Functional motor skills are often taught using chaining procedures. Research suggests that chaining procedures are not likely to be effective if they do not focus on the accuracy and speed of composite skill completion. Precision teaching (PT) research suggests that improved performance of a composite skill can be achieved if the performance speed of the component behaviors is increased. This study assessed the effects of repeated timed practice of component motor skills on speed and accuracy of composite skills and the effects of fluent component motor skills on the completion of daily living composite skills. Three children with autism participated. The results suggest that all participants were able to perform the component skills at their individual aims and performed most of the component skills at fluent levels as assessed by retention and endurance checks. Each participant increased the number of composite skill steps performed independently and one decreased the overall time to complete the composite skill.

Children use motor skills to explore the environment, interact with others, participate in physical activities, and develop academic skills. Proper motor skill development is essential to participation in activities that promote the acquisition of other skills. Children with autism are often reported to have relatively strong motor skills; however, several studies provide evidence that motor skill deficits may be a significant concern for this population (Lord & McGee, 2001; Provost, Lopez, &
Heimerl, 2007). The Autism Society of America (2007) lists deficits in gross and fine motor skills as one of the defining characteristics of autism. Some specific problem areas include motor imitation, balance, finger to thumb opposition, and coordination (Lord & McGee, 2001). Deficits in these motor areas can affect simple goal directed motor tasks and daily living skills such as eating, dressing, and grooming that are necessary for independent daily functioning.

There are few empirically validated treatments for building motor skills (Eastridge & Mozzoni, 2005) and those that have been validated (e.g., backward or forward chaining) focus exclusively on accuracy. Research has shown that chaining procedures are not likely to be effective if they do not focus on the accuracy and speed of composite skill completion. For example, McManus (2001) and his team at Life Force Inc. found that their students were unable to maintain skills for long periods of time or perform at better than prevocational levels if chaining procedures focused only on the accuracy of the performance. Some have suggested that fluency training can be used to address the limitations of interventions such as backward chaining that do not produce responding that maintains over time (Merbitz, Vieitez, Merbitz, & Binder, 2004).

Binder (1996) suggests, ‘behavioral fluency is that combination of accuracy plus speed of responding that enables competent individuals to function efficiently and effectively in their natural environments’ (p. 163). He goes on to suggest that improved performance of a composite skill can be achieved if the performance speed of component behaviors is increased. Similarly, Merbitz et al. (2004) assert that all visible behavior is comprised of smaller component behaviors that if performed fluently, expedite instruction on the more complex composite behaviors. Backward chaining, however, does not require a fluency requirement for the performance of the component skills. Combining fluency-based instruction and backward chaining may address the limitations of backward chaining alone to teach daily living skills. McManus (2001) suggests that it is more effective to build composite behaviors if the component movements are practiced to fluent levels. Component-composite skill analysis and fluency are major tenants of Precision Teaching (PT). PT bases educational decisions on changes in continuous self-monitored performance frequencies displayed on standard celeration charts (Lindsley, 1992). Haughton (1980) described a PT strategy to teach component motor skills to fluent levels as the ‘Big 6 + 6’.

Early Precision Teachers identified the ‘Big 6’ components of skilled hand movements including reach, touch, point, place, grasp, and release (Binder & Haughton, 2002; Haughton, 1980). The ‘Big 6 + 6’ are basic fine motor movements that must be at fluent performance rates for individuals to be capable of manipulating objects, completing self help skills, exercising mobility, and communicating non-verbally (A. Desjardins, personal communication, February 17, 2003). The term
conveniently labels the six movements described above as well as the ‘+ 6’ which includes push, pull, shake, squeeze, tap, and twist (A. Desjardins, personal communication, February 17, 2003). These skills are the foundation for hand function. Deficits on any of these component elements could explain why an individual cannot perform a skill or why the performance of the skill is slow (Merbitz et al., 2004).

Implementation of the Big 6 + 6 skill elements to increase performance of component skills to fluent levels has been shown to be an effective way to improve a composite skill. Eric Haughton, one of the pioneer developers of the Big 6 + 6, used performance time samples of adults to estimate ranges of competent performance and to create aims for individuals who were severely disabled (Binder, 1996). These aims, along with isolated practice of the fine and gross motor skill elements, allow individuals with disabilities to attain functional skills that were previously not part of their repertoires (Binder, 1996).

Currently, there are few published research studies that have explore the ‘Big 6’ as an intervention; however, those that have been published provide evidence of its effectiveness. For example, Eastridge and Mozzoni (2005) studied the effects of fluency training on Big 6 + 6 on functional motor skills with four participants who experienced hand and arm impairments due to brain injury. The Big 6 skills included reach, grasp, place, and release. They found that functional use of both the impaired and non-impaired hand increased on the gross motor task of ball movement after fluency training. Eastridge and Mozzoni (2005) found that fluency training, along with occupational therapy and physical therapy, supported positive changes in participants’ scores for activities of daily living skills (ADLs). However, experimental control was not demonstrated between the gains in ADLs and the use of the Big 6 + 6. This limits the strength of their conclusions regarding the impact of Big 6 + 6 on ADLs. Additional research is necessary to control for the effects of extraneous variables and to demonstrate a functional relation between the use of the Big 6 + 6 and improvement on ADLs.

Pahl, Fabrizio, King, and Diakite (2005) also showed positive effects of Big 6 + 6 on motor function. They implemented daily timings for tap, pinch, reach, squeeze, release, shake, place, and twist with a four-year-old boy with autism to improve his writing skills. The dependent measures were the number of correct and incorrect movements. The results indicated that the participant’s number of correct movements per minute increased from 12 to 155. Pahl et al. (2005) did not assess the effects of their intervention on composite skills or ADLs.

Some researchers have shown that fluency training is an effective way of bringing component motor skills to fluent levels in order to increase functional hand use in populations with autism and traumatic brain injury (Eastridge & Mozzoni 2005; Pahl et al. 2005). However, Pahl et al. (2005) only included one participant and did not
measure the effects of the Big 6 + 6 on composite skill performance. Eastridge and Mozzoni (2005) also noted some limitations including the length of treatment conditions and the absence of scheduled retention, endurance, application, and stability (REAPS) checks. Given the paucity of research regarding motor skill instruction and the associated deficits in children with autism (Jasmin, Couture, McKinley, Reid, Fombonne, & Gisel, 2009), more research in this area is necessary.

The current study addressed the limitations of previous research by assessing the effects of the Big 6 + 6 on composite skill performance for three participants with autism. In addition, the current study included REAPS assessments. The specific research questions addressed were: (a) What are the effects of repeated timed practice of identified Big 6 + 6 component motor skills on speed and accuracy of the target skill as assessed by REAPS? and (b) What are the effects of fluent component motor skills on the speed and accuracy of daily living composite skills?

METHOD

Participants and Setting

Three children between the ages of 3 and 5 with a diagnosis of autism participated in the study. Billy and Ian were 5-years-old and George was 3-years-old. All participants had parental consent for participation, unrestricted movement of left and right hands and arms, the ability to attend to objects in space, and the ability to emit the component skill for at least six consecutive seconds. Verbal praise also functioned as a reinforcer for each participant. Sessions were conducted three to five times per week in the participants’ homes in a variety of different rooms. Materials used included timers, hand held counters, reinforcing stimuli, bag clips, therapy bands, and articles of clothing.

Dependent Measures

Component or Big 6 + 6

The dependent variables were the Big 6 + 6 skill elements (i.e., reach, touch, point, grasp, place, release, push, pull, shake, squeeze, tap, twist) and the corresponding daily living skills. See Table 1 for a list of specific dependent measures and fluency aims for each participant. Reach occurred when the participants followed an object that was held in front of them with one hand. The left and right hands were practiced separately. Ian’s reach response was modified so he could follow the object while alternating the left and right hand. Grasp and release occurred when participants grasped and released an object (the participants were not required to reach for or place...
the item). The palmar prehension grasp was used for all participants. Occupational therapy literature suggests that the hold-for-use motion most frequently employs a palmar prehension grasp with the pads of the thumb tip and the first two fingertips together (Zimmerman, 1960). In addition, this grasp closely corresponded with the target composite skills for each participant. Two different operational definitions were used for pull. For Billy, pull occurred when he pulled down on a therapy band wrapped around his shoulders with his left and right hands. For George, a pull occurred when he grasped the two sides of a sock and pulled outward with his left and right hands. Place occurred when the participant placed a circular object with an open bottom (a hat) on top of his head.

### Composite or Activities of Daily Living

The ADLs chosen for each participant were defined with a task analysis detailing the steps required to complete the behavior chain. The target skill for each participant was chosen based on the results of an initial assessment that included both indirect measurements (i.e., parent interviews) and direct measurements (i.e., observing the child’s behaviors and component skill completion during specific tasks). Billy’s target composite skills were putting on socks and putting on shirt; Ian’s composite skill was putting on underwear; and George’s composite skill was putting on socks.

### Data Collection

Baseline data were taken on the correct and incorrect component skills emitted during the completion of the identified ADL. No prompting or chaining occurred during baseline. During intervention, data were collected on the correct number of Big 6 skills (e.g., reaches, grasps, pulls, places) emitted during 15 s timed intervals.

<table>
<thead>
<tr>
<th>Participant aims</th>
<th>Composite skills</th>
<th>Component skills</th>
<th>Individual aims (min⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Billy</td>
<td>Putting on socks</td>
<td>Reach</td>
<td>80–100</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Grasp</td>
<td>90–150</td>
</tr>
<tr>
<td></td>
<td>Putting on shirt</td>
<td>Pull</td>
<td>90–120</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Place</td>
<td>90–120</td>
</tr>
<tr>
<td>Ian</td>
<td>Putting on underwear</td>
<td>Reach</td>
<td>50–70</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Grasp</td>
<td>90–150</td>
</tr>
<tr>
<td>George</td>
<td>Putting on socks</td>
<td>Reach</td>
<td>50–70</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Grasp</td>
<td>90–150</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pull</td>
<td>90–120</td>
</tr>
</tbody>
</table>
Reach and grasp were measured separately for each hand (i.e., left and right), except for Ian who alternated hands during the timing. Three timings were conducted during each session and the highest rate of correct responses was graphed on the standard acceleration chart. In addition, composite skill performance was assessed once per week following the start of intervention. Data were taken on the independent completion of each task in the chain. Once the participant emitted all responses in the task analysis, the duration of task completion was also recorded.

**Procedure**

**Baseline**

The participants were observed engaging in the target daily living skill. Prompting and chaining procedures were not used and no teaching occurred. The activity was terminated when the participant was unable to independently complete the identified component skills.

**Intervention**

The Big 6 + 6 skill element(s) were practiced during 15 s timed intervals. For example, to teach the Big 6 + 6 target skill element reach, the experimenter sat across from the participant and used a preferred stimulus to evoke the response. This stimulus could change each session as determined by preference assessment results. The participant was told that he should reach for the object as many times as he could before the timer went off (e.g., ‘Let’s see how fast you can reach today. Ready? Go!’). The experimenter then started the timer and presented as many opportunities as possible for the participant to reach for the preferred stimulus. The experimenter moved the object to a different location in front of the participant each time the participant reached for the object while simultaneously directing the participant to ‘reach’ (This verbal direction was used and faded as needed for each participant). Verbal praise (e.g., ‘good job’, ‘nice reaching’, ‘good looking’, etc.) was given contingent on every one to three responses. A terminal reinforcer was delivered at the completion of each timed interval. Timing intervals were conducted until the participant met the recommended fluency aim for the component skill or until the participant could independently complete the activity of daily living. Table 2 provides detailed information regarding each Big 6 + 6 skill practiced with each participant throughout the course of the study.

Occasionally, Ian and George did not make progress on a new component skill when it was first introduced (as shown by a steady or decreasing trend on timing data). When this occurred, a warm up activity was used prior to the timed
practice. According to Fabrizio, Moors, and Pahl (2001), using ‘Maxi-guiding’ as a warm up activity can help increase the frequency of skills emitted per interval. They describe ‘Maxi-guiding’ as full hand over hand prompting that involves very fast movements per timing. These procedures were presented in a fun way with preferred objects and short intervals. The experimenter sometimes counted Ian’s responses overtly.

When Billy met his frequency aim on the Big 6 + 6 component skills reach and grasp and was observed to independently put his socks on during weekly checks, a new composite skill (putting on shirt) and corresponding component skills (pull and place) were selected. When all three participants met their aim on target Big 6 + 6 skills but had not yet achieved independent performance on the composite skill, another component skill from the task analysis was targeted (see Table 1 for the sequence of component skill instruction for each participant).

When a participant attempted to escape the task during experimental sessions, the experimenter terminated the timing. This happened with only Ian. The experimenter explained that Ian could try again later. The experimenter then reassessed reinforcer preference and attempted the intervention again using the new preferred stimulus. When Ian and George attempted to use both hands at the same time for reach or grasp ( timings were completed separately for left and right hands), the experimenter gently

<table>
<thead>
<tr>
<th>Skill</th>
<th>Stimulus</th>
<th>Procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reach</td>
<td>Preferred stimulus</td>
<td>Presented instruction (i.e., ‘Let’s see how fast you can reach.’) and started timer. Moved the object to a different location in front of the participant each time he reached for the object while simultaneously directing the participant to ‘reach.’</td>
</tr>
<tr>
<td>Grasp</td>
<td>Small bag clips with soft pads for fingers and thumb</td>
<td>Gave participant the stimulus (if necessary, helped with finger position), presented instruction (i.e., ‘I want to see you grasp really fast,’) and started timer. Continued to direct participant to ‘grasp’ If participant dropped the stimulus, the experimenter picked it up, gave it back, and instructed him to continue.</td>
</tr>
<tr>
<td>Pull (Billy)</td>
<td>Easy resistance therapy bands</td>
<td>Placed the stimulus around participant’s shoulders. Instructed him to grasp ends of band with corresponding hands. Presented instruction (i.e., ‘pull down fast with both hands’) and started timer. Continued to direct participant to ‘pull’ (bands down toward waist).</td>
</tr>
<tr>
<td>Place</td>
<td>Colored top hats</td>
<td>Gave participant stimulus and directed him to hold it over his head. Presented instruction (i.e., ‘let’s see how many times you can place the hat on your head’) and started timer. Continued to direct participant to ‘place’ (hat on head).</td>
</tr>
<tr>
<td>Pull (George)</td>
<td>Sock</td>
<td>Gave participant stimulus and directed him to grasp each side of the opening (if necessary, helped with positioning). Presented instruction (i.e., ‘pull the sock apart really fast’) and started timer. Continued to direct participant to ‘pull.’</td>
</tr>
</tbody>
</table>

Table 2. Description of Big 6 + 6 Skill Procedures.
placed her hand over Ian or George’s non-target hand. Ian occasionally resisted the placement of the experimenter’s hand, which was considered escape behavior and the timing was immediately terminated. This occurred during Ian’s reach timed practice, which resulted in the modification of his reach definition to include alternating the left and right hand.

**REAPS**

Big 6 + 6 skill retention was assessed after the practice timings were stopped for 1 week. After a week without practice, another set of timings was completed. Data were evaluated to determine whether the participant maintained the same frequency of responding as emitted prior to the retention assessment. Skill endurance was assessed by an adjusted timing interval. The experimenter adjusted the timing interval (i.e., 15 s) by multiplying times three. For example, if the participant grasped at a rate of 100 grasps per minute in a 15 s interval, the endurance timing interval was 45 s. Application was assessed by measuring the participant’s performance on the composite activity of daily living.

**Experimental Design**

A nonconcurrent (delayed) multiple baseline across participants design (Carr, 2005) was used to evaluate the effects of the intervention on each participant’s component-composite skills. Conclusions were strengthened with a replication across composite skills for one participant. Baseline continued until data were stable or indicated a decreasing trend. Once treatment was implemented for Billy, baseline measurement continued for Ian and George. Treatment was implemented for Ian when baseline data indicated a steady or decreasing trend and the intervention data for Billy indicated an increase in performance on the dependent measures. The same procedure was followed for George.

**Interobserver Agreement**

Two observers were trained to observe the dependent variables to at least 90% accuracy. Interobserver agreement (IOA) was scored for 33% of all conditions including both the timed practice of the Big 6 skills and the probes for the daily living skill. IOA was scored by calculating the smaller count of occurrence divided by the larger count of occurrence and multiplying by 100. The mean IOA for the timed practice of component skills was 96% (range, 75%–100%). The mean IOA for the daily living skill probes was 100%.
Treatment Integrity

Treatment integrity was assessed for 30% of intervention sessions. Observers were trained to a criterion of 90% agreement on mock experimental sessions. Data were collected on the experimenter’s implementation of Big 6 timings for each component skill. Treatment integrity data were calculated by dividing the number of steps performed accurately by the total number of steps and multiplying by 100. Treatment integrity for all component skill timings was 100%.

RESULTS

Assessments

Informal Activity of Daily Living Assessment

Parents were given an informal interview adapted from the self-help skills assessment and motor skills assessment sections of The Assessment of Basic Language and Learning Skills-Revised (ABLLS-R) (Partington, 2006). These responses were used to develop a list of daily living skills that the participants were unable to perform independently. Skills assessed with the ABLLS-R included dressing, eating, grooming, and toileting. The experimenter asked the parent to rate the participant’s skill level according to the criteria specified for each task. The tasks that received the lowest scores and were identified as high priority skills became the composite skills targeted. This skill was then broken down into its component motor skills that were targeted using the Big 6 + 6 behaviors. The results of Billy’s skills assessment suggests that prior to intervention he was able to pull his pants up and down, remove his socks and shoes, remove his coat, eat finger foods, drink from a straw and cup, use a fork or spoon with prompts, wash and dry hands with prompts, and use the restroom with minimal assistance. Ian’s skills assessment suggests that prior to intervention he was able to pull his pants down, remove his shoes and socks, eat finger foods, drink from a straw and cup, wash and dry hands with verbal prompts, urinate in a toilet, and remain dry with no more than two accidents per week. George’s skills assessment suggests that prior to intervention he was able to pull his pants up and down, remove his socks and shoes, remove his shirt and coat, unzip zippers, unfasten large buttons and snaps, eat finger foods, drink from a straw and cup, pour liquids into a cup, dry hands and face with prompts, and urinate in a toilet (ABLLS-R results can be obtained from the first author).

Preference Assessment

Parents were given the reinforcer assessment for individuals with severe disabilities (RAISD; Fisher, Piazza, Bowman, & Amari, 1996) to develop a list of preferred items.
and activities. A multiple stimulus without replacement (MSWO) preference assessment (DeLeon & Iwata, 1996) was also conducted prior to intervention. Stimuli were selected for the MSWO based on the responses to the RAISD. The highest ranked items were used during the Big 6 + 6 procedures. For example, if the participant consistently chose a toy train first each time it had been presented, then that train was used during reach timed practice. Preference assessments were completed throughout intervention as needed to determine possible reinforcers for each participant.

**Component Skills**

After repeated timed practice of the Big 6 + 6 skills, all participants were able to perform the target component skills at their individual aims. In addition, all participants performed the component skills (except reach) at fluent levels as assessed by retention and endurance checks. All participants performed just below their individual aims during reach retention and endurance checks.

Billy’s performance during Big 6 + 6 timed practice sessions are depicted in Figure 1. Reach was the first component skill practiced. Billy’s reaching rate improved over baseline from 64 movements per minute with his right hand and 60 movements per minute with his left hand to 92 and 88 movements per minute with his right and left hands, respectively. Billy’s reaches dropped significantly during the 2-week retention check and during the 45 s endurance check (Figure 1 and Table 3). Billy improved his rate of grasping by X1.4 standard celeration after 4 days of practice. His grasping rate improved over baseline from 88 movements per minute with his right hand and 84 movements per minute with his left hand to 136 and 116 movements per minute with his left and right hands, respectively. Billy retained this level of performance during the 1-week retention check and during the 45 s endurance check (Figure 1 and Table 3). After the completion of timed practice for reach and grasp, Billy was able to independently complete his first composite skill.

The next skill Billy practiced was pull. He met his frequency aim on day one pulling at a rate of 128 movements per minute. He maintained this performance over 4 days of practice. Billy retained his aim after the 1-week retention check and during the 45 s endurance check (Figure 1 and Table 3). Place was the final component skill Billy practiced. He improved his rate of placing by X2 standard celeration after 4 days of practice (72 movements per minute during baseline to 128 movements per minute after practice). Billy retained this level of performance during the 1-week retention check and during the 45 s endurance check (Figure 1 and Table 3). After 2 days of timed practice on the skill place, Billy was able to independently complete his second composite skill.
Ian’s performance during Big 6 + 6 timed practice sessions are depicted in Figure 2. Ian’s reaching rate of X1 standard celeration showed no improvement over baseline when his right and left hands were practiced separately. After the definition of reach was modified to include alternating right and left hand reaches, Ian improved his rate of reaching by X4 standard celeration after 4 days of practice. His reaching

Table 3. Retention and endurance performance by participant and Big 6 + 6 skill element.

<table>
<thead>
<tr>
<th>Participant</th>
<th>Skill element</th>
<th>Retention</th>
<th>Endurance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Billy</td>
<td>Reach</td>
<td>R–72/L–76</td>
<td>R–71/L–71</td>
</tr>
<tr>
<td></td>
<td>Grasp</td>
<td>R–128/L–120</td>
<td>R–109/L–112</td>
</tr>
<tr>
<td></td>
<td>Pull</td>
<td>104</td>
<td>101</td>
</tr>
<tr>
<td></td>
<td>Place</td>
<td>144</td>
<td>112</td>
</tr>
<tr>
<td>Ian</td>
<td>Reach</td>
<td>52</td>
<td>33</td>
</tr>
<tr>
<td></td>
<td>Grasp</td>
<td>R–140/L–120</td>
<td>R–91/L–87</td>
</tr>
<tr>
<td>George</td>
<td>Reach</td>
<td>R–40/L–56</td>
<td>R–55/L–52</td>
</tr>
<tr>
<td></td>
<td>Grasp</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td></td>
<td>Pull</td>
<td>n/a</td>
<td>n/a</td>
</tr>
</tbody>
</table>
rate improved over baseline from 28 movements per minute to 60 movements per minute. Ian retained his aim during the 1-week retention check but performed below aim during the 45 s endurance check (Figure 2 and Table 3). Grasp was the final component skill Ian practiced. Ian improved his rate of grasping by X2 standard celeration after 6 days of practice. His grasping rate improved over baseline from 68 movements per minute with his right hand and 64 movements per minute with his left hand to 168 movements per minute with his right hand and 168 movements per minute with his left hand. Ian retained this level of performance during the 1-week retention check. His grasps per minute dropped markedly during the 45 s endurance check (Figure 2 and Table 3).

George’s performance during Big 6 + 6 timed practice sessions are depicted in Figure 3. George improved his rate of reaching by X4 standard celeration after 5 days of practice. His reaching rate improved over baseline from 24 movements per minute with his right hand and 16 movements per minute with his left hand to 60 and 52 movements per minute with his right hand and left hands, respectively. George’s performance dropped slightly during the 1-week retention check; however, he maintained performance rates during the 45 s endurance check (Figure 3 and Table 3).
George’s grasping rate improved over baseline from 40 movements per minute with his right hand and 32 movements per minute with his left hand to 96 and 84 movements per minute with his right and left hands, respectively. George practiced the final skill, pull, for only 3 days. Nevertheless, George’s pulling rate improved over baseline from 60 movements per minute to 92 movements per minute. Retention and endurance checks were not conducted for grasp and pull.

**Composite Skills**

Figures 4 and 5 illustrate each participant’s composite skill performance. Figure 4 shows the improvements in the percentage of steps completed and Figure 5 illustrates Billy’s improvements in duration of task completion. Each participant increased the number of composite skill steps performed independently and Billy decreased the overall time to complete the composite skill.

Baseline data for putting on socks indicate that Billy was unable to independently complete any of the task-analyzed steps. After reach timed practice, he completed 80% of the steps in 64 s. Following 1 day of grasp timed practice, Billy completed 100% of the steps in 32 s and after another week practicing grasp he completed all of the steps in only 26 s. At a 1-month retention check, Billy put on his socks in 32 s,
maintaining both accuracy and speed of performance on the composite skill. Billy’s mother conducted a generalization probe with Billy while he was getting ready for school. Billy generalized accurate performance of the composite skill but his completion time increased to 64 s.

Figure 4. Percentage of composite skill steps performed before and after composite skill practice.

Figure 5. Duration of composite skill completion for Billy as measured during weekly observations.
Baseline data for putting on shirt also indicate that Billy was able to complete only 38% of the task-analyzed steps. The steps that he completed correctly required him to reach and grasp – skills that were already fluent from previous Big 6 + 6 practice for socks. After pull timed practice, he completed 62% of the steps for putting on his shirt in 70 s. Following 2 days of place timed practice, Billy completed 100% of the steps in 52 s and after the retention and endurance checks he completed all of the steps in only 17 s. A similar generalization probe, as described above, was conducted. Billy generalized accurate performance of the composite skill but his time to completion increased slightly to 27 s.

Baseline data for putting on underwear indicate that Ian was unable to independently complete any of the task-analyzed steps. After reach timed practice, with separate timings for his left and right hands, Ian only completed 43% of the steps. After reach timed practice, with alternating left and right hands, he completed 71% of the steps. Following 1 week of grasp timed practice, Ian completed 86% of the steps in 64 s and after another week of practice he completed 86% of the steps in 61 s.

Baseline data for putting on socks indicate that George was only able to complete 60% of the task-analyzed steps. After reach timed practice, he completed 70% of the steps correctly. After grasp timed practice, he completed 80% of the steps. Following 3 days of pull timed practice, George completed 80% of the steps in 120 s.

Social Validity

A questionnaire was administered to parents of the children who participated in the study. Questions that assessed perceptions of the effectiveness of the intervention and the extent of generalization to other skills, settings, and individuals were included. Results from the social validity questionnaire suggest that the parents were pleased with their child’s progress on the activities of daily living after participation in the study. All parents reported improvements in the composite skill and reported generalization to other skills that require the targeted component skills. Finally, all parents reported they would let their child participate in similar studies in the future.

DISCUSSION

All three participants achieved fluent levels of the target component skills after Big 6 + 6 timed practice as determined by REAPS. All participants also improved performance of the corresponding daily living composite skill by increasing the percentage of steps performed independently. Billy also decreased the over all time to complete the composite skill. They achieved fluency with timed practice of the Big
6 + 6 skills reach, grasp, pull, and place. The results of this study suggest that fluency training on component motor tasks improves functional composite skill performance. In addition, timed practice improved composite skill performance whether the baseline problem was related to motivation, skill deficit, or both.

All three participants were observed laughing and smiling during the timed practice and at the completion of the interval when they were shown and/or told their performance score. Billy would request to look at the number on the hand held counter immediately after the timer went off. He was also able to recognize whether he moved faster than in the previous session. He indicated this by attempting to move the dial to a higher number or vocalizing comments such as ‘Oh no, I’ll try again’ if his performance was not as fast. Ian, who was not vocal, demonstrated faster performance when the experimenter counted his number of movements overtly. George always requested to have the hand held counter in sight during the timing interval and tended to move faster when he could see the numbers increasing. After the first few sessions of timed practice, two of the participants began to request the counter as the terminal reinforcer. These behaviors imply that students participating in timed practice may demonstrate more fluent performance when they can directly observe or come into contact with their increasing count and final results. It is important for practitioners to ensure that all students are aware of their performance goals and progress. Lindsley (1992) noted that in best PT procedures the learner is ‘informed’ and can see the time, counts, and performance changes.

Fluent levels of the Big 6 + 6 component skills resulted in improvements in the completion of the identified daily living composite skills for all three participants. Billy was able to correctly perform two composite skills (putting on socks and shirt) in a time efficient manner. Data indicate that he was unable to complete any of the task-analyzed steps for either skill during his first baseline phase. However, after the first two component skills, reach and grasp, were performed at fluent levels, Billy was able to independently put on his socks. Specifically, he did not complete any steps in the task analysis during baseline for socks and completed only 38% of the steps in the task analysis for shirt. The steps that he was able to perform in the task analysis for shirt involved reaching and grasping which suggest that these component skills, targeted for putting on socks, generalized to another composite skill. The generalization probes suggest that he also generalized putting on his socks and shirt to a different setting (the natural morning routine setting) and to another person (his mother). This finding is consistent with the outcomes of fluent performance as assessed by REAPS which reflect that high performance frequencies seem to increase the probability that students will maintain attention to a task over extended durations of performance with distractions (Binder, 1996). The social validity measure indicated that Billy’s parents continued to observe quick and accurate performance of the composite skills daily, which were skills that they typically had to perform in order...
for him to make it to school on time. This result is socially significant considering the possible effects PT and fluent performance have on a learner’s independence.

Although Ian was unable to perform all of the task-analyzed steps to put on his underwear correctly, he still made significant improvements over baseline. During the last two composite measures, Ian demonstrated the ability to correctly perform 86% of the steps required to put on underwear. It should be noted that the steps that he was unable to perform correctly required him to place his legs in the corresponding openings. This particular skill could not be addressed by the Big 6 + 6 considering it involved movements of the legs and feet. There may be a need to expand the current procedures to include component skill practice of placing with feet in order to further enhance performance. Future research should consider extending Big 6 + 6 timed practice to include component motor skills that involve body parts other than the hands. Although a formal generalization probe was not conducted for Ian, it should be noted that the social validity questionnaire indicated the parent observed the same improved performance during everyday dressing situations.

George’s data also indicate improvements in the completion of his composite skill after timed practice on three component skills. Due to time constraints, George was only able to participate in intervention for 3 weeks which limited the number of exposures to timed practice for his last component skill – pull. Task-analyzed measures of the composite skill indicate the incorrect steps involved pulling apart the sock in order to place his toes inside. Data collection stopped after the third day of timed practice on component skill pull. Although he was not able to put on his socks independently by the end of the study, it should be noted that his final duration measure was 120 s. During baseline, after 3 s of attempting each step, he would hand the sock to the experimenter. The final 120 s completion time suggests that he made more attempts to correctly complete the steps he was having trouble with before requesting help.

The results of this study suggest that breaking apart the component skills that make up a composite skill and practicing them until fluent levels are achieved will improve the overall performance of the composite skill. These results are consistent with those found by Eastridge and Mozzoni (2005) and Pahl et al. (2005). The results extend those of previous Big 6 + 6 studies by conducting scheduled REAPS assessments and by increasing the number of participants (and skills) and measuring the effects of the Big 6 + 6 on composite skill completion. It should be noted that one of the achievements of this research was in obtaining more retention and endurance data.

A limitation of this study, evident in Ian’s case, is that the procedures did not include timed practice of any component skills other than the Big 6 + 6. Children who are not fluent in other gross motor skills, besides just those of the hands and arms, could also benefit from timed practice. Another limitation of this study involved the number of sessions per week for each participant. For example, Ian missed 2 weeks of
intervention due to family vacation and illness. These scheduling difficulties are often apparent in applied settings, and it would be very difficult to insure constant and continuous sessions at all times. This time constraint, along with the fact that George participated in timed practice for a short duration limit the studies findings given that not all participants had sufficient time to improve all of the component skills needed to complete the composite skill correctly. The final limitation of this study also involves a factor of time. Ian and George both ended intervention before generalization measures could be taken. The reported strain of having to perform the identified daily living skills for their child prior to intervention was a noted concern of all caregivers and to improve the social significance of the procedures, generalization probes need to occur in order to decide if further teaching is needed to promote generalization.

The efficiency of the procedure is important for practitioners who need to teach more in less time. Furthermore, this study contributes to research on PT and expand the current body of research on REAPS. Future research is needed to identify the effects of timed practice on component/composite relations beyond the Big 6 + 6 skill elements. The steps that Ian and George were unable to perform (placing foot in hole of underwear, and placing toes in sock) correlated with component skills that were not practiced because they were not Big 6 + 6 skills. Future research should also attempt to keep the number of session per week consistent. Other time constraints could be addressed by allowing sufficient time to improve composite skill performance by practicing each of the task-analyzed component skills to fluent levels. Finally, it is extremely important for research to allow time for the parent or guardian to conduct composite skill measures in order to promote generalization to everyday routine situations and to increase the social significance of the intervention.

REFERENCES


The effects of fluent levels of big 6 + 6