be explored, including the use of physical structure, visual schedules, visual structure within materials, and the use of work systems in a variety of settings, including general education classrooms, other areas of the special education classroom, and in the broader community

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Appendix A

Observer Rating Form for Treatment Fidelity

Observer_____ Date_____ Student_____

List tasks for work system: 1. _____ 4._____

2. _____ 5._____

3. _____ 6. _____

1. Was furniture set up correctly? (refer to Figure 1 and 2 if necessary)	Yes	No
2. Were tasks mastered prior to use in work system? Dates mastered (per teacher records) 1. _____; 2._____; 3._____ 4._____; 5._____; 6._____	Yes	No
3. Were tasks placed in corresponding numbered trays? (Mark)	Yes	No
3. Were tasks placed on shelves to the left of the play space? (Scott & Chris)	Yes	No
4. Were all required materials placed in corresponding numbered tray (e.g. document to scan)? (Mark)	Yes	No
4. Were all required materials placed with task on shelf to left of the play space (e.g. paint bottle, puzzle pieces) ? (Scott & Chris)	Yes	No
5. Were numbered visual cues placed on desk? (Mark)	Yes	No
6. Was the "what's next" visual cue provided?	Yes	No
7. Was the finished shelf cleared prior to student beginning tasks?	Yes	No
8. When the independent work/play time was complete, was the finished work collected from the finished shelf and counted?	Yes	No

Number of steps completed correctly_____

Percentage of steps completed correctly_____

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