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Training and Assessment of Toothbrushing Skills among Children with Special Needs

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By

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Abstract

The success of applied behavior analysis (ABA) interventions relies heavily on adherence to measures of social importance. One area identified by caregivers, educators, and researchers as having social importance is the area of daily living skills; particularly in populations of children with special needs. A number of studies employed the use of a task analysis to objectively measure toothbrushing, with various training procedures utilized. Behavioral Skills Training (BST) is an effective procedure used to train a variety of skills. Further, research indicates the addition of an in situ assessment promotes generalization of trained skills. The current study examined the use of a task analysis and BST with in situ assessment to systematically measure and train toothbrushing skills in children with special needs. Training procedures were adapted from a similar study by Poche, McCubbrey, & Munn (1982). Five children participated in this study; four male and one female; each having a medical diagnosis indicating special needs. Objective and subjective measures were obtained with a task analysis data sheet and a pre/post intervention parent surveys. Results indicate the intervention successfully increased correct toothbrushing responses in four of the five participants. For the other participant, the intervention had no effect. Fading assessments were conducted 1-5 weeks following intervention, and maintenance effects were variable. The

efficacy of BST to train skills and a task analysis to measure responses has been extended to different populations based on the findings in this study.

Chapter One:

Introduction

Social Validity

The field of Applied Behavior Analysis (ABA) has grown exponentially since its initial progression from behavior modification. A large body of research and clinical work focuses on the development and implementation of effective intervention methods for individuals with special needs. Principles and procedures of behavior analysis have been applied across a variety of behavioral domains within these populations, including: reductions of problem behavior, increases in the frequency of novel mands, acquisition of social skills, and increasing the duration of academic task engagement to name a few. The success of such interventions relies heavily on an adherence to measures of social importance.

The subjective construct of social importance is not easily defined by a field embedded in objectivity; however, it is the cornerstone of ABA. Of what value is our science without its social validation? Society will be less likely to use an intervention, however potentially effective or efficient it may be, if not regarded as significant (Wolf, 1978). Wolf (1978) identified three levels of social validation: the social significance of the goals, the social appropriateness of the procedures, and the social importance of the effects. More specifically, if the behavioral goals are what society wants, the intervention procedures are considered acceptable, and if consumers are satisfied with the results, an

intervention would be considered socially valid. In an effort to maintain the fidelity of the inception of ABA, researchers should concern themselves with advancement in the technological applications of the principles of behavior analysis to these sometimes obscure conceptions.

Autonomy within special needs populations. Society expects its members to perform certain everyday behaviors independently (O'Leary & Dubey, 1979); thus a primary goal of most caregivers and educators of individuals with special needs is to increase their independence when performing simple daily living skills and self care tasks (Mays & Heflin, 2011). Further, those acquiring independence early in life will have more potential to thrive in both domestic and vocational settings (Pierce & Schreibman, 1994). Achieving autonomy is especially important for individuals with special needs, considering deficits in this domain often impose a life-long dependence on others. These individuals may require extensive training or assistance to complete daily routines, acquire vocational, social, or academic skills and maintain a functionally adaptive environment. The time and energy required can create stress for the caregivers or other consumer directly involved with the individual (Mays & Heflin, 2011). The potential benefit of applying functional value to autonomy is of great significance to the individual, caregivers and consumers directly involved with the individual, and society as a whole. Thus, systematic training for, acquisition, and maintenance of independent daily living skills such as dressing, grooming, eating, and bathing are critical skills to be targeted within this population. Further, such trainings should incorporate principles of behavior such as reinforcement and generalization to promote lasting behavior change.

Pediatric oral hygiene. The oral health of children is an area often neglected despite widespread dental problems before age 3 (Swain, Allard, & Holborn, 1982). Half of all 2-year-olds have one or more cavities, and 90% of all children have dental decay by the age of four (Greenberg, 1977). Though primary teeth are lost and replaced by permanent teeth, tooth decay can be transmitted, and could precipitate development of periodontal disease (Poche, McCubbrey, & Munn, 1982). Periodontal disease involves the tissue surrounding the teeth and could lead to the loss of teeth. Some studies indicate as many as 65% of children have periodontal disease (Blount, Santilli, & Stokes, 1989). An early and less severe form of periodontal disease is gingivitis, which can be controlled by engaging in adequate daily oral hygiene routines.

The reduction of plaque has also been examined in studies pertaining to oral hygiene regimens. To control plaque, evidence suggests brushing *effectively* twice a day is sufficient to maintain oral health (Blount et al., 1989). The important distinction between merely brushing and brushing effectively should be made. An individual may brush his or her teeth twice a day, however if his or her particular method of toothbrushing is not effectively executed, the functional value of toothbrushing is null.

In a critical review of oral hygiene in pediatric dentistry, Blount et al. (1989) indicated several available procedures, of varying success, to promote oral health in children: instruction, changing attitudes and beliefs, supervised brushing, training, modeling, and reinforcement. Most dental programs are provided in schools and consist of a single lecture and demonstration, although such instruction-only programs are not sufficient in promoting the cleanliness of children's teeth (Swain et al., 1982). It can also

be assumed that parents will teach their children how to brush, or assist them in doing so, although there is no clear indication whether or not this occurs (Poche et al., 1982). Without proper measurement and training, toothbrushing skills may never be effectively performed by the individual. Among children and adolescents, deficits have been found related to the effectiveness of brushing, the duration of brushing, and a lack of systematic approach to brushing (Blount et al., 1989).

With this evidence, it can be presumed that deficits in oral hygiene skills of children with special needs likely exist as well. As previously mentioned, the extensive time and effort sometimes required to train daily living skills (or prerequisite skills needed to complete the task) to individuals with special needs also suggests a need for effective training methods and objective measurement in this domain.

Previous Toothbrushing Research

Task analysis. The process of analyzing a behavioral chain by breaking it down into its individual stimulus-response components is called a task analysis (Miltenberger, 2008). In this way, a chain of behaviors, such as picking up a toothbrush, bringing it to one's mouth, moving the arm in a back and forth motion, etc. can be readily identified and measured. The systematic measurement of toothbrushing behaviors has typically been employed through the use of a task analysis (Horner & Keilitz, 1975; Mays & Heflin, 2011; Poche et al., 1982).

Horner and Keilitz (1975) developed a comprehensive evaluation of a toothbrushing program for adolescents with intellectual disabilities using a task analysis and training components specific to the task analysis. However, only 3 of the 15 steps

involved actual toothbrushing behaviors. Other steps were related to component behaviors that form the complex stimulus-response chain of toothbrushing. For example, behaviors such as removing the cap from the toothpaste, application of the toothpaste, moving the bristles across the teeth, filling a cup with water to rinse the mouth, etc. are topographies of behaviors that make up a sequence called a behavioral chain. By definition, a behavioral chain is a complex behavior consisting of many component behaviors that occur together in a sequence (Miltenberger, 2008). The analysis of such components was appropriate for adolescents, considering the American Dental Association (ADA) recommends children should be able to brush their teeth independently without supervision by the age of 10 or 11. Regarding younger children, by age 6 or 7, they should be able to brush their own teeth twice a day with supervision (ADA, 2005). Thus, in studies involving pre-school or school aged children, interventions should focus on training the actual brushing behaviors that occur within the behavioral chain of toothbrushing.

Poche et al. (1982) extended and refined the study conducted by Horner and Keilitz (1975) by employing a 16-step task analysis solely measuring the actual manipulation of the brush in the mouth. All other behaviors in the toothbrushing chain were completed with assistance by the trainer. Further, correct brushing at each step included four criteria: holding the bristles at a 45 degree angle with the tooth surface, using a circular "soft-scrub" motion, brushing the appropriate tooth surface in the sequence described in the task analysis and brushing this surface continuously for at least 5 seconds. Areas of the mouth were classified by the outside and inside surfaces of the

upper and lower teeth, as well as the biting surfaces of the upper and lower teeth. Poche et al. (1982) developed a thorough analysis of actual toothbrushing executed with great success by 3 and 4-year-old preschool children. In this study, participants achieved mastery of skills within 14-25 training sessions, indicating the implementation of effective training procedures to complete this skill.

The task analysis is a useful measurement tool when behavioral chains are variables of interest. Once a task analysis has been developed, the next step is to choose a strategy for teaching the skill (Miltenberger, 2008). Several different procedures have been used to train toothbrushing skills, both to typically developing children and those with special needs. Procedures included picture prompts (Pilebro & Backman, 2005), self-operated auditory prompts (Mays & Heflin, 2011), response prompts (Horner & Keilitz, 1975) and behavioral skills training (Poche et al., 1982). It should be noted that the use of response prompts and behavioral skills training were not explicitly labeled as such in each respective study. However, in order to remain technologically fidelity within behavior analysis, Horner and Keilitz (1975) utilized verbal, modeling, and physical prompts; and Poche et al. (1982) employed the use of behavioral skills training procedures.

Extrastimulus prompts. The use of extrastimulus prompts, such as picture or auditory prompts can be a useful method when training toothbrushing and other daily living skills to children with special needs, especially when training techniques involving extensive amounts of training time are not viable or possible. Picture prompts in an unsupervised setting were used to train three boys with autism, ages 6-9, to complete

tasks of getting dressed, setting the table, making lunch, doing laundry, making a drink, and making the bed (Pierce & Schreibman, 1994). Picture prompts were also employed in a study by Pilbero and Backman (2005). In this study, a series of picture prompts were utilized in a program to teach toothbrushing skills to 14 children with autism, ages 5-13. Researchers provided pictures representing the sequences of steps in toothbrushing to the participant's parents and instructed them to display the pictures in their bathroom at home. Parent questionnaires and measures of plaque were used to collect outcome data on participants' performance. Although five participants learned how to brush their teeth and left the program, it should also be noted that this particular study was conducted over an exhaustive amount of time, with outcome measures performed at 8 months, 12 months, and 18 months. Further, two participants made no progress due to a lack of understanding of the picture sequence, and there was no indication that any type of training other than a display of pictures was used (i.e., no instructions or modeling provided). In an effort to develop comprehensive toothbrush training techniques, systematic and technological procedures should be paramount.

Response prompts. Horner and Keilitz (1975) employed a different method of prompting to train toothbrushing skills; response prompts. A response prompt is defined by the behavior of another person evoking a desired response in the presence of a discriminative stimulus (SD), and can take the form of either gestural, verbal, modeling, or physical prompts (Miltenberger, 2008). In Horner and Keilitz's (1975) study, trainings consisted of a succession of four procedures: (1) No Help, (2) Verbal Instructions, (3) Demonstration + Verbal Instruction and (4) Physical Guidance + Instruction. While

these procedures, coupled with the objective measurement of a task analysis, were successful in training the chain of skills in toothbrushing to adolescents with intellectual disabilities, a successive prompting method in which the participant has the potential to exhibit an incorrect response first every time, could lead to the development of a response chain of no help → error in step → trainer provides prompt, possibly creating a prompt dependency for the learner with no real acquisition of independent skill.

Behavioral skills training. The four behavioral skills training (BST) procedures include: instruction, modeling, rehearsal, and feedback; and are typically used to teach skills that can be simulated in a role-play context (Miltenberger, 2008). The use of instructions includes a description of the appropriate behavior for the learner, and to be most effective, should be specific. In a chain of behaviors, specific instructions should be delivered for each component of the chain. The modeling procedure includes the demonstration of the correct response for the learner, learner observation of the model's behavior, and leaner imitation of the model. With rehearsal, the learner has the opportunity to practice the behavior after receiving instructions and/or modeling has taken place. During rehearsal, an opportunity is presented for the trainer to assess responding and subsequently correct any errors in the performance by the learner. In the final procedure of BST, feedback in the form of praise or other reinforcers is provided to the learner contingent on correct performance. Further, feedback may also involve further instruction and correction of errors, if needed. Feedback should be provided immediately following rehearsal procedures, and always involved descriptive praise (or other reinforcers) for some aspect of the behavior that was correct. If corrective feedback

is needed for incorrect performance, it should always be preceded by praise. A procedure called in situ training has also been an effective method to promote generalization after training. With in situ training, the trainer sets up an assessment in the natural setting, without the learner's knowledge that he or she is being assessed. If the skills are not performed during in situ assessment, the trainer enters the assessment and turns the assessment into a training session, and the trainer has the learner rehearse the skills (Miltenberger, 2008).

Poche et al. (1982) used instructions, a three-phase modeling procedure, physical guidance, and reinforcement to train preschoolers to brush their teeth. Simple instructions were used to describe each step in the sequence, followed by a three-phase modeling procedure where a trainer would demonstrate correct brushing with exaggerated motions and provide examples of good and poor brushing. After the trainer modeled the step alone, the trainer and child performed the step together, then the child performed the step alone. If during the third phase of the modeling procedure the child exhibited an error in that step, the trainer would then implement physical guidance as a correction procedure and gently wrap his or her hand around the child's hand and moved the brush in the desired motion and angle on the tooth surfaces. As the child displayed the correct response, the trainer's hand was gently removed. The fourth procedure included descriptive praise for a correct component of brushing. To promote efficient acquisition of responding and maintenance of that response, the trainers first used continuous then faded to intermittent schedules of reinforcement when a child exhibited a correct response That is to say, descriptive praise was provided every time a component was

performed at first, and later, descriptive praise was provided after several components were performed correctly. Additionally, if a child completed all 16 steps correctly, they were awarded a star on a chart of brushing steps. Although the labels and composition of these procedures vary slightly from those originally identified by Miltenberger (2008) as behavioral skills training, the procedures implemented by Poche et al. (1982) demonstrate an effective use of behavioral skills training components.

BST is a proven effective method to teach a variety of skills, such as abduction prevention and sexual abuse prevention; and has been extensively used with children (Miltenberger, 2008). BST techniques have also been employed with populations of individuals with autism and intellectual disabilities (Gunby, Carr, & Leblanc 2010; Miltenberger, Roberts, Ellingson, Galensky, Rapp, Long, & Lumley, 1999).

Gunby et al. (2010) employed BST with in situ feedback to train abduction prevention skills to children with autism. Skills were acquired by all the children participating in the study, and maintained at a 1-month follow-up assessment. In addition, one of the three participants was able to demonstrate the skills during an in situ assessment in the community. The success of this study indicates the efficacy of using BST to train skills to children with autism, as well as the potential usefulness of in situ training to promote generalization of taught skills to a natural setting.

A study by Johnson et al. (2006) examined the use of BST alone to BST with in situ training to teach abduction prevention skills to schoolchildren. Although both programs were effective in teaching these skills, the participants receiving in situ training scored significantly higher than those who received BST only at a 3-month follow-up

assessment. Thus, the utility of including an in situ component when using BST to train skills and promote generalization is further supported.

Generalization

Generalization can be defined as the occurrence of relevant behavior under different, non-training conditions, without the scheduling of the same events in those conditions as had been scheduled in the training conditions (Stokes & Baer, 1977). In an example of toothbrushing, generalization will have occurred if the responses exhibited during trainings conducted only at school are also exhibited at home in the learner's natural environment, or any other relevant context (e.g., at grandmother's house). There is currently no available research examining generalization programming for toothbrushing skills in children with special needs. However, generalization techniques of training sufficient exemplars, training loosely, and using indiscriminable contingencies as identified by Stokes and Baer (1977) will be integrated into the current study to promote generalization of taught skills.

Training sufficient exemplars. Training sufficient exemplars has been identified as perhaps one of the most valuable areas of generalization programming. Further, to program generalized responding, trainings should occur across a sufficient number of settings and trainers (Stokes & Baer, 1977). In general, training by two or three experimenters is sufficient to promote generalization (Stokes, Baer & Jackson, 1974).

Training loosely. With training loosely, teaching is conducted with relatively little control over the stimuli presented and the correct responses allowed, so as to maximize sampling of relevant dimensions from transfer to other situations and other

forms of the behavior (Stokes & Baer, 1977). Regarding toothbrushing, different stimuli such as a selection of available toothbrushes and toothpaste can be provided to promote generalization of skills. Further, variations in responding during brushing such as beginning with the outer left upper surfaces of the teeth one session and beginning with the outer right lower of the teeth another session, could promote further generalization of these skills.

Indiscriminable contingencies. When referring to the use of indiscriminable contingencies, the term intermittent reinforcement is referenced (Stokes & Baer, 1977). Intermittent reinforcement is featured by its unpredictability and has been proven particularly resistant to extinction, compared to continuous schedules of reinforcement (Ferster & Skinner, 1957). This resistance to extinction can be regarded as a form of generalization across time; thus promoting generalization through the use of indiscriminable contingencies (Stokes & Baer, 1977). For example, a child receives a reinforcer (e.g., praise, a sticker, piece of sugar free candy) one week on Monday, Wednesday and Friday following toothbrushing. The next week, they receive a reinforcer Tuesday and Friday following toothbrushing, and so on and so forth. In this way, the contingencies for receiving reinforcement are obscure, making it more likely the child will engage in toothbrushing on all provided opportunities to obtain reinforcement (i.e., resistance to extinction).

Reinforcement

Reinforcement is a basic principle of behavior, and defined as the process in which a behavior is strengthened by the immediate consequence that reliably follows its

occurrence. When the occurrence of a behavior is reinforced, it increases along relevant dimensions of behavior such as frequency, duration, or intensity over time. There are several different types of reinforcement and its effectiveness is influenced by different factors, including: immediacy, contingency, establishing operations, individual differences, and magnitude (Miltenberger, 2008). In any case where the desired outcome would be an increase in responding, principles of reinforcement should be applied.

Regarding oral hygiene studies, one of the most effective procedures for producing maintenance of trained skills was through the use of an intermittent schedule of reinforcement (Blount et al., 1989). Swain et al. (1982) implemented a school-based contingency dental hygiene program. In this study, classes from grades one and two were divided into teams and took part in the "Good Toothbrushing Game". The cleanliness of teeth was assessed by mean plaque levels, and the team with the lowest mean was declared the daily winner. Winning teams received stickers and had their names posted in the school. This use of reinforcement with a group contingency proved effective at reducing levels of plaque in both first and second grade classrooms, maintained at 9-month follow-up. Although there were no clear training procedures identified (toothbrushing occurred at home and was measured in school), this study supports the application of reinforcement principles in oral hygiene programs.

Current Study

The field of ABA has advanced technological methods across a variety of domains of social importance, in both in research and clinical settings. Of these domains,

the independent performance of daily living skills and self-care tasks by children with special needs has been identified as particularly important to parents, caregivers, educators and researchers. Independent performance of such skills also provides direct benefit to the individual performing these skills, as it promotes development of autonomy, and maintenance of a functionally adaptive and enriching environment. Toothbrushing is an important daily living skill to acquire independent performance in, as this task is typically performed twice daily to maintain proper oral hygiene. Not only is it important to perform this task, but in order for toothbrushing to truly have functional value, actual toothbrushing must be effective (i.e., reduce levels of plaque). To increase opportunities to acquire effective methods of toothbrushing, systematic training and measurement procedures should be employed. Of the available toothbrushing research, several studies have used a task analysis to objectively measure toothbrushing skills, with various training procedures employed. A limited number of studies implemented reinforcement contingencies, and none specifically addressed the promotion of generalization; although several did complete follow-up assessments to assess maintenance of trained skills.

The current study aimed to extend the literature on the systematic measurement and training of toothbrushing skills in children with special needs. Similarly to previous research, this study utilized a task analysis to objectively measure toothbrushing skills. This study replicated BST training procedures used by Poche et al. (1982), including: instruction, three-phase modeling, physical guidance (if needed), and descriptive praise. Additionally, this study included an in situ training component to assess trained skills and

promote generalization of such skills. The in situ training also included a reinforcement contingency using intermittent schedules of reinforcement to promote strength and durability of engagement in toothbrushing behaviors. Further, the implementation of reinforcement contingencies may have potentially increased the overall reinforcing value of toothbrushing, thus making it more likely for the participant to engage in toothbrushing behaviors in the future under the same or similar conditions. Generalization techniques of training loosely and training sufficient exemplars were also integrated into procedures to promote the generalization of toothbrushing skills to be employed across different settings, with different people, and with different stimuli present in the environment.

Chapter 2:

Method

Participants and Setting

Five students participated in this study, all of whom were enrolled at Sydney's School for Autism in Tampa, Florida. Participants were between 5 and 7-years-old, and had a medical diagnosis indicating special needs; including but not limited to: Autism, Sensory Processing Disorder (SPD), and PDD (Pervasive Developmental Disorder). The participants in this study included four males and one female. To be eligible to participate in this study, each participant met three prerequisite criteria: be able to hold a toothbrush firmly in one hand, follow basic directions and imitate simple fine motor movements.

Sydney's School is a private school for preschool, kindergarten and first grade students. Children with special needs attend this school and typically receive three hours of ABA therapy daily and spend the other half of the school day in an inclusion classroom with typically developing peers. Children receiving ABA therapy services also typically receive other therapy services such as: Occupational Therapy, Speech Therapy, and Physical Therapy. Sessions were conducted in available lavatories at Sydney's School. Two available lavatories included five bathroom stalls, three sinks, one paper towel dispenser and two waste bins. Training and assessments each lasted approximately 15 minutes; collectively sessions lasted approximately 30 minutes.

Materials and Equipment

Materials included a selection of: 3 child size toothbrushes per participant and 4 different gel fluoride tubes of toothpaste to promote stimulus generalization. The use of gel fluoride toothpaste was selected based on recommendations from the ADA (2005). One adult toothbrush was also provided for the trainer. The trainer collected objective data via a task analysis data sheet, a pen and a clipboard. Additionally, a tri-fold mirror was placed behind the sink.

Dependent Variables and Data Collection

The dependent measure of this study was the participant's independent completion of task analysis steps. The hypothesis of this study was that the utilization of a task analysis and BST with in situ training would be an effective and efficient method to systematically measure toothbrushing skills and train children with special needs how to brush their teeth independently.

Task analysis. Participants' behavior was recorded with a task analysis data sheet. The task analysis data sheet consisted of a diagram of each section of teeth (i.e., top-right-outer, lower-left-inner). Data were collected during baseline, assessments, and fading to track the participant's independent completion of each toothbrushing step. If the participant completed a step correctly by meeting the performance criteria described in the procedures, the trainer placed an X in the box next to the appropriate section of teeth. If, during assessment, the participant missed a section of teeth entirely, or did not meet performance criteria, the trainer left that respective box blank. For a description of

task analysis steps and an example of the task analysis data sheet, refer to appendices A and B, respectively.

Parent survey. Adjunct measures of social validity were collected in addition to objective task analysis data. Parents or caregivers were provided with a social validity survey pre and post intervention. The survey included five questions related to levels of social validity as described by Wolf (1978) and also included a section for any additional comments or concerns about the intervention. To view an example of the parent survey, refer to Appendix C.

Reliability

An independent observer was present and collected Interobserver Agreement (IOA) data for 25% of intervention and fading assessments. There was 96.6% overall agreement between the independent observer and the trainer. Agreements ranged between 91%-100% by participant. A reliability observer sat approximately 1 – 1.5 meters slightly behind and to the side of the participant (also to the other side of the trainer) and recorded his or her toothbrushing behaviors using the task analysis data sheet. An agreement occurred when both observers gave the task step the same score (either occurrence or non-occurrence). A disagreement occurred when the observers scored a task step differently. The number of agreements from the independent observer and the primary investigator were divided by the number of agreements plus the number of disagreements, multiplied by one hundred.

Experimental Design

A multiple-baseline-across-subjects design was used to measure the number of steps completed correctly during the assessment portion of the session. With the multiple-baseline design, different baseline and intervention phases occur for different subjects, behaviors, or settings. The baseline of each participant was different lengths, thus intervention was staggered over time. Evidence that the intervention itself, not some extraneous variable, was responsible for behavior change is supported if changes in behavior occur only after intervention begins (Miltenberger, 2008). For example, if during baseline a participant completed on average 3 steps correctly, then during intervention completed 5, then 8, then 10 steps correctly, it is likely this behavior change (i.e., increase in steps completed correctly) is due to intervention, rather than some extraneous variable.

Procedures

Baseline. During baseline, participants were brought into the lavatory and handed a toothbrush with toothpaste on it, and given the instructions: "(Name), brush your teeth the best you can." No consequences were provided for correct (or incorrect) toothbrushing. Baseline sessions ended when the participant no longer manipulated the toothbrush in or around his or her mouth for a period of 30 seconds. The participant was then provided with a cup of water (approximately .88 mL) to rinse his or her mouth, and a paper towel to wipe his or her face.

Intervention. During intervention, the participant was brought into one of the available lavatories at the school. Each session included training and later assessment,

occurring approximately three hours apart. Sessions took place each school day the participant was in attendance until 30 data collection days were completed, or, mastery of task analysis steps was achieved; whichever occurred first. Mastery was achieved when the participant completed at least 80% (10 or more) of the task analysis steps correctly during assessment for three consecutive sessions. Trainings and assessments were conducted by the Principle Investigator.

Task analysis steps were recorded as correct if the participant met three performance criteria: held the bristles at a 45 degree angle to the tooth surface as recommended by the American Dental Association (ADA), brushed the tooth surfaces of the corresponding section for at least 5 seconds collectively, and brushed using a back and forth motion. Ascribing to a "loose training" technique to facilitate generalization (Stokes & Baer, 1977), responses were recorded as correct regardless of the sequence in which the step was completed. For example, if the participant first brushed the inside sections and later brushed the outside sections and bite, rather than beginning with the outside bite section, the responses were still considered correct if they met performance criteria.

Training. Behavioral Skills Training included four major components: instruction, three-phase modeling, physical guidance (as needed), and descriptive praise. For each section of the mouth, the trainer provided a simple instruction describing the current step of the sequence, such as, "You're going to hold the brush like this and brush back and forth for 5 seconds here on the top outside part of your teeth." The trainer then began the three-phase modeling by demonstrating the correct brushing technique;

exaggerating the motions and providing examples of correct and incorrect brushing. Once the trainer modeled the correct step alone, the trainer and the participant performed the step together. Then, the participant performed the step alone. Physical guidance was used as a correction procedure, as necessary, when the participant incorrectly demonstrated the step during independent rehearsal (i.e., the last phase of the modeling component). The trainer gently wrapped her hand around the participant's hand, so that both of them held the brush, and then moved the brush in the back and forth motion with the correct bristle angle. The trainer's hand was gradually removed as the participant displayed the correct response. Descriptive praise was provided to the participant initially after each correct brushing response (i.e., continuous reinforcement). As independent responding by the participant increased, descriptive praise was then delivered after completion of several correct steps (i.e., intermittent reinforcement). Trainings occurred in the morning and assessments in the afternoon.

Assessment. Following previously scheduled lunch times, participants were brought to an available lavatory in the school for an assessment of skills trained earlier that morning. The trainer placed a cup of water and a paper towel on the sink and handed the participant the toothbrush with toothpaste applied (as selected by the participant) and given the same instructions as provided during baseline, "(Name), brush your teeth the best you can." The trainer sat approximately 1-1.5 meters away from the participant and recorded his or her behavior using the tri-fold mirror for observation. Assessment termination mimicked baseline procedures and ended when the participant no longer manipulated the toothbrush in or around his or her mouth for a period of 30 seconds. In

lieu of a star chart as used by Poche et al. (1982), following assessment termination, participants were shown the task analysis data sheet and told the number of and which steps they completed correctly and which steps they missed or completed incorrectly. If the participant missed any step entirely or did not meet performance criteria for a section during assessment, the trainer implemented the steps used during BST for the respective step(s).

Reinforcement. Reinforcement contingencies were implemented at the end of assessments using a Variable Ratio (VR) schedule of reinforcement. Using a VR (4) schedule, the participant was given a selection of tangible reinforcers. Tangibles were various party favor bags filled with novelty dental themed items including: stickers, pencils, and small toys. Reinforcers were kept in a cardboard treasure chest and participants were allowed to select one "goody bag" of his or her preference from the treasure chest. Reinforcers were provided to the participant regardless of the number of steps completed correctly. In this way, the contingencies of reinforcement may have been obscure to the participant (i.e., indiscriminable contingencies), potentially increasing the strength and durability of engagement in toothbrushing responses.

Fading. Approximately one, two, three and five weeks following completion of training (or mastery), participants completed fading assessments. In this phase, trainings did not take place in the morning, and only afternoon assessments were conducted. Conditions in this phase mimicked assessment conditions. The participant was brought into the bathroom, given a toothbrush with toothpaste applied, a cup of water, paper towel, and instructed to brush the best he or she could. Following assessment termination

the participant was given descriptive praise and corrective feedback and shown his or her score on the task analysis data sheet. When the participant entirely missed or did not perform a section(s) to criterion, BST procedures were used, as completed during intervention assessments.

Chapter 3:

Results

Of the five participants, four achieved mastery criteria within 30 days of data collection, within a range of 9-23 training and assessment sessions; as displayed in Figure 1. One participant did not complete any steps independently. An intervention phase change was implemented, but this participant still did not complete any steps independently throughout the duration of the study. This participants' data is displayed separately in Figure 2. Trainings and assessments were terminated following mastery of skills, and for the participant who did not respond to intervention, data collection was terminated on the last day of the school year. Baseline data ranged between 0 and 3 steps across participants. Most independent scores obtained in baseline consisted of the outer top and bottom sections (the section of teeth visible when smiling), across participants. For some participants, other sections were attempted but did not meet criteria, such as not using a back and forth motion or not brushing a section for at least five seconds collectively.

Multiple-Baseline Results

Figure 1 displays the data of the four participants who achieved mastery criteria during the course of the study. Two of the participants exhibited rapid skill acquisition, achieving mastery within 9 and 10 sessions following intervention. The other two participants exhibited slower, incremental increases in skill acquisition between 15 and

23 sessions following intervention. The two participants who exhibited rapid skill acquisition were ages 6 and 7 and assigned to the same first grade classroom. These participants varied in diagnosis but were of similar skill and academic levels. The two participants who exhibited slower, incremental skill acquisition were ages 4 and 5 and assigned to the same kindergarten classroom. One participant left the study due to a family move out of town and was not available for fading assessments. However, this participant achieved mastery criteria by his last day in attendance at the school. Fading assessment results varied by participant and scores were maintained at mastery criteria for one of the three available participants. One participant maintained some of the skills learned, scoring 6 and 5 steps correct in fading assessments. The other participant did not maintain toothbrushing skills during fading assessments and scored similar to baseline scores prior to intervention.

Andrew. During baseline, Andrew would typically attempt several sections of teeth, but not brush to criteria. Baseline levels did not surpass two correct sections. Throughout trainings Andrew's motivation to complete tasks was perceivably high, as he would often request to go brush his teeth whenever he saw the trainer throughout the school day. He also verbally expressed interest in the treasure chest by making comments such as, "If I do a good job, I'm going to get treasure"; even though such a contingency was not indicated by the trainer. He readily complied with the instructions and was able to use proper motor control, motion and duration during modeling and independent rehearsal portions of trainings. Andrew also did not require the use of the correction procedure during trainings.

During assessments, he quickly progressed from baseline levels to eight correct sections for 4 consecutive sessions. However, there was variability in the sections of the mouth he missed. As Andrew's independent skill acquisition increased, he would typically brush each section twice, exceeding duration criterion. For incorrect sections, he would miss sections entirely, typically inclusive to one or several of the outside left or right sections. Within nine intervention sessions Andrew was correctly brushing sections to mastery criterion and achieved mastery by scoring 12, 11, and 12 steps correctly for 3 consecutive sessions. Andrew completed 4 fading assessment sessions approximately one, two, three, and five weeks following mastery. During the first fading assessment he scored 7steps correctly. During this assessment other individual's were in the lavatory possibly acting as extraneous variables effecting performance. For the remaining 3 fading assessments Andrew exhibited mastery criterion and correctly completed 11, 12, and 11 steps respectively.

Derrick. During baseline Derrick correctly brushed between 0 and 3 sections. During intervention, he progressed at a slower pace than Andrew; however he steadily increased in correct brushing with a slight decreasing trend between sessions 20 and 25. On session 21, Derrick engaged in several physical aggressions towards the trainer during training, with an open and closed fist to her arms and torso. Following cessation of physical aggressions, Derrick followed all instructions and scored eight steps correctly in assessment that afternoon. On the following sessions, his level of independent responding increased, and he met mastery criterion by session 30. During trainings, Derrick often needed the error correction procedure to correct the motion of brushing and the angle of

the bristles to the tooth surface. When not using the proper motion, he would often scrape the bristles over the tooth surface instead of using a fluid back and forth motion.

During assessments, Derrick would typically brush the same sections correctly several times. He would often persist brushing the front outside top and bottom, and the left outside top and bottom sections. Some assessments lasted longer than others as Derrick would make faces in the mirror, wrap his mouth around the entire head of the brush or look away from the mirror, although he would typically return back to brushing before the 30 second cutoff criteria was reached. For incorrect sections, he would typically attempt the section but not meet the duration criteria. On some occasions he was not holding the brush firmly in his hand, resulting in improper brush angle and incorrect motion. As the study continued, Derrick was exceeding the duration criteria less and persisting on the outside sections less. Alternatively, he was correctly brushing more of the inside sections and any errors for these sections were typically due to incorrect bristle angle to the tooth surface. However, even as independent brushing increased, he would still engage in incompatible behaviors and exceeded criterion for correct sections by brushing for longer durations than required. Derrick reached mastery criteria by scoring 12, 11, and 11 steps consecutively over 3 sessions, and fading assessments were completed approximately one, two, and three weeks following mastery. Derrick exhibited a decreasing trend during fading assessments, scoring 4, 3, and 2 steps correctly. During fading assessments, Derrick missed sections entirely and reached the 30 second cutoff criteria each time due to engagement in incompatible behaviors.

Tyler. Tyler consistently scored zero levels during all baseline sessions. On several days of baseline data collection, if Tyler attempted to brush a section, it was the front bite, typically the bottom, but only for 2 to 3 seconds in duration. During baseline he would typically turn to the trainer and ask questions or make comments such as, "How do you do it?", "I don't know how to brush, can you show me how?" "Do you brush on your head?" "No" "Do you brush on your arm?" "No" while shaking his head no, smiling and laughing. He would also mimic brushing "on his head" and "on his arm" when making such comments. When Tyler engaged in such behaviors, the trainer kept her head down (would put head back up once the participant turned back toward the mirror) and did not make any comments or answer any of Tyler's questions. Several times Tyler was aware no attention was going to be delivered and would say, "Awww" and turn back around; typically to brush one front section for 2 to 3 seconds then stop manipulating the brush in his mouth. Tyler consistently engaged in these repertoires throughout baseline.

During training periods, Tyler exhibited proper motor control, motion and duration during modeling and independent rehearsal, and rarely required the correction procedure. Over the first 6 sessions of intervention assessments Tyler would correctly brush between 1 and 3 sections, typically the front outside top and bottom and either of the remaining outside sections of teeth. However, he would also engage in attention seeking behaviors such as asking for help, shaking his head saying, "No, I don't want to brush my teeth.", frowning, throwing his head back, and lightly stomping his feet on the floor. Following session 6, Tyler's compliance with instruction improved, and he exhibited a slower, incremental progression of skill acquisition. On several assessment

sessions, he walked over to the trainer and attempted to see how many X's he received on the data sheet. The data sheet was not visible to him and after the trainer put her head down; he turned back towards the mirror and continued to brush his teeth. For the sections Tyler did not complete correctly during assessments, he would typically attempt all the sections in his mouth but only brush for 2 to 3 seconds, similar to baseline behaviors. He did however exhibit the proper back and forth motion and angle of the bristles to the tooth surface consistently. Tyler reached mastery criteria by session 15 and scored 10, 12, and 12 steps correctly for 3 consecutive sessions. Tyler was not available to collect fading assessment data.

Sean. During baseline, Sean would consistently brush only his tongue, scoring zero nearly every baseline session. On one session, he brushed the front outside top section of his teeth but never attempted any other sections throughout baseline. During trainings, Sean consistently followed instructions and was able to independently exhibit criterion behaviors. The correction procedure was rarely needed during training, but when used, required correction of the angle of the bristles to the tooth surface or correction of the back and forth motion.

During assessments, Sean progressed quickly, similar to Andrew's rate of correct responding. On sessions where Sean scored 6 steps correctly, he first brushed the inside left and right sections, and either the inside or outside front (bite) sections. He brushed these sections twice, but neglected other sections of the mouth. When Sean scored between 9 and 11 steps correctly, he would typically forget to brush either the top outside left and right sections and/or the inside top and bottom sections. Similarly to Tyler, Sean

attempted to gain the trainers attention during some assessments to try to see how many X's he received on the data sheet, but turned around and continued brushing after the trainer put her head down. Sean also exhibited behaviors similar to Derrick by gazing away from the mirror, although he would continue brushing at the same time. Sean also perseverated on certain sections, brushing sections for 10 to 15 seconds each, but neglected other sections entirely. Sean reached mastery criteria after 10 intervention sessions, scoring 10, 11, and 11 steps consecutively over 3 sessions. Two fading assessments were completed approximately three and four weeks following mastery. Sean did not maintain mastery of skills, and scored 6 and 5 steps correctly during fading assessments.

Intervention with Phase Change Results

Lauren. Figure 2 displays the data for the participant who did not respond to the intervention. For this participant, an intervention phase change was implemented on session 9 and data collection then consisted of measures of prompt levels needed to complete each section (i.e., independent, gestural/verbal prompt or physical prompt). Trainings and assessments in this phase were conducted in the same fashion by using a least-to-most prompting method. On session 14, Lauren began an escape-extinction procedure with her usual ABA therapist to decrease urination refusal. This intervention interfered with training and assessment times and lasted the duration of the study. Following session 14, data were collected during scheduled training times as not to interfere with escape-extinction procedures being implemented during previously scheduled ABA therapy in the afternoon.

Consistently each time Lauren was given the opportunity for independent performance across baseline, training, and assessments, she would grasp the toothbrush with two hands and flick it towards and away from her. If the toothpaste tube was on the sink she would also attempt to manipulate it in the same way. Throughout trainings and assessments Lauren would consistently engage in escape and avoidance behaviors by a combination of falling to the ground, gazing away from either the trainer or mirror, laughing, attempting to run out of the bathroom or hiding in the corner and pushing her arm and hand away from her mouth when physical prompts were being attempted. Over the course of this study, duration and frequency of escape and avoidance behaviors exhibited decreased, yet formal data collection consisted only of prompt level and duration and frequency data based on escape and avoidance behaviors is anecdotal. Following the intervention phase change, she did not exhibit any increases in independent responding and physical prompts were primarily required to complete each section. On two sessions, only verbal and gestural prompts were needed to complete one outside section. However, this behavior did not persist and Lauren would consistently engage in flicking the toothbrush if given the opportunity. Thus, both intervention and intervention phase changes were unsuccessful at increasing independent toothbrushing skill acquisition for this participant. Trainings and assessments for this participant were terminated following the last calendar day of the school year, and fading assessments were not completed for this participant.

Social Validity Survey Results

Parent survey. The results of the parent survey are displayed in a bar graph represented in Figure 3. For both pre and post intervention surveys, parents responded the same for questions 1 through 4. These questions represented parents' ratings of skill acquisition, training, generalization, and reinforcement, respectively. Scores for these questions ranged between 4 and 5 across participants, on a 5-point scale. A score of 1 represented strong disagreement with a question, and a score of 5 represented strong agreement with a question. Thus, parents' ratings of these questions represented either agreement or strong agreement with behavioral principles relating to skill acquisition, training, generalization, and reinforcement. Question 5 of both pre and post intervention surveys represented parents' ratings of their child's current level of independent toothbrushing. Of the parents who responded to the post intervention survey, responses to question 5 increased across all participants. For Tyler, question 5 responses were 3 in the pre-intervention survey and 4 in the post-intervention survey. For Derrick, question 5 responses were 3 in the pre-intervention survey and 5 in the post-intervention survey. For Sean, question 5 responses were 2 in the pre-intervention survey and 4 in the post-intervention survey.

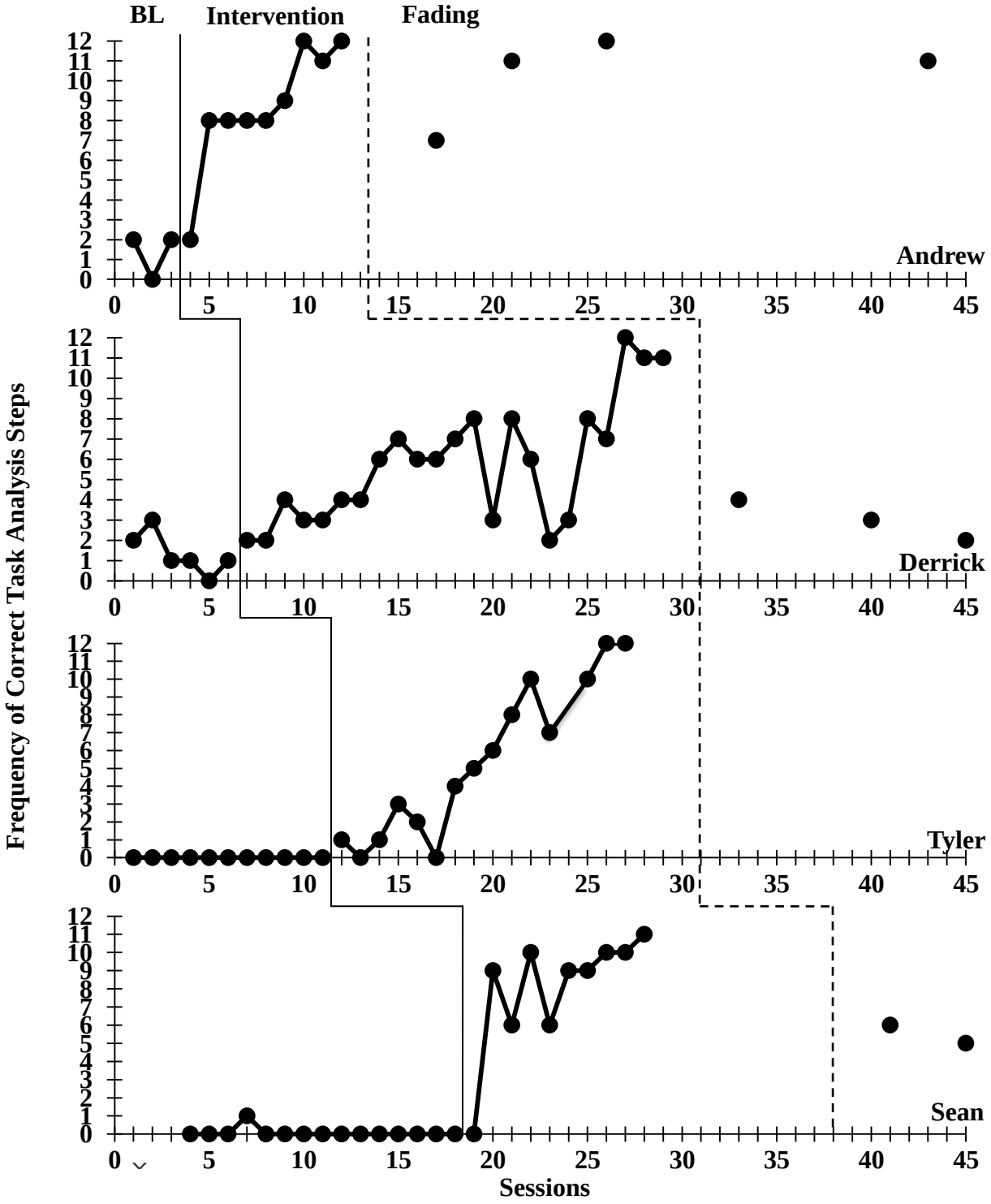

Figure 1: Multiple-Baseline Results. Results indicate independent skill acquisition across participants, all reaching mastery criteria in less than 25 intervention sessions.

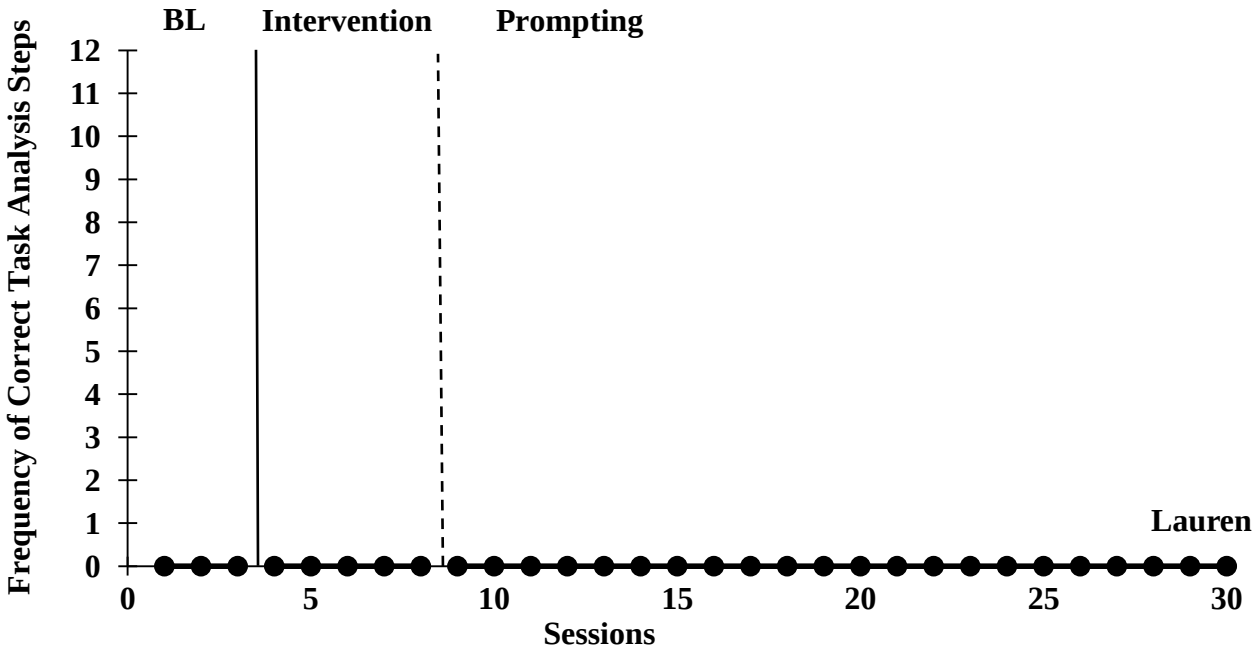

Figure 2: Intervention with Phase Change Results. Figure 2 data represents the participant who did not respond to intervention or intervention phase change when least-to-most prompting was implemented. Intervention phase change was implemented on the sixth intervention session and continued until the last day of the calendar school year.

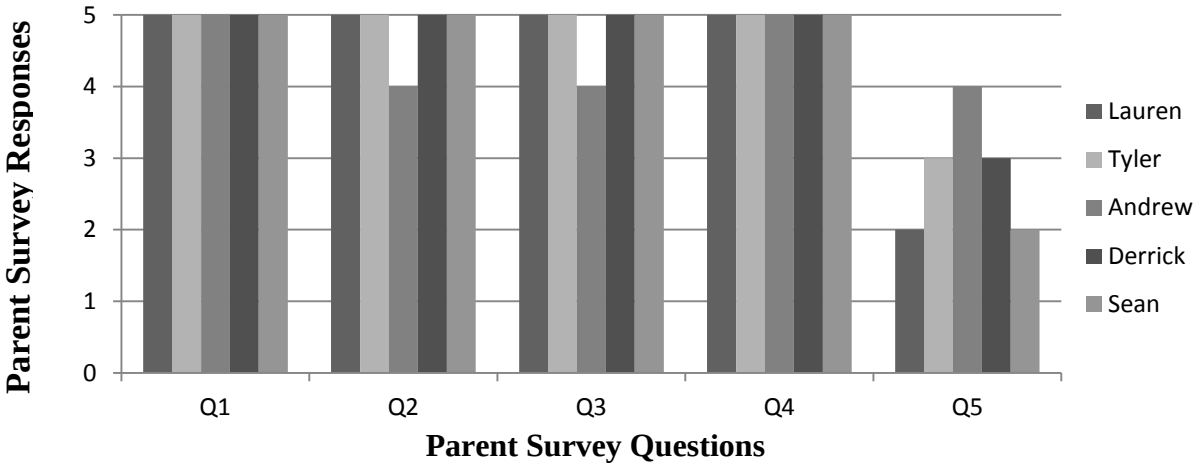

Figure 3: Social Validity Pre-Intervention Parent Survey Results. Figure 3 shows the pre-intervention parent survey results. The x-axis represents survey question, while the y-axis represents parent responses. Questions addressed topics related to social validity. Refer to Appendix C for survey questions.

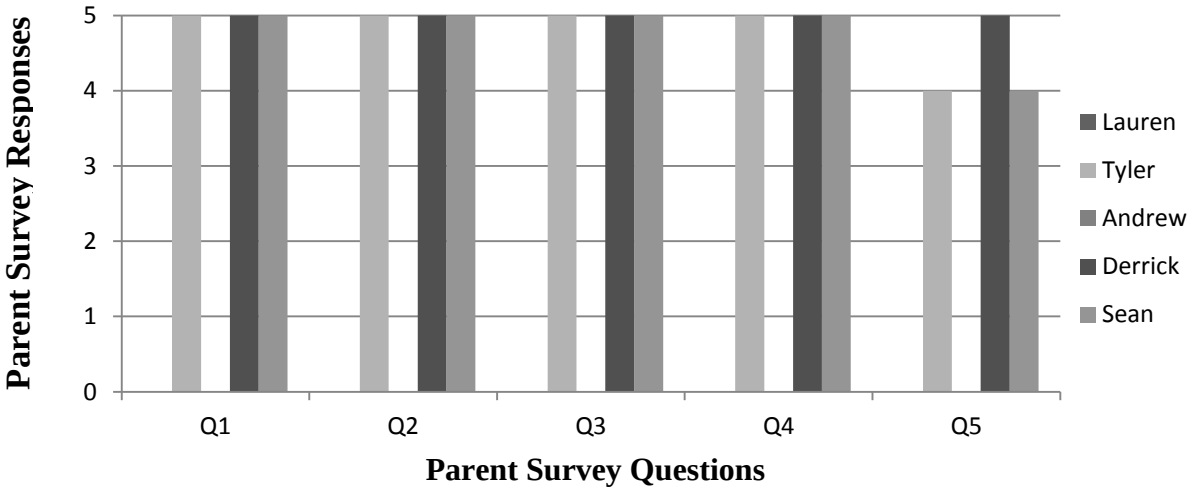

Figure 4: Social Validity Post-Intervention Parent Survey Results. Figure 4 represents the post-intervention parent survey results. The x-axis represents survey questions, while the y-axis represents parent responses. Two parents did not complete the post-intervention survey.

Chapter 4:

Discussion

The hypothesis that the utilization of a task analysis and BST with in situ training would be an effective and efficient method to systematically measure toothbrushing skills and train children with special needs how to brush their teeth independently was supported with four of the five participants in this study. Results of this study were similar to those of Poche et al. (1982) who trained typically developing preschoolers using the three-phase modeling technique and task analysis of teeth sections, as replicated in the current study. Comparatively, two participants in the current study exhibited much more rapid skill acquisition than those in Poche et al.'s (1982) study. However, the two participants who acquired mastery of skills in less than 10 sessions were 3-5 years older than the participants in Poche et al.'s (1982) study; albeit with a medical diagnosis indicating special needs. Variables such as learning and reinforcement histories, motor imitation skills, verbal language skills, and receptive instruction repertoires could have all contributed to the ability for these participants to acquire taught skills at a faster pace than younger children. The other two participants for which intervention was successful more closely resembled Poche et al.'s (1982) findings. These participants exhibited slow and relatively stable incremental skill acquisition over the course of the study. These participants were between ages 4-5 and may have had similar skill levels to those in Poche et al.'s (1982) study. For the participant who did not respond to the initial

intervention or phase change, variables such as sensory stimulation and motivation may have effected responding. The utility of the procedures, considerations for special needs populations, limitations, and directions for future research are all discussed.

Utility of Procedures

The procedures employed in this study consisted of BST using a three-phase modeling technique to train skill acquisition and a task analysis to objectively measure it. The success of the intervention supports not only the use of such techniques to train toothbrushing skills, but possibly a range of daily living skills across populations; including both typically developing individuals and those with special needs. This particular intervention also did not require extensive amounts of time, training, or resources to carry out; and could be employed in a school setting with relatively little impact on daily classroom (and therapy) routines or school budgets. The use of a tri-fold mirror behind the sink was also cost-effective and enabled the trainer to collect data at a distance, behind the participant, without an obstruction of vision of the participants' mouth and toothbrushing behaviors, and without sitting directly next to or slightly in front of the participant. However, it was beneficial to have the trainer present for data collection as she was able to provide immediate feedback and correction procedures to the participant, if needed, directly following assessment terminations. Another aspect of training that may have accounted for the success of the intervention would be that trainings and assessments were completed every school day the participant was in attendance over the course of the study. The repetition of training procedures and daily practice of skills could have accounted for increases in skill acquisition over the course of

intervention. This claim is further supported by the four participant's mastery of skills in less than 25 sessions overall.

Limitations and Future Directions

Unobtrusive measurement and reliability. At the inception of the study, an in situ assessment was intended to be employed for data collection of task analysis steps. The trainer was intending to remain unobtrusive during assessment periods. However, given the setting of the current study and method of data collection (pen and paper); a true in situ assessment could not be utilized. It is evident that the trainer was a salient stimulus during assessments because the participants would walk towards the trainer and ask questions, make comments and seek eye contact. In fact, Andrew, Tyler, and Sean all made comments about receiving checks and attempted to see the data sheet before assessment termination on several sessions. Such behaviors indicate a level of awareness of an observer, and could have unintentionally influenced performance by creating a social contingency. To reduce the likelihood of such extraneous variables, future studies could employ the use of less obtrusive data collection methods, such as a video camera. This method of measurement may lead to more reliable data as well, as the recorded behaviors can be coded for exact duration, angle and motion of brushing. Videos can be played several times to ensure reliability of data, whereas live data collection may create more possibility for error. For instance, if the trainer looks down even for a second or two to mark a box on a data sheet, the participant may have been brushing a section to meet criteria, but a variable such as the duration could be recorded incorrectly if the participant was brushing a section during the seconds the trainers attention was diverted

and the trainer did not include those seconds when measuring completion of that step. In this study, most often each participant would brush sections completed correctly several times, far exceeding the duration criterion set in place. Such perseverations may be unique to this population. Measures of plaque could also be an effective way of eliminating the need for a live observer. Plaque measures could provide a permanent product e of effective brushing and the participants could be provided with the opportunity to brush their teeth alone in the bathroom prior to plaque readings. It should be noted that plaque measures were not included in this study as were in Poche et al.'s (1982) study due to the sensory sensitivities experienced by many children with special needs. Future studies would benefit from the use or comparison of these different methods of data collection when measuring toothbrushing behaviors.

Training and assessment considerations. During trainings, the front outside sections were brushed first, then the remainder of the outside sections, followed by the inside sections. The left outside and inside sections were typically brushed first as the trainer is left handed. For the exact order of steps taught during trainings, refer to Appendix A. Although the order of steps completed did not determine the participant's score during assessment, it would be useful to examine the success of the intervention with this population had the order of step completion effected scoring, as done in Poche et al.'s (1982) study. If the behavior were trained and assessed in a systematic order, a stimulus-response chain may develop over time; potentially reducing the likelihood of a participant missing entire sections of teeth during assessments. Learning new skills and completing tasks in a routine and systematic order may be easier to remember and thus be

effectively executed, and future studies should seek to examine effects when order is and is not a controlling variable.

Another training consideration would be the systematic use of fading within intervention. Although fading assessments were conducted following mastery of skills, specific programming for fading was not implemented, and assessments were taken on arbitrary days between 1-5 weeks following mastery. The use of a more systematic fading procedure may have increased the likelihood that participants would maintain mastery of skills over time. For instance, a trainer could provide trainings every day until a certain performance criteria is reached, for example, every 3 step increase, then begin to fade trainings to every other day, every 3 days, every week, etc. until mastery is achieved and maintained. Future research would benefit from the development of a systematic fading procedure integrated into this intervention to enhance maintenance effects of learned skills.

During assessment times, the trainer would sit behind and to the side of the participant, but not engage with him or her other than to give the instruction, "Brush your teeth the best you can." Following assessment termination, the trainer would then provide feedback and training for incorrect steps, as needed. However, during the actual assessment time when data was being collected, the trainer did not provide any feedback or prompting. Given that most of the participants engaged in diverted attention in some form throughout the study; an effect that is apparent in this population, it would be useful to examine the use of verbal and/or gestural prompts as a redirection back to the task during assessment times when considering the use of these procedures in the future. It is

likely that prompts are provided when toothbrushing occurs in the home, and a trainers redirection during assessment could mimic a parent's instruction to, "Go brush a little bit more", for example. Further, the ADA recommends that parents provide assistance to children when brushing teeth until the age of 7, supporting considerations to consider different assessment methods, including prompting and fading, in future interventions.

Generalization and maintenance. Although generalization was not specifically measured in this study, methods to increase the likelihood of generalization were integrated into the procedures; such as providing the participant with a selection of toothbrushes and toothpastes. The actual effects of such variables and the performance of each participant in the home is unknown, but information provided in the comments box of the parent surveys indicate changes in behavior were generalized to the home environment. It should be noted that current maintaining contingencies in the home could make independent toothbrushing more or less likely to occur in the future, following cessation of the intervention, and could account for decreases in responding.

The maintenance of mastered skills was variable by participant. Sean scored 6 and 5 steps correctly during fading assessments, not maintaining mastery of skills over a period of approximately three weeks. His parents reported that he can brush on his own now, but prefers if they do it for him. In this case, the functional value of independent toothbrushing is reduced when in the home. If the trained skill is not being completed daily or is no longer a part of the individual's repertoire, the strength of the response decreases over time and could account for reductions in responding during fading assessments. Derrick also did not maintain mastery of skills over a period of

approximately four weeks, although his caregiver reported he is, "doing a great job brushing his teeth independently" and gave a score of 5 (strongly agree) to question 5 of the parent social validity post-intervention survey. Although his performance did not maintain during fading assessments with the current controlling variables of the school setting, the information obtained from the survey does indicate a generalization of skills to natural maintaining contingencies occurring in the home. Alternatively, Andrew did maintain mastery after approximately five weeks of fading assessments, although his performance in the home is unknown. Tyler was not available for fading assessments, but his parent did report that he is brushing independently and gave a score of 4 out of 5 on the post-intervention survey.

Future studies should seek to systematically program for generalization and maintenance, potentially by training parents to implement procedures in the home, completing trainings and assessments in the home, or comparing choice versus no choice responding options during intervention.

Considerations for Special Needs Populations

As is the case with many children with autism and related disorders, difficulties in attention to tasks, comprehension of verbal language and socially mediated behavior in general are apparent and can hinder development and skill acquisition across a variety of domains, including: academics, verbal language, social skills and imitation skills; to name a few. Within this study, variables such as diverted attention, stimulus control, sensory defensiveness, and reinforcement may have influenced participant's responding.

Diverted attention. Often times, children with special needs have difficulty maintaining continuous attention towards a task or skill; inhibiting fluent completion or promoting a perceived need for assistance. These individuals may have the ability to complete such tasks, but may fail to do so because they lack the attending skills necessary to fluently complete the task independently. When provided opportunities for independent responding within this study, obstructing variables such as diverted attention were apparent in four of the five participants. Lauren would consistently engage in incompatible behaviors such a flicking the toothbrush back and forth with her hand(s), and Derrick would often gaze away from the mirror, make faces in the mirror, wrap his mouth around the toothbrush, or scrape the bristles of the toothbrush along the bottom of the sink faucet. In this way, attention was not directed toward the task (i.e. completing toothbrushing steps practiced in training that morning), but towards some other controlling variable. Participant's perseveration on sections may also be accounted for as a form of diverted attention. For sections Derrick scored correctly in assessments, he would often brush these sections several times throughout the assessment, but miss other sections entirely. Sean would typically brush each section in methodical order each assessment, and often began brushing the inside sections first, and then completed the outside sections. On two sessions his performance was exactly the same and he completed all the inside sections and outside bite sections, but missed brushing the other sections entirely. For the sections Sean completed correctly, he would typically brush exceeding duration criterion by 10-15 seconds. Andrew also exhibited a form of perseveration during assessments by brushing each section two to three times. In this

way, instead of fluently completing each step to criterion and completing the task, certain sections were brushed several times and others missed entirely; prolonging overall task duration and potentially influencing correct independent responding. Future studies should seek to evaluate training and assessment methods to reduce the likelihood of such behaviors during task completion.

Stimulus control. Children with special needs often receive therapy services ranging in specializations on a regular basis every week, and often times, every day. Learning histories associated with following instructions and completing tasks delivered by an adult could have accounted for the overall compliance of participant's during training procedures. Regarding stimulus control, or lack thereof, behaviors such as task avoidance and task refusal may have been less likely to occur if trainers consisted of individuals the participant had developed a learning history of delivery of and compliance with instructions; such as parents and current therapists. These individuals would likely also have longer histories of reinforcement and they themselves are likely conditioned reinforcers operating as a discriminative stimulus evoking task completion repertoires such as compliance with instructions and attention to a task; reliably consequated by some form of reinforcement. Although the trainer in the current study was familiar with each participant, she had no history of working in a 1:1 context with any of the participants, which could have accounted for occurrences task refusal. For example, Tyler exhibited task refusal occurred during intervention session 1-6. His current therapist collected IOA data on the sixth intervention assessment, observed his behaviors, and reported her observations to his mother. It is unclear what extraneous variable

accounted for Tyler's compliance following session 6, but it is perceived that a conditioned stimuli/reinforcer (i.e. his mother) influenced future responding. Future research would benefit from comparative analyses of novel vs. conditioned trainers to evaluate any differences in intervention effects.

Sensory defensiveness. Another variable to consider when evaluating intervention effectiveness within this population is that of sensory stimulation. Children with autism and related disabilities often experience heightened levels of sensory sensitivity when compared to their typically developing peers; often referred to as sensory defensiveness. Regarding toothbrushing, a behavior such as brushing the bristles of the toothbrush against the tooth surface may create establishing operations making escape and avoidance behaviors more likely to occur, based on histories of reinforcement and punishment of the learner. While issues of sensory defensiveness may not create an impediment for all individuals with special needs, it is perceived that this variable will affect intervention effects in some portion of these populations, as supported by Lauren's lack of skill acquisition over the course of the study. It is possible that the reason she engaged in escape behaviors so frequently was not to escape compliance with a task, but to escape the sensory experience of toothbrushing. During training sessions throughout intervention, Lauren consistently did not follow instructions to brush sections of teeth, during both phase two and phase three of the modeling procedures. Thus, the correction procedure was needed throughout each training session, and typically for each section of teeth. At these times, Lauren would hold the toothbrush in her hand with the correct bristle angle, but would not bring the brush close enough to touch her mouth, teeth, or

gums. When the correction procedure was used, Lauren would tighten her grip on the toothbrush and her arm muscles and attempt to push the brush away from her mouth. Training times for Lauren were typically longer than the average 15 minutes, as the trainer would wait for Lauren to not have a tightened grip and tensed arm muscles before the correction procedure was used, and the respective section of teeth was brushed. It should be noted that the teeth in Lauren's mouth were ground down and the bristles of the toothbrush would mostly touch the gums of her mouth. Therein lies the potential for sensory defensiveness as a controlling variable. The sensory stimulation caused by brushing bristles along the gums may have been operating to make compliance with instructions less likely to occur during training sessions. Had Lauren a full set of teeth in her mouth with little bristle to gum contact, the value of engaging in escape behavior during training sessions may have been reduced.

During the session Derrick engaged in physical aggressions towards the trainer, the correction procedure was needed for several steps during training. It is also possible that the stimulation experienced with the error correction procedure may have evoked escape behaviors in the form of physical aggressions with Derrick. In this way, the topography of the behavior may vary (i.e. tensed muscles vs. physical aggression) but the function may be the same. Future research could benefit from evaluations of methods to systematically reduce levels of sensory defensiveness in this population. Research of this type would be especially useful if directed toward interventions involving daily living skills and some form of sensory stimulation such as brushing one's teeth or washing one's face.

Reinforcement.

Automatic (sensory) reinforcement. Staying on the topic of sensory stimulation, the variable of sensory, or automatic, reinforcement should also be examined. As was the case with Lauren, the value of sensory reinforcement received from engaging in behaviors such as flicking the toothbrush back and forth competed with skill acquisition considerably. So much in fact, that consistently when provided with an opportunity for independent responding she would choose to engage in flicking the toothbrush over completing toothbrushing steps. Establishing operations such as satiation and deprivation could be manipulated to make engagement in competing stimulatory behaviors more or less likely to occur. Future studies should also seek ways to adapt the procedures to be successful in populations of children with autism whose value of sensory reinforcement outweighs the value of other types of reinforcement.

Social positive reinforcement. Automatically reinforcing behaviors that potentially hindered skill acquisition for Lauren and Derrick, such as gazing away from the mirror or flicking the toothbrush back and forth, were not apparent in other participants. In fact, on several occasions Andrew and Tyler indicated reinforcing value of the goody bags by specifically asking when they would receive one next, on sessions following the first delivery of tangible reinforcement. Sean and Derrick did not verbally request the goody bags, but immediately prior to goody bag selection, their behaviors indicated sought reinforcement by appropriately waiting for the treasure chest to be taken out of the closet, orienting their body and eye contact towards the trainer and treasure chest, as well as peering into some of the available bags to see what was inside, reliably

followed by an independent selection of the preferred bag. This tangible reinforcer was delivered on a variable ratio schedule, and was not contingent on toothbrushing performance. It would be interesting to see any difference in responding, had the delivery of reinforcement been contingent on correct performance or meeting specific criteria.

Social reinforcement was also delivered during trainings and assessments to follow the BST component of descriptive praise or, feedback. As with Poche et al. (1982), feedback was delivered first continuously for each step rehearsed correctly and later intermittently when several steps were rehearsed correctly. This form of social reinforcement may have differentially reinforced correct brushing and the continuous and intermittent reinforcement received may have made correct brushing responses more likely to occur during both training and assessment times. Future studies could compare different schedules and types of reinforcement, given other proven successful training and measurement variables (e.g., BST with 3-phase modeling and a task analysis) remain consistent across participants.

Functional reinforcement. The tangible reinforcers delivered following assessments were perceived to have functioned as reinforcers for the participants who responded to the intervention. However, this evidence is anecdotal based on the behaviors of the participants described above. Formal evaluations of reinforcer effectiveness were not employed in this study, so the value of social positive reinforcement, either by praise or tangibles, making correct toothbrushing more likely to occur in the future, cannot be unequivocally determined. Given the verbal and physical

behavior of the participants throughout the study, it can be inferred that the goody bags and/or social praise were reinforcing the participants' independent completion of toothbrushing steps, and may have also contributed to their motivation to follow instructions and complete tasks. In Lauren's case, social positive reinforcement did not have an effect on independent responding, leading to the topic of functional reinforcement. A reinforcer is reinforcing because an organism is likely to engage in a behavior or set of behaviors that will bring them into contact with that reinforcer again. The true value of a reinforcer can best be determined by the organism seeking it, at that moment in time. So, if a goody bag has no value to an individual, it is possible that being able to flick a toothbrush back and forth intermittently throughout trainings, or before and after assessments, could increase the likelihood that independent toothbrushing will occur in the future. The evaluation and utilization of functional reinforcers embedded into the training procedures of this study could provide useful evidence to increase the effectiveness of these procedures, and should be considered for future research topics.

Conclusion

The efficacy of BST to train skills and a task analysis to measure responses has been extended to different populations based on the findings in this study. Not only did four of five participants achieve mastery criteria, but parents who responded to social validity post-intervention surveys all reported increases in their child's independent toothbrushing skills. Several limitations and future directions have been presented to guide further development of effect daily living skills interventions targeted at children with special needs within the field of Applied Behavior Analysis.

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Appendix A

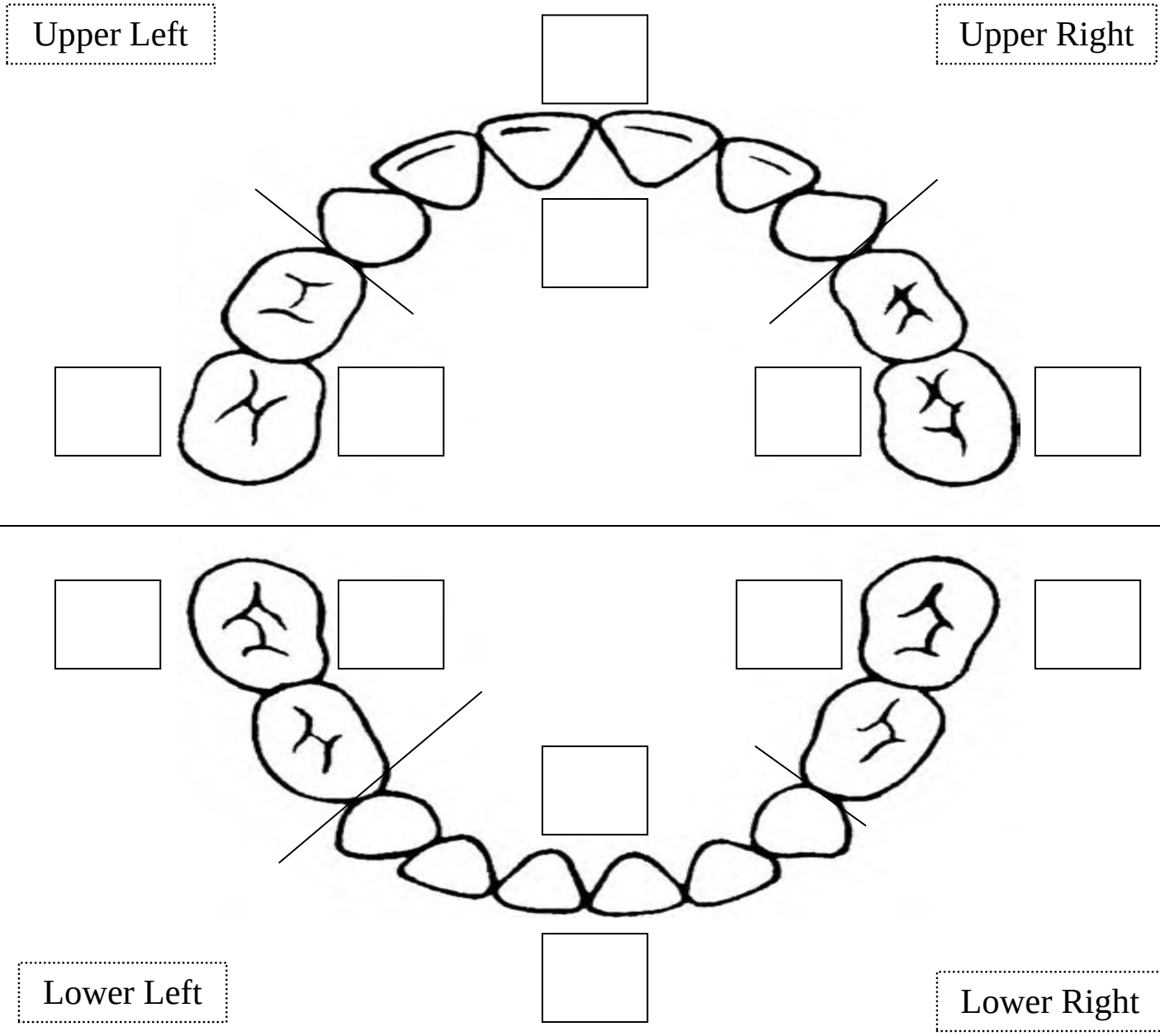
Task Analysis Toothbrushing Steps

There are 12 sections of the mouth that were measured, listed below. The order of steps completed did not matter for scoring purposes during assessments. However, the steps listed below are in order they were completed during trainings.

1. BITE – OUTSIDE – TOP
2. BITE – OUTSIDE – BOTTOM
3. LEFT – OUTSIDE – TOP
4. LEFT – OUTSIDE – BOTTOM
5. RIGHT – OUTSIDE – TOP
6. RIGHT – OUTSIDE – BOTTOM
7. LEFT – INSIDE – BOTTOM
8. RIGHT – INSIDE – BOTTOM
9. LEFT – INSIDE – TOP
10. RIGHT – INSIDE – TOP
11. BITE – INSIDE – TOP
12. BITE – OUTSIDE – BOTTOM

Appendix B

Task Analysis Data Sheet



Appendix C

Social Validity Parent Survey

Please circle the choice that best represents your opinion. Below a box is provided for additional comments, questions or concerns. If needed, you will be contacted by the principle investigator to have any questions answered and address any concerns you may have. Thank you for your participation and feedback!

Strongly Disagree	Disagree	Neither Agree Nor Disagree	Agree	Strongly Agree

1. It is important for my child to learn how to brush his or her teeth.

1 2 3 4 5

2. It is important for my child to have toothbrushing skills specifically trained.

1 2 3 4 5

3. It is important for my child to use learned skills in his or her natural environment (ex: use toothbrushing skills trained at school in the home).

1 2 3 4 5

4. It is important to praise appropriate and desirable behaviors.

1 2 3 4 5

5. My child is able to brush his or her teeth independently.

1 2 3 4 5

Comments, questions or concerns: