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The effects of procedural integrity on skill acquisition

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THE EFFECTS OF PROCEDURAL INTEGRITY ON SKILL ACQUISITION

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By

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In Partial Fulfillment of the requirements

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The Effects of Procedural Integrity on Skill Acquisition

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The Effects of Procedural Integrity on Skill Acquisition

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Abstract

Procedural integrity is the extent that the independent variable is implemented exactly as procedures are written. The current study examined the effects of different levels of procedural integrity on the skill acquisition of a 12 year-old girl diagnosed with autism. She was taught to wash clothes using 100% procedural integrity and to dry clothes at 50% procedural integrity. The task taught in the 100% procedural integrity condition took 90 trials to mastery. 6 errors were made while the skill taught with 50% procedural integrity took 132 trials to master, and 17 errors were made. These findings are consistent with previous studies suggesting that lower levels of procedural integrity will result in more trials to mastery and more errors.

Procedural Integrity

Procedural integrity is defined by Billingsley, White, and Munson, (1980), as cited in Cooper Heron, and Heward, (1987), as the interobserver agreement measured on the occurrence or non occurrence of the independent variable. The field of Applied Behavior Analysis relies on the principle that measurable changes in behavior must be due to systematically controlled variables in the environment (McIntyre, Gresham, Digennaro, and Reed, 2007). Further, treatment integrity is the degree to which treatment is delivered as intended. According to Wilder, Atwell and Wine (2006), it is likely that behavioral interventions are implemented at close to 100% procedural integrity in controlled settings. However, in applied settings such as schools it is not always so. Without an adequate description of the independent variables a study cannot be characterized as technological, a criterion for a study to be considered applied behavior analytic.

Greesham, Gansle and Noell (1993) reviewed all studies with children as participants that have been published in the Journal of Applied Behavior Analysis (JABA) between 1980 and

1990. The authors found that approximately 16% of these studies measured the accuracy of implementation of the independent variable. However, 66% of these studies did not operationally define all elements of the independent variables.

McIntyre, Gresham, Digennaro & Reed (2007) conducted a similar review of all school based interventions with children that were published in JABA between 1991 and 2005. Exactly 152 studies were coded according to various criteria including whether or not the operational definition of the independent variable was adequately described or if treatment integrity was monitored. Approximately 95% of the experiments defined the independent variables operationally. However, 30% of the studies did not provide treatment integrity data. Approximately 45% of studies were considered to be at risk for treatment inaccuracies.

The following studies have manipulated levels of procedural integrity and have yielded conflicting findings for the field of Applied Behavior Analysis. Vollmer, Roane, Ringdalh, and Marcus (1999) conducted a study that had two purposes: To demonstrate the challenges faced with running a differential reinforcement of alternative behavior procedure (DRA), and more significantly, to evaluate the effects of treatment integrity on appropriate and problem behavior. The participants were three children diagnosed with autism. After conducting a functional analysis to identify the maintaining variables of aberrant behavior, a differential reinforcement of other behavior (DRO) treatment was implemented. For two of the participants, DRO was implemented with 100% integrity, and for the other participant DRO was implemented with 50% and 0% integrity. Results indicated that when the DRO was implemented at high levels of integrity, almost all aberrant behavior was replaced by appropriate behavior. Additionally, when the DRO was implemented at 50% integrity aberrant behavior was significantly reduced. Last, at 0% integrity, there was no observed decrease in problem behavior. The authors concluded that

partial implementation can be effective when implementing certain DRO treatments for aberrant behavior.

Northup, Fisher, Kahng, Karrel, and Kurtz (1997) examined the effects of different levels of treatment implementation of DRA and time out to decrease aggression and pica in three individuals with developmental disabilities. Treatment implementation was delivered at 100%, 50% and 20% integrity. Two participants demonstrated a decrease in aberrant behavior when treatment was implemented at 100% procedural integrity. These results were maintained when the treatment was implemented at 50% procedural integrity. Additionally, the third participant demonstrated that treatment success could be maintained at 25% implementation. These results maintain that positive results in behavior can occur with partial implementation of the independent variable.

Wilder, Atwell and Wine (2006) examined the effects of varying levels of treatment integrity on compliance in children. They implemented a multistep prompting procedure (Horner & Keilitz, 1975) with two participants with autism. The independent variables were varying levels of treatment integrity, (100%, 50%, and 0%). The dependent variable was compliance when given one of three directives. The authors used a multielement design to examine the effects of varying treatment integrity levels.

The highest percentage of trials of compliance for both participants occurred when the prompting procedures were implemented at 100% procedural integrity. The lowest percentage of trials of compliance for both participants occurred when the procedures were implemented at 50% procedural integrity.

Shirley, Iwata., Kahng, Mazeleski, and Lerman, (1997) compared the effects of functional communication training (FCT) implemented at full implementation paired with

extinction of problem behavior and reinforcement of the functional communication response on a fixed ratio 1 minute schedule (FR1). The other condition included FCT without extinction of problem behavior. Results indicate that without extinction, the problem behavior did not decrease. However, when FCT was paired with extinction procedures aberrant behavior decreased significantly. Shirley et al. suggests, partial implementation of a treatment package had less than ideal effects.

Some studies have investigated the effect of training on efficacy of behavior interventions. Sarakoff and Sturmey (2004) examined the effects of behavioral skills training on staff implementation of discrete trial teaching. Baseline measures of correct teaching procedures were 43%, 49% and 43% for all teachers. Clinicians then implemented training in the form of feedback, instructions, rehearsal and modeling. Results indicated that training increased treatment integrity in teaching procedures.

Digennaro, Martens and Kleinmann (2007) examined the extent to which treatment integrity of four special education teachers were trained by goal setting, performance feedback and meeting cancellation contingencies. Teachers underwent training to implement function-based treatments to intervene with students' problem behavior. In the first condition, teachers set goals for students' behavior and received formal written feedback about the students' progress or lack thereof. In the second condition, teachers received additional feedback concerning their accuracy in implementation. The feedback was given to avoid meeting with a superior where the staff would be retrained on the treatment packages that they failed to implement correctly. This condition increased levels of integrity above baseline levels. Additionally, higher levels of treatment integrity were correlated with lower levels of students' problem behavior in 70% of teacher-student dyads.

Experts have cited problems with monitoring treatment integrity. Yeaton and Sechrest (1981) state that it is close to impossible to measure the extent to which treatment is implemented as written in procedures without constant supervision of practitioners. Further, even with a monitoring system in place, there is a possibility that errors will occur. Gresham, Gansle, and Noell (1993) suggests that, if significant behavior change does not occur, and if the integrity of treatment is not monitored, one simply cannot distinguish between an ineffective treatment and effective treatment implemented with poor integrity.

Task Analyses

Cooper, Heron, and Heward, (1987) define a task analysis as a procedure in which complex behaviors are broken down into smaller components. Bancroft (2004) explained that teaching complex behaviors often involves developing a task analysis where the smaller responses that makes up the behavior are systematically identified and sequenced so that behaviors can be taught one component at a time. The author clarified that the term “task analysis” is often used to indicate the list of responses making up a chain of behaviors.

A behavior chain includes a series of discrete responses (Cooper, Heron, and Heward 1987). Each component serves a dual purpose in promoting skill acquisition with the exception of the first and last steps. Each component of the behavior chain (i.e., with the exception of the first and last step) serves as a conditioned reinforcer. If the complex behavior is brushing teeth, the response of turning on the water is a conditioned reinforcer to the behavior of picking up the toothbrush. Components of a behavior chain also serve as discriminative stimuli. Turning on the water is a discriminative stimulus because in the presence of the water, the behavior of putting ones toothbrush underneath the faucet is more likely to be reinforced is its presence than in its absence.

Cuvo, Leaf, and Borokove, (1978) state that a task analysis is beneficial because it identifies the prerequisite responses needed to complete a task, the objective of training, and the sequence of instruction. The authors state that a task analysis is pragmatic and the clear specification of correct responses facilitates reliable scoring.

Demchak (1990) states the importance of task analyses as a teaching method cannot be emphasized enough. Teachers of individuals with severe handicaps must work to increase the behavioral repertoires of those individuals. Additionally, it is important that learned behaviors are exhibited in the presence of naturally occurring stimuli and maintained by natural consequences.

It should also be mentioned that past research has established functional relations between prompting techniques and the acquisition of skills with typical students. However, there is a limited body of knowledge that relates to prompting research focusing on students with learning disabilities (Morton, and Flynt 1976).

Using various prompting procedures for each step of a task analysis allows for a near errorless training procedure that can be used in a variety of environments with a variety of individuals. Foxx and Azrin (1973) used chaining to effectively teach toileting skills to individuals with developmental delays. The task analysis outlined specific responses necessary to successfully use a toilet. Additionally, Horner and Keilits (1975) successfully used a task analysis teaching technique to train participants with developmental disabilities to brush their teeth.

Pavlovich and Greene (1984) used task analyses to teach children to install window treatments. Two participants worked to assemble window treatments in tasks of equal difficulty. One participant worked on activity A using a task analysis, while one participant worked on

activity B using an instruction manual. The dependent variable was quality which was rated on a likert-type scale with rankings from one to five. The installations that were a product of following the instruction manual were rated below three while those that were a product of the task analysis were rated above three. This study demonstrated that a behavior chain may be more effective than an instruction manual to teach new skills.

Researchers have presented multiple methodologies in the task analysis literature. However, there has been a paucity of research on task analysis over the past 20 years (Bancroft, 2004). And an examination of the various methodologies present in the literature may provide a basis for resuming research in this crucial area of study.

There are several considerations to be made when designing an individualized task analysis. One consideration is the type of chain to use: forward, backward, or total task chains. Another consideration is the type of prompting procedure to use in order to generate responses to be reinforced. A third consideration is deciding what to do with untrained steps of the chain. Options include the teacher completes the chain, manually guides the student to complete, or does not complete the steps of the chain at all.

Forward Chaining

In forward chaining, only the first step in the task analysis is trained and reinforcement is delivered at the completion of that step relative to the prompt. Criteria are set for moving on to training the next step. For example, a step is mastered when it is performed independently for five trials in a row. Responses are trained sequentially from first to last, one step is trained during each trial, and reinforcement is delivered contingent on the cumulative completion of the training step and all previous steps that have already been trained and independent (Cooper, Heron, and Heward 1987).

There are a variety of benefits of using a forward chain task analysis. Training staff to use a forward chain is relatively easy. . Some limitations of using this method include that the learner is not reaching the natural contingency of the finished behavior until she is trained on the final response. For example, if a student is using forward chaining to learn to tie his shoe, the natural contingency would be his shoes being tied and the chain being finished. However, in a forward chain he would not meet the natural contingency as a result of his independent behavior until the end of the chain.

Wilson, Reid, Phillips, and Burgo (1984) used a forward chain procedure to teach mealtime skills to children with mental retardation. Participants received a preferred edible or praise contingent on completing the training step at the prescribed prompt and all previously trained steps. The chain was an effective teaching procedure to train these skills; however, the forward chain presentation was not compared to any other type of task analysis.

Backward Chaining

Backward chaining is the process by which steps are learned when the practitioner completes all of the steps in when chain with the exception of the last step, or training step. When the student completes the last behavior of the chain at the predetermined criterion level, reinforcement is delivered. Then, the reinforcer is delivered when the last and second to last behavior in the chain are completed. This sequence occurs backward until every step in the chain has been mastered (Cooper, Heron & Herward, 2007).

Hagopian, Farrell, and Amari (1996) successfully used a backward chaining presentation to teach fluid acceptance to a child with autism and other developmental delays. The last step in the chain was swallowing followed by having liquid in the mouth and drinking from a cup. Once swallowing occurred, training was focused on the second to last step, and finally drinking from a

cup.

Total Task

In a total task procedure, the teacher trains the individual on each step in the behavior chain during every session. Assistance is given on any step that is not performed in a predetermined amount of time or on any step that is performed incorrectly. Benefits of the total task approach are that the learner is subjected to the stimulus presentation for each expected response, the learner receives training for each step of each session which could potentially increase the rate in which skills are acquired (Bancroft, 2004), and the total task method can be used as a baseline procedure. In addition to these benefits, numerous limitations to using total task training exist. First, the training time for each session can be significantly longer than other methods because each step is being trained and can require prompting. Also, in a total task presentation, the learner does not have to achieve independence on a step to continue training on the rest of the chain.

Croning and Cuvo (1971) used a total task procedure in which least-to-most prompting was used to teach mending skills to adolescents with mental retardation. Training continued until participants reached 100% independence of all steps in the chain. The number of independent steps was significantly higher than baseline, however, the total task presentation was not compared to any other training procedures.

Shleien, Wehman, and Kieran (1981) also used a total task presentation with least to most prompting to teach dart throwing to adults with developmental delays. The purpose of teaching the skill of dart throwing to these adults was to teach age appropriate leisure skills. The chain was broken down into a seven-step task analysis where participants were trained on each step in every session until they reached 100% independence of the task. The number of independent

steps increased from baseline, however; no other comparisons were made with other chaining procedures.

Types of Response Prompts

As previously mentioned, studies have been successful in using specific task analysis presentation whether it be forward, backward or total task chaining. However, those studies lacked a comparison with other types of chaining procedures. Demchak, (1990) reviewed the research related to different types of response prompting procedures that have been used in training discrete trials and chained responses. The author's review is a comprehensive comparison of more than twenty studies that have been completed regarding task analysis procedures. The author compared four methods of prompting and fading: least-to-most, most-to-least, graduated guidance and time delay procedures. Conclusions include that for acquisition, most-to-least prompting resulted in fewer errors than least-to-most. Fluency was best achieved using least-to-most prompting instead of most-to-least. Progressive time delay and least-to-most were equally effective but time delay may be more efficient. Constant time delay and least-to-most were equally effective but constant time delay may be more efficient. Additionally, constant time delay may be easier for teachers to implement.

Demchak (1990) measured efficacy of a particular chaining procedure using the following criteria: time to criterion, trials to criterion and number of errors. Further, the author mentions that learning should be errorless because once an error is emitted there is a good chance that it will be repeated and that correcting errors will take additional time. Also, participants may be more likely to emit aberrant behavior when faced with difficult or novel tasks. Additionally, it is difficult to know if one task is more difficult than another unless perhaps an expert from an outside field observes the tasks. For example, for a student, the chain of washing ones hands may

be simpler than learning to clean the kitchen. Unless the behavior therapist is also an orthopedic therapist, it is difficult to equate the difficulty of these two tasks.

Morton and Flynt (1976) compared the efficacy of constant time delay and prompt fading to transfer stimulus control. Four students from a special education program participated in this experiment. A multiple baseline design paired with a try-procedure was used to observe a preferred learning strategy for reading words. Results showed that both constant time delay and prompt fading were preferred teaching techniques.

Walls, Zane, and Ellis (1981) compared the efficacy of forward, backward, and total task learning programs to teach 22 participants with mental retardation vocational tasks. Authors used an alternating treatments design and concluded that the total task approach produced the greatest amount of errors.

Wall and Gast 1999 assessed whether 12 high-school aged students with moderate developmental delays could acquire a response chain vocational skill with fewer than 10% errors using both constant time delay as well as task analysis with no time delay. Clinicians used a multiple probe across six dyads. Results indicated that the constant time delay method produced nearly errorless learning.

Weiss (1978) sought to identify the relative effectiveness of forward and backward procedures for the acquisition of response chains using 10 typical college aged students. Experimenters taught a key pressing task in an AB alternating treatments design. Although there were no baseline or reversal conditions resulting in limited experimental control, participants learned the task with fewer errors using forward chains.

Glendenning, Adams, and Sternberg (1983) compared the frequency of self-initiated responses in three types of prompting procedures. Participants learned a 40-step string-tying task

analysis. The prompting sequences were varied and included verbal cues, modeling, physical assistance and gestures. Results show a difference in responding as a function of the type of prompting sequence. The prompt sequence that began with a verbal cue paired with physical assistance yielded a higher frequency of self-initiated responses. Additionally, verbal prompts alone resulted in a low probability of self-initiated responding.

Walls, Sienicki, and Grant (1981) compared the efficacy of a physical guidance fading procedure with a most-to-least and partial verbal model procedure. The dependent variables were rate of acquisition and number of errors. The authors used counterbalanced learning sequences to conclude that the participants can learn task analyses quickly and with few errors, regardless of the sequence of steps. A graduated guidance procedure was examined in a multiple baseline design across behaviors to evaluate its efficacy of teaching independent dressing. Trainers provided assistance as needed; however, prompts were systematically faded according to the specific prompt hierarchy used. Generalization and maintenance of treatment effects to similar clothing items was observed by conducting follow up probes for both participants.

In a study by Day (1989), clinicians taught six participants with profound mental retardation two tasks of equal difficulty using antecedent and consequent procedures. The antecedent prompting procedure involved the clinician prompting the participant according to the prompting hierarchy prior to the response, while fading prompts on subsequent trials. During the consequent procedure, the clinician prompted the participant after a wrong response then gradually faded the prompts on subsequent trials. Results showed that responding with fewer errors occurred in the antecedent procedure than in the consequent prompting procedure.

In the ongoing quest to find the most efficient and effective way to train a behavior chain researchers and clinicians must consider the generalization and maintenance of these skills. This

is rare in vocational literature (Cuvo, Leaf, and Borokove 1978). One of the benefits of teaching chains is that the natural contingency of completing the chain becomes a reinforcer to the learner. Cuvo, Leaf, and Borokove (1978) examined the efficacy of a specific task analysis program compared video modeling to teach six participants janitorial skills. Clinicians measured acquisition, generalization and maintenance for task completion and correct responses of a bathroom cleaning task analysis. A multiple baseline design across participants and responses was used. Results demonstrate that the effectiveness of combining task analyses and prompting sequences to train participants with disabilities cleaning programs. Additionally, results showed that generalization of learning steps in another similar restroom occurred, and after a two week post check, performance was maintained in the bathroom where the chain was initially learned.

Task analysis can be a highly effective way to train skills to individuals with developmental delays.. A thorough understanding of forward, backward and total task chaining procedures, along with their benefits and limitations, is necessary in creating task analyses, Additionally, knowledge of prompting and fading procedures such as least-to-most, most-to-least, graduated guidance and time delay procedures will also benefit an instructor and learner.

There is a thin body of research containing information on training leisure skills to individuals with developmental delays by way of chaining. Although time and resource intensive it is necessary to compare the three main types of chaining techniques with the four primary prompting and fading techniques. Studies and reviews examining the effects of varying levels of procedural integrity as well as quality of procedural integrity have been conducted in the past; Greesham, Gansle and Noell, 1993; McIntyre, Greshem, Digennaro and Reed, 2007; Vollmer, Roane, Ringdahl, and Marcus, 1999; Northup, Fisher, Kahng, Karrel, and Kurtz, 1997; Shirley, Iwata., Kahng, Mazeleski, and Lerman, 1997; Wilder, Atwell and Wine, 2006. However,

research on the effect of procedural integrity in skill acquisition when using task analyses is limited.

In a controlled setting, procedural integrity is often well measured and controlled. In school settings, extensive monitoring to endure high levels of treatment integrity does not occur regularly. While some research suggests that procedures can be implemented at low rates of procedural integrity with positive effects on behavior, other research suggests that partial implementation of the independent variable can have less than ideal effects. Additionally, manipulating levels of procedural integrity in a simple behavior chain has not been assessed in depth.

Weiss, Libby, Ferrell and Perry, (2006) investigated the effects of lower levels of procedural integrity on task acquisition while teaching students using behavior chains. Researchers trained participants to build eight-piece Lego structures using a forward chaining task analysis and a most-to-least prompting strategy. Two different Lego structures were taught, each designated with a different color Lego board. One structure was taught with 100% procedural integrity, while the other structure was taught with programmed errors. In the programmed error condition, the structure was taught with 70% and 50% procedural integrity. Results of the study showed that the students took longer to learn the Lego structures trained with 70% procedural integrity, and the participants simply did not learn to construct the structures taught with 50% procedural integrity. However, at 100% integrity, the participants learned the chain relatively quickly, and with few errors. Some limitations to this study include that the task was not difficult, as the only behaviors involved were picking up Legos and placing them on a board in a predetermined order. Additionally, research should focus on the length and difficulty of chains taught in educational settings to see if error rate can be reduced. Further,

some criticize that building Lego constructs was an arbitrary task and that it is more practical to teach functional tasks such as self-care, vocational, or play skills.

The current study is a systematic replication of the Weiss et al study (2006). The purpose of the current study was to teach a participant with autism two functional tasks at differing levels of procedural integrity. Additionally, the study examined to see if errors occurred as a function of the manipulation of procedural integrity.

Method

Participants

One participant was included in this study. Susie was an 11-year-old girl diagnosed with autism. She attended a substantially separate classroom based on the principles of applied behavior analysis at a public middle school.

Setting and Materials

The task of washing and drying clothing took place in a gym locker room at the school. Materials include data sheets, pencil, video camera, tripod, washer, dryer, laundry detergent, dryer sheets, and dirty clothes. A task analysis consisting of 10 steps was written for the tasks of washing and drying clothes in a forward chain presentation using most-to-least prompting. Each response was believed to be similar in response effort. The steps in the washing clothes task analysis were opening the door to the washing machine, putting the dirty clothes into the machine, getting the laundry detergent, taking the cap off of the laundry detergent, pour the correct amount into the cap of the bottle, putting detergent down, closing the door to the machine, turning the knob to the correct setting and pressing the start button. Steps for drying the clothes were opening the door to the washing machine, opening the door to the dryer, get clothes in the washing machine, putting the wet clothes from the washing machine into the dryer, closing

the washing machine door, getting the dryer sheet, putting the dryer sheet into the dryer, closing the dryer, turning the knob to the correct setting and pressing the start button.

Dependent Variables and Operational Definitions

The dependent variables were: (a) number of trials to mastery of the step and (b) number of errors that occurred when training each step. A correct response was recorded when the participant completed the step at the prescribed prompt and an incorrect response was recorded if the participant did not complete the step at the prescribed prompt.

Measurement and Reliability

Sessions were videotaped to allow interobserver agreement (IOA) and procedural integrity to be measured. Two trained observers independently recorded the participant's responses on the training step and prompts delivered by the experimenter during each trial. IOA data were collected for 33% of all trials for both tasks. IOA was calculated by dividing the number of agreements by the total number of agreements plus disagreements, and then multiplying by 100. Interobserver agreement ranged from 90%-92%. Procedural integrity was assessed during 33% of all trials for each task. The observer collected data on (1) whether the experimenter followed the steps of the task analysis in the correct order, (2) whether the experimenter provided the appropriate prompt or programmed error determined by the data sheet, and (3) whether the experimenter provided reinforcement at the appropriate step if it was warranted. Procedural integrity for this study averaged at 91% (range 88%-94%).

Experimental Design

Baseline sessions were conducted for each task analysis prior to training. During baseline conditions, the discriminative stimulus was delivered and no prompting or reinforcement occurred. After stable responding occurred in baseline sessions training began.

Training in each condition occurred one at a time. Once mastery occurred in the 100% procedural integrity condition, training began in the 50% procedural integrity condition. Training began with the first steps that the participant responded to incorrectly during the baseline session. Most-to-least prompting was used with the following prompting hierarchy: manual guidance, forearm, upper arm, light touch and independent (Weiss et al. 2006). Criteria to decrease intrusiveness of the prompt required the participant to respond correctly at the prescribed prompt for two consecutive trials. Criteria to increase intrusiveness required the participant to make an error at the prescribed prompt for two consecutive trials. Criteria to advance a step required the participant to complete a step independently for two consecutive trials. Criteria to move back a step required the participant to complete a step incorrectly at manual guidance for two consecutive sessions. If the student did not learn a step in 40 trials, the step was taught using errorless teaching at 100% PI. In the 50% procedural integrity condition, if the step was not mastered in 10 trials, two probe trials were implemented so that the participant had an opportunity to demonstrate mastery of the step.

Results

Results are shown in figures 1 and 2. Figure 1 depicts number of errors in baseline, initial training, retraining, and probe trials during task 1. During baseline, steps 1, 2, 6, and 7 had 0 errors. These steps all exhibited mastery during baseline sessions and therefore were not taught. In initial training, steps 3, 4, 5, 8, and 10 were learned with 0 errors. However, in initial training, step 9 was learned with 1 error. No steps were retrained because criteria for retraining, failure to teach a step at manual guidance for two trials in a row never occurred. Figure 1 depicts number or errors in baseline, initial training, post criterion, retraining and probe sessions. In baseline sessions, steps 1, 2, and 3 contained no errors because no responding

occurred. In subsequent baseline sessions, steps 4, 6, 7, 9 and 10 contained 0 errors. Step 5 contained 1 error and step 8 contained 2 errors.

Initial training sessions were defined as training due to a step that was not mastered in baseline. In the initial training sessions steps 1, 2, 9, and 10 were taught with 0 errors. Steps 3 and 5 were taught with 1 error each in initial training. During the first initial training of step 3, only 5 trials were run.

The results of task 2 are depicted in figure 2. In the 50% procedural integrity condition, if the step was not mastered in 10 trials, 2 probe trials were implemented so that the participant had the opportunity to show mastery of the step. Because of this procedure, step 3 was trained 5 separate times. The first session was already described. However, the second training session of step 3 contained 5 trials and 0 errors. The third training sessions contained 4 trials and 1 error. The fourth training session contained 3 trials and 1 error and the fifth sessions consisted of 10 trials and 0 errors.

Post criterion sessions were defined as sessions that occurred after the step had been mastered. In the post criterion sessions steps 4, 6 and 7 contained 1 error. Step 2 contained 2 errors in 4 out of 5 post criterion sessions. In the fifth post criterion session 1 error occurred.

Retraining sessions were defined as sessions that occurred because a step that had been previously mastered had met criteria to be retrained; a error on the same step in two consecutive trials. In the first retraining session step 2 had 1 error. In the second retraining session, step 2 contained 0 errors. In the third retraining session step 2 had 1 error. At this time the step had been trained at 40 trials and criteria was met for the step to be taught at 100% procedural integrity. Therefore, the fourth, fifth and sixth retraining sessions of step 2 contained 0 errors.

Probe sessions were implemented for reasons described previously. In the first probe

sessions steps 2, 3 contained 1 error and steps 5, 8, 9, and 10 contained 0 errors. In the second probe sessions, step 2 contained 2 errors and step 3 contained 0 errors.

Discussion

The results of the current study suggest that there was a functional relation between teaching the chains with low integrity and trials to acquisition as well as number or errors. The participant learned the task more rapidly in the 100% procedural integrity condition than in the 50% condition. Additionally, fewer errors were emitted in the 100% condition than in the 50% condition. Although there was only 1 error emitted in initial training in task 1, it is not clear whether or not the errors in task 2 were a function of low integrity. In task 2, 5 errors were made in initial training. Initial training of step 3 was repeated as a result of step 2 meeting criteria to be retrained during all but one initial training sessions of step 3 even though step 2 was mastered in baseline. It must be noted when step 2 was in its fifth retraining session, the order of the steps were changed so that step 3 came before step 2. Once this change in the procedure was made step two was trained with 0 errors and criteria for retraining did not occur again. This finding indicates that the natural sequence of steps for a participant must be noted and written into procedures. If the participant completes the task in their natural sequence, there is not a reason to change it. This study suggests that changing the natural sequence of steps may cause errors.

This study had multiple limitations. First, one individual participated in the study. It would be beneficial to see if the procedural integrity effected both trials to mastery and number of errors across multiple participants to increase the external validity of this study. Secondly, this study examined the manipulation of procedural integrity in forward chains only. Although there is a plethora literature related to procedural integrity and there is research examining the efficacy of chaining methodologies, the examination of the two combined is limited. An investigation on

the effects of varying procedural integrity on total task, backward, and time-delay would add to the body of research significantly. Task analyses are widely used to teach many skills, and findings on this topic would increase the quality of procedures used today. It is crucial that individuals learn skills in a timely manner, and with as few errors as possible. The examination of different types of behavior chain procedures with varying levels of procedural integrity could maximize learning potential for multiple types of tasks.

An additional limitation to this study was the length of the chains used. The current study investigated the effects of high and low levels of procedural integrity on skill acquisition and prominence of errors in ten-step chains. It would be beneficial to know if these results would generalize to 15 or even 30-step chains, and investigate if low levels of procedural integrity would effect longer or shorter chains to any extent.

It is crucial to know the extent to which implementation can be varied without impairing the students' ability to learn. Often, staff are improperly trained or unmotivated to implement procedures as written. Recent legislation such as the No Child Left Behind Act (U.S. Department of Education, 2002) and Individuals with Disabilities Improvement Act (2004), as cited in McIntyre, Gresham, DiGennaro & Reed, 2007, demands that school-based clinicians as well as teachers be held accountable for their practices. Hence the need for evidence-based practices within these settings. Hopefully this incentive will increase procedural integrity of the used to teach children new skills.

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Table 1. Number of errors emitted in each condition of task 1 taught with 100% procedural integrity.

Table 2. Number of errors emitted in each condition of task 2 taught with 50% procedural integrity.

Figure 1. Number of errors in task 1 per condition.

Condition	Steps									
	1	2	3	4	5	6	7	8	9	10
Baseline	0	0	NR	NR	NR	0	0	NR	NR	NR
Initial Training			0	0	0	0	0	0	1	0
Post Criterion							1			
Retraining Probes						0				

Figure 2. Number of errors in task 2 per condition.

Condition		Steps									
Baseline	1	2	3	4	5	6	7	8	9	10	
	NR	NR	NR	0	1	0	1	2	0	0	
Initial Training	1	2	3	4	5	6	7	8	9	10	
	0	0	1(5) 0(3) 1(4) 1(3) 0(10)		1			2	0	0	
Post Criterion	1	2	3	4	5	6	7	8	9	10	
	1	2		1		1	1				
	2	2									
	3	2									
	4	2									
	5	1									
Retraining	1	2	3	4	5	6	7	8	9	10	
	1	1									
	2	0									
	3	1									
	4	0									
	5	0									
	6	0									
Probe	1	2	3	4	5	6	7	8	9	10	
	1	1	1		0			0	0	0	
	2	2	0								