Implementing Precision Teaching With Students With Moderate to Severe Disabilities

DISSERTATION

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By

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Abstract

The main focus of this dissertation is implementation of precision teaching with students with moderate to severe disabilities. This dissertation contains an introduction that provides an explanation of precision teaching and discusses the problem addressed by this dissertation. After the introduction there are three stand-alone papers. Chapter 2 is a literature review that evaluated the research base for using precision teaching with students with moderate to profound disabilities. The findings of the literature review were used to develop a research study to extend the research literature related to frequency building and Big 6 + 6 skills within the context of precision teaching. Therefore, Chapter 3 is a research study that examined the impact of frequency building on the performance of fine motor activities for students diagnosed with autism. Chapter 4 is a practitioner paper that was developed by incorporating the methods and results of the research study conducted in chapter 3. This paper provides teachers and practitioners with guidance on how to incorporate frequency building in the classroom for students with moderate to profound disabilities. Chapter 5 concludes this dissertation with a research statement that summarizes my research and provides an outline of my plans for future research.
This dissertation is dedicated to Blake for the support and dedication he provided to me over the past 3 years in fulfilling this accomplishment.
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# Table of Contents

Abstract ................................................................................................. ii

Acknowledgments ................................................................................ iv

Vita ....................................................................................................... v

Publications ............................................................................................ v

Fields of Study .................................................................................. vi

List of Tables ......................................................................................... ix

List of Figures ...................................................................................... x

Chapter 1: Introduction .......................................................................... 1

Chapter 2: Literature Review ............................................................... 13

Chapter 3: Research Paper .................................................................. 48

Chapter 4: Practitioner Paper .............................................................. 96

Chapter 5: Research Statement ........................................................... 114

References ........................................................................................... 124

Appendix A: Consent Form ................................................................. 130
Appendix B: Task Analysis Data Sheet for Pouring Soap ............................................. 135
Appendix C: Treatment Integrity Data Sheets ............................................................. 137
Appendix D: Reinforcement Assessment for Individuals with Severe Disabilities
(RAISD) .................................................................................................................... 141
Appendix E: Multiple Stimulus Without Replacement Data Sheet ......................... 144
Appendix F: Timing Probe Data Sheet .................................................................... 146
Appendix G: Frequency Building Data Sheet ......................................................... 148
List of Tables

Table 1. Characteristics of participants in each study included in the review by reference ................................................................. 25

Table 2. Description and results of each study ................................................................................................................................. 26

Table 3. Sample list of academic skills to target with frequency building developed from Johnson & Street (2013) ................................................................................................................................. 107

Table 4. Sample goals and materials to use for Big 6 + 6 skills developed from Fabrizio et al. (2001) and McManus (n.d.) ................................................................................................................................. 110
List of Figures

Figure 1. Responses per minute during timing probes for Adam ........................................... 65
Figure 2. Standard Celeration Chart of responses per minute during timing probes for
Adam’s left hand ......................................................................................................................... 66
Figure 3. Standard Celeration Chart of responses per minute during timing probes for
Adam’s right hand ...................................................................................................................... 67
Figure 4. Highest response per minute during each frequency building session for Adam
.................................................................................................................................................. 68
Figure 5. Percentage correct and duration of pouring soap for Adam ............................... 71
Figure 6. Responses per min during timing probes for Kallie ......................................... 74
Figure 7. Standard Celeration Chart of responses per minute during timing probes for
Kallie’s left hand .......................................................................................................................... 75
Figure 8. Standard Celeration Chart of responses per minute during timing probes for
Kallie’s right hand ......................................................................................................................... 76
Figure 9. Highest response per minute during each frequency building session for Kallie
.................................................................................................................................................. 77
Figure 10. Percentage correct and duration of pouring soap for Kallie ........................... 78
Figure 11. Responses per minute during timing probes for James .................................. 80

x
Figure 12. Standard Celeration Chart of responses per minute during timing probes for James’ left hand ................................................................. 81

Figure 13. Standard Celeration Chart of responses per minute during timing probes for James’ right hand ................................................................. 82

Figure 14. Highest response per minute during each frequency building session for James ........................................................................................................... 83

Figure 15. Percentage correct and duration of pouring soap for James......................... 85
Chapter 1: Introduction

Precision teaching is the process of measuring learning and performance and using data from the Standard Celeration Chart (SCC) to guide decision-making (Kubina & Yurich, 2012). Lindsley (1990) and the teachers who worked with him, developed precision teaching by applying the free-operant conditioning work of B. F. Skinner to the classroom to identify effective applications with students. The focus on measuring rates of responding (also referred to as frequency) and the cumulative recording of responses are what separate the precision teaching data collection system from other forms of collecting data and directly link precision teaching to Skinner’s free-operant conditioning research (Lindsley, 1991).

Precision teaching is not a specific intervention or curriculum to use with children, rather it is the process of measuring behavior and using the data to guide decision-making (Kubina & Yurich, 2012; Lindsley, 1992). This process involves four steps: pinpointing, recording, changing, and trying again. Pinpointing refers to selecting the observable behavior of interest and encompasses the procedures used to identify and describe these skills in order to reliably measure them. Recording involves daily measurement of the target behavior(s). This record is created by plotting the data on the SCC and using frequency as a measure of the pinpointed behavior. Changing is the third
step, and it results in precision teachers changing the learning environment to improve learner performance. In this step, precision teachers monitor the data daily to determine what changes, if any, need to be made to the learning environment in order to accelerate learning. Trying again refers to continuing to make changes and modifying additional variables as needed if or when the initial change does not work to improve learner performance (Kubina & Yurich, 2012).

Kubina and Yurich (2012) conceptualize precision teaching as a system that has elements that combine to serve different functions. These functions are not necessarily unique to precision teaching, but they should make precision teaching a viable option for those who teach and aim to impact the learning of others. Progress monitoring, problem solving, making discoveries, and differentiating instruction are four of the functions of precision teaching (Kubina & Yurich, 2012).

Progress monitoring is achieved with precision teaching by counting and recording student behavior using daily timings, which generally range from 10 s to 5 min (Binder & Watkins, 1990). This provides an efficient method for monitoring student progress. Because of the progress monitoring inherent within precision teaching, schools can use precision teaching to enhance their response to intervention (RtI) efforts (Kubina & Yurich, 2012).

Daily or weekly analyses of the data collected during progress monitoring results in opportunities to problem solve. Teachers and students can review charts to determine if changes in the current instructional methods or interventions need to be made. Problem solving also involves making changes to elements based in precision teaching such as
using different learning channels (e.g., presenting a skill so that the student sees the problem and then says the answers as opposed to hearing the problem and writing the answer), changing the length of timings (e.g., decreasing the timing from 1 min to 30 s for a student whose performance slows down as the timing progresses), or changing the curriculum. Once changes are made, problem solving continues until the desired level of progress is achieved (Kubina & Yurich, 2012).

Precision teaching also focuses on the use of inductive learning and discovery (Lindsley, 1990, 1991, 1992). The frequent measuring of behavior allows precision teachers and students to make discoveries about learning. This function of precision teaching contributes to a better understanding of human behavior (Kubina & Yurich, 2012). For more information regarding specific discoveries identified by the use of precision teaching as a measurement system, see Lindsley (1992).

The use of individual SCCs, specified learning channels, and individualized interventions, allow precision teachers to base learning decisions on each student’s needs. Differentiating instruction results in building off the individuality of students and optimally improving the success of each student (Kubina & Yurich, 2012). This is especially true for students with disabilities who may require more differentiation in instruction than other students (Bender, 2012).

Over time, four guiding principles were developed that guide all precision teachers. These principles are drawn from Skinner’s free-operant research and are identified as (a) the learner knows best, (b) focus on directly observable behavior, (c) frequency as a measure of performance, and (d) use of the Standard Celeration Chart.
In general, teachers incorporate the first two principles into their classroom on some level, but the literature within precision teaching provides clear guidance and explicit and systematic instruction to teachers regarding how to fully implement each of these guiding principles (e.g., Kubina & Yurich, 2012; White, 1985). Despite the level of clarity provided in the precision teaching literature, research is needed to determine how the use of these guiding principles (as described in the literature) compares to similar data collection and decision-making models (e.g., curriculum-based measurement, equal interval graphing).

Many precision teachers consider the learner knows best to be the most important of the guiding principles (Cooper, 2000; White, 1986). Even though educators recognize the uniqueness of each of their students, there may be a tendency to blame the student when progress is not made (Binder & Watkins, 1990). Precision teachers focus on measuring the student’s individual performance and identifying variables within the instructional environment that need to change when progress is not made. At first glance, this may not seem different from the process used by effective teachers. However, the intensive focus on the learner’s progress differentiates precision teaching from other systems. This is not to imply that this does not happen outside of precision teaching but simply to describe that precision teachers heavily focus on the learner knowing best.

Precision teachers base decisions on daily timings and not on expectations related to what an evidence-based curriculum or instructional strategy would predict. This means that when an evidence-based curriculum or instructional strategy does not produce the
results one would expect, a precision teacher does not insist that something is wrong with the student, instead she would look at the student’s performance to determine what changes in the environment need to occur in order to produce the desired performance. Within a week or less, precision teachers will determine if the learner’s performance indicates an intervention change is necessary. This may not be the case for other decision-making or teaching models. For example, Liberty, Haring, and White (as cited in White, 1985, p. 317) showed that teachers who used decision-making guidelines developed by precision teachers selected effective interventions for students with moderate and severe disabilities two to five times more than when no decision rules were used.

Precision teachers also focus on directly observable behavior. This results in improving behavior and more effectively measuring the impact of intervention (Kubina & Yurich, 2012; White, 1986). When using precision teaching, students and teachers record directly observable behavior during specified observation times. Attempts to measure non-observable behavior, such as silent reading or vague descriptions of behavior such as obsessive-compulsive behavior, reduce the ability to precisely measure behaviors of interest and result in less effective interventions (Kubina & Yurich, 2012; White, 1986).

The third guiding principle of precision teaching is the use of frequency as a measure of behavior. Lindsley’s (1990) recognition of the importance of using frequency as a measurement of behavior was one of the driving forces behind the creation of precision teaching as a measurement system. Frequency measurement refers to counting
the target behavior and dividing it by the observation time. In comparison to using percentage as a measure of behavior, several advantages to using frequency exist. Frequency is a more sensitive measure of behavior than other recording measures such as percentage correct (Binder & Watkins, 1990; Lindsley, 1990). Frequency measurement also allows repeated measures of an observable behavior. This improves a precision teacher’s ability to monitor intervention because the measurement is the same each time (Kubina & Yurich, 2012). Lastly, Lindsley (1991) recognized Skinner’s position that frequency is a universal datum but argued that it represents more than this, because it is a dimension of behavior (i.e., changing the frequency of a behavior, changes the behavior).

The use of the SCC to graph behavior is the fourth guiding principle of precision teaching. The SCC was developed by Lindsley (1990) in order to provide a standardized means of interpreting learning rates. Each aspect of the chart has a rationale behind it and was developed with purpose. For example, the use of the logarithmic scale allows teachers to focus on large changes in behavior (e.g., 11 to 100) as opposed to trivial, small changes in behavior (e.g., 11 to 13). Kubina and Yurich (2012) explain that the SCC allows teachers to achieve the same level of standardized and effective decision making as other fields of science, such as a cardiologist identifying abnormalities of heart rhythms using an electrocardiogram.

Current educational trends also focus on measuring and analyzing student progress, and precision teachers have used a systematic procedure of collecting data through daily timings and assessing the student’s learning picture prior to the development of this trend. The learning picture is the picture formed on the student’s
chart after several timings. Based on this picture, precision teachers can quickly determine what types of instructional changes to make to the intervention (White, 1985). The standardized features of the SCC have allowed for precision teachers to develop decision rules that can be used universally by all teachers.

Each of the four guiding principles results in a focus on effective and efficient decision-making. The ability of precision teachers to quickly engage in problem solving using the SCC and decision rules may increase the effectiveness of intervention for students with disabilities. The development of precision teaching focused on how to most effectively monitor student performance in order to provide effective interventions. Effective teachers collect data and make decisions based off of this data, but they also frequently make these decisions based on their own opinions and do not receive systematic training regarding what to analyze on the graph and how to proceed based on the data (Jimenez, Mims, & Browder, 2012). In contrast, teachers who receive training in the system of precision teaching learn how to assess the celeration of performance (a multiplicative measure of change in the rate of behavior), assess the learning picture of the student and make specific changes to the intervention based on this picture, develop individualized goals for each student based on the student’s performance, and break a compound skill down to teach the component behaviors necessary to learn the compound skill (Kubina & Yurich, 2012).

Precision teachers have determined fluent performance is evidenced by retention, endurance, application, and performance standards to form the acronym REAPS (Kubina & Yurich, 2012; Lindsley, 1992). Retention refers to the performance of the behavior
maintaining over time. Endurance occurs when the performance occurs at the same rates during longer timings and in the naturally occurring environment. Application is when component behaviors achieve a certain frequency and then apply to a composite behavior. For example, saying letter sounds and segmenting words into sounds can combine to achieve the composite behavior of blending sounds into a word (Kubina & Yurich, 2012). Performance standards identify the performance necessary to stop focusing on the current skill and move onto the next skill (Kubina & Yurich, 2012). The research defining fluent behavior continues to evolve with additional components being identified. The newer components identified by Johnson and Street (2013) form the acronym MESsAGe: maintenance, endurance, stability, application, and generativity. Stability refers to the ability to perform the behavior at the same frequency with environmental distractions such as someone talking, playing loud music, or moving around nearby. Generativity refers to new activities recruiting performance that previously occurred in a different situation and context. Inclusion of a focus on using these measures to determine whether a skill is fluent, could improve the long-term outcomes for students with moderate to severe disabilities and decrease the probability that students will master a skill and then fail to perform the skill after instruction is removed (Binder, 1996).

Precision teaching developed because of a commitment by Lindsley (1990) and the teachers working with him to incorporate free-operant conditioning within the classroom to improve the effectiveness of their teaching. White (1986) recognized the successful use of precision teaching with a variety and range of learners: students with
severe disabilities, graduate students, the very young, and the very old. Although this statement was made nearly 30 years ago, public schools have yet to experience the benefits of adding precision teaching to their instruction (Binder & Watkins, 2013). Educational performance in schools in the United States appears to be worsening and American students are falling behind those in other countries, but the technology exists to address this problem using precision teaching (Binder & Watkins, 2013). Federal law is also changing to address this problem. Schools are increasingly taxed with incorporating RtI models to promote student success, the use of evidence-based strategies, and data collection to monitor progress to address the lower performance of students (Kubina & Yurich, 2012; Slocum et al., 2014; Spencer, Detrich, & Slocum, 2012).

The addition of precision teaching techniques can improve student performance as well as provide schools with an avenue for meeting the requirements of these federal laws. With regard to RtI, precision teaching can support learners regardless of the learners’ tier placements. Precision teaching can also provide a micro-level of assessment within each tier and frequency building practice to improve skill acquisition. Lastly, precision teaching may prevent students from moving to higher tiers and facilitate students moving back to Tier 1 (Kubina & Yurich, 2012).

Precision teachers have long recognized the effectiveness of incorporating precision teaching as a decision-making model within the classroom. Research in the field of precision teaching supports this claim and Kubina and Yurich (2012) conclude there is enough research to identify precision teaching as meeting the definition for research-based. However, this conclusion is drawn from a multitude of peer-reviewed
journal articles and does not specify a relation to a specific population, such as students diagnosed with moderate to severe disabilities.

The Morningside Model of Generative Instruction provides evidence of the effectiveness of using precision teaching to achieve gains of two academic years in one year for students with learning disabilities (Johnson & Layng, 1992). Additionally, published research in the field of precision teaching shows that it can improve performance in a variety of academic skills for students with mild learning disabilities. Lovitt and Fantasia (1983) used precision teaching to improve the performance of 182 students with learning disabilities in reading, math, and spelling. They also conducted two additional studies to compare the performance of two smaller groups of students with learning disabilities in a precision teaching condition (13 students in the second study and 14 in the third study) and a non-precision teaching condition (13 in the second and third studies). The students in the precision teaching condition outperformed the non-precision teaching condition significantly in reading. Precision teaching has also been used to improve self-management of writing errors (Seevers, Malanga, & Cooper, 2003) and to show that students make faster progress in mathematics and reading when the component skills (e.g., writing answers to addition problems) are brought to fluency prior to teaching the compound skill (e.g., writing answers to multiplication problems; Mc Dowell & Keenan, 2002).

More recently Twarek, Chion, and Eshelman (2010) showed the effectiveness of using precision teaching to improve performance in the daily living skill of dressing for three students with autism. The component skills of reaching, pulling, grasping, and
placing that are required to engage in dressing behavior were trained to fluency using
daily timings. After achieving fluent performance on these skills, the students’
performance on task analyses related to a dressing skill was assessed. Without specific
training, the students improved performance from baseline levels.

Although studies exist to support the effectiveness of precision teaching with
students diagnosed with mild to severe disabilities (e.g., White, 1986), the breadth of this
research specific to students with moderate to severe disabilities is lacking. Precision
teaching may be an effective technology to incorporate in classrooms of students with
moderate to severe disabilities, but not enough research exists to support this claim. It is
important to determine the most effective methods of improving interventions for
students with moderate to severe disabilities, because this will improve the likelihood that
the students learn the skills necessary to function as independent adults (Browder &
Spooner, 2011).

Precision teaching may improve the application of evidence-based interventions
and curricula for students with moderate to severe disabilities by improving teachers’
abilities to systematically measure behavior and problem solve to modify interventions
for their students (Binder & Watkins, 2013; White, 1985, 1986). Research is needed to
determine the extent to which precision teaching can enhance the outcomes for students
with moderate to severe disabilities.

Therefore, the focus of this dissertation is to add to the research base related to the
application of precision teaching with students with moderate to severe disabilities. First,
a literature review of these applications sought to (a) examine the literature for research-
based applications of precision teaching with school-aged individuals with moderate to severe disabilities, (b) determine the effectiveness of incorporating precision teaching with school-aged individuals with moderate to severe disabilities, and (c) identify limitations and gaps in the current research base and identify areas of future research.

Second, a research study was conducted to determine if students with moderate to severe disabilities would reach aims on several Big 6 + 6 motor movement skills as described by Fabrizio, Moors, and Pahl (2001). The study also examined what impact daily timings on these motor movements had on performance of other skills requiring the same motor movements for a vocational task. Third, the methods from this study were used to develop a practitioner paper on how to incorporate frequency building to improve student performance in a variety of skill areas in the classroom. Finally, this dissertation concludes with a discussion about future research in the application of precision teaching with students diagnosed with moderate to severe disabilities as well as a description of my own research goals in this area.
Chapter 2: Literature Review

In this chapter, a review of the literature on the use of precision teaching with students with moderate to severe disabilities is presented. The first section provides an overview of the literature and identifies the questions addressed within the literature review. This is followed by the method section that details how the literature review was conducted, the results section that describes the results of the literature review, and the discussion that explains the implications of these findings and identifies limitations and areas of future research.

Abstract

Precision teaching is the process of measuring behavior to make data-based decisions regarding student progress and interventions. Given that precision teaching is not a curriculum, this process can be incorporated into any classroom. Research suggests precision teaching is effective whenever it is applied (Lindsley, 1991, 1992; White, 1986). However, a dearth of research related to precision teaching exists within schools, specifically for students with moderate to severe disabilities. The necessity for systematic instruction and data-based decision making with this population suggests precision teaching may be a viable option for improving the teacher’s ability to meet the needs of students with disabilities. The purpose of this review was to evaluate the current research
base for precision teaching applications with students with moderate to severe disabilities to determine the effectiveness of incorporating precision teaching to improve learner outcomes for this population and suggest areas of future research.
Precision Teaching: A Review of Applications With Students With Moderate to Severe Disabilities

Fifty years ago, Dr. Ogden Lindsley worked to identify the most effective methods of applying research from the work of B. F. Skinner and free-operant conditioning in the classroom (Lindsley, 1964). From this research and a focus on receiving input from teachers, precision teaching was born (Lindsley, 1990). Binder (2010) describes the development of precision teaching as maintaining Skinner’s original formulation of the science of behavior. General reviews of precision teaching literature indicate the methods are effective whenever they are applied (Lindsley, 1991, 1992; White, 1986).

Precision teaching can facilitate the use of evidence-based strategies and data collection to monitor progress. Schools already using evidence-based interventions can add precision teaching to improve implementation of these interventions as well as evaluate the effectiveness of new interventions (Binder, 1988; Binder & Watkins, 2013; White, 1985, 1986). Teachers do not inherently use data to make decisions and are not always trained in how to make these decisions (Jimenez, Mims, & Browder, 2012). This is despite evidence that data-based decision-making improves student progress, especially for those students with significant disabilities (Jimenez et al., 2012). Precision teaching requires the use of daily timings to measure and analyze student performance, which results in a learning picture that documents the student’s progress (Crawford & Olson, 1990). Decision rules are then used to decide on next steps to take in the intervention (White, 1985). Therefore, data-based decision-making is inherent in any instructional

In addition to the general improvements that precision teaching can provide schools, research conducted within the field of precision teaching indicates the benefit of using precision teaching with a variety of learners. The *Journal of Precision Teaching and Celeration* contains a multitude of articles documenting the effectiveness of precision teaching with students in mainstream classrooms and students with learning disabilities. The journal also contains some articles regarding the effectiveness of precision teaching with students with moderate to severe disabilities.

The Great Falls Precision Teaching Project involves a series of studies documenting the use of precision teaching in a school system over the course of several years (White, 1986). The project involved entire schools and assessed the performance of teachers and students within the school. One of the schools using precision teaching outperformed a school closely matched where precision teaching was not incorporated. The students in the precision teaching school performed on average in the 95th percentile in reading and 86th percentile in math. However, the control school students only performed at the 71st and 54th percentiles (White, 1986).

As early as 1964, Lindsley identified the possible benefits of using precision teaching with children with disabilities. In this seminal paper, he explains the concept of response building. This process involves identification of movements involved in an operant reflex. The individual is taught to move the muscles involved in the response for
movements that are emitted but do not occur regularly enough to serve as part of the operant reflex.

McManus (n.d) explains how in 1978 he incorporated the concept of response building and the work of Eric and Elizabeth Haughton to improve the performance of adults with significant disabilities by focusing on the tool skills (i.e., basic movements involved with a motor response) and component skills necessary to complete a task. The use of standard behavior analytic techniques of backward chaining and errorless learning did not result in improved performance on vocational tasks. The addition of bringing the Big 6 skills (i.e., reach, tap, point, grasp, release, and place) to fluency improved the performance level on vocational tasks so much that they outperformed the other clients at the work site, whereas prior to intervention, performance levels were so low it made them ineligible for placement at the work site. Unfortunately, these findings were not discovered in a controlled research setting. However, Twarek, Cihon, and Eshelman (2010) recently showed the effectiveness of bringing component skills to fluency to improve performance on dressing skills for children with autism.

Students with moderate to severe disabilities require quality education that includes a focus on systematic instruction, self-determination, teaching academic skills, and teaching functional skills in order to achieve independent functioning as adults (Browder & Spooner, 2011). Early research in the field of precision teaching focused on whether the application of techniques with students with moderate to severe disabilities (White, 1986) could improve the quality of education for these students. For example, precision teaching was used successfully by teachers of students with severe disabilities
to improve decision-making (Haring, Liberty, & White as cited in White, 1986, p. 530). Teachers who did not use systematic data-based rules had to try three or four tactics before finding an effective intervention for their students. The use of systematic data-based rules improved the teachers’ performance in selecting a successful intervention the first time for more than 80% of attempts.

Despite the fact that precision teaching techniques can assist teachers address the ever-increasing focus on evidence-based practice, data driven decision-making, and documented progress for students with and without disabilities (Binder & Watkins, 2013)—as suggested in the Journal of Precision Teaching and Celeration and as evidenced by The Great Falls Precision Teaching Project—it is not widely accepted or applied regularly in classrooms for students with moderate to severe disabilities. Additionally, precision teaching is one of the only instructional applications of free-operant conditioning and the science of behavior analysis, so it is also not clear why more behavior analysts are not using these methods (Binder, 2010). The discrepancy in the purported effectiveness and use of precision teaching within educational and behavior analytic settings may be due to the lack of controlled published studies by precision teachers.

The field of precision teaching has not historically focused on publishing research because of the popularity of the procedures amongst a smaller faction of teachers and practitioners, the implementation of techniques by those directly working in the school as opposed to researchers (Binder & Watkins, 1990), and the reluctance of behavioral journals to publish Standard Celeration Charts (SCC; Binder, 1996). Because teachers
and applied practitioners are either not trained in conducting research or are focusing their time on performing a job that does not include a research component, they do not often conduct controlled research studies. This is an unfortunate obstacle within the field of precision teaching that precision teachers are focusing to overcome regardless of where they are employed (Binder & Watkins, 2013). More recently, research publications regarding the use of precision teaching with special education populations including autism have started to appear in the *Journal of Precision Teaching and Celeration* as well as in other journals that focus on special education, general education, and developmental disabilities (Binder & Watkins, 2013).

The growing recognition of the need for evidence-based practice and data driven decision-making coupled with the early and more recent research in the field of precision teaching showing the capability of using these methods to improve historically effective techniques provides a strong rationale for examining the research on the use of precision teaching with students who have moderate to severe disabilities. Therefore, the purpose of this review was to (a) examine the literature for research-based applications of precision teaching with school-aged individuals with moderate to severe disabilities, (b) determine the effectiveness of incorporating precision teaching within academic or behavioral interventions for school-aged individuals with moderate to severe disabilities, and (c) identify limitations and gaps in the current research base and identify areas of future research.
Method

Procedures for Article Search and Selection

Studies for this review were identified through a search of several databases (i.e., Academic Search Complete, H.W. Wilson Education Full Text, Education Research Complete, ERIC, Medline, PsycINFO, and Psychology and Behavioral Sciences Collection) through May 2015, using the following search terms: “disab*” and “precision teach*”; “autis*” and “precision teach*”; “retard*” and “precision teach*”; and “Down syndrome” and “precision teach*”. The search returned 62 results with 2 articles meeting inclusion criteria. The Journal of Precision Teaching and Celeration was hand searched for all publications from inception to last publication (1980–2012). This search returned an additional 11 results. All articles that met inclusion criteria were hand searched and cited forward to provide a comprehensive search of the relevant literature. No additional articles met criteria in these searches.

Studies that met the following criteria were included in this literature review. The study had to (a) be published in a refereed journal; (b) include participants of school-age 3 to 22 years old; (c) include a description of disability consisting of having moderate, severe, or profound mental retardation (MR); autism; or Down syndrome, or describe the participants as having an IQ less than 70 for single participants, or a range that did not exceed 79 when there were multiple participants; (d) the use of a baseline measure prior to starting intervention; and (e) the use of the Standard Celeration Chart or standard behavior chart to evaluate the intervention. Studies were excluded if (a) the participant or all of the participants was (were) solely described as having a learning disability, other
health impairment, attention deficit disorder, attention deficit hyperactivity disorder, dyslexia, emotional-behavior disturbance, mild disability, or an individual participant was identified as having an IQ greater than 70; (b) participants were 23 years of age or older; (c) there was no baseline measure; or (d) there was no Standard Celeration Chart or standard behavior graph. The majority of studies were excluded because the participants had a mild learning disability or there was no baseline measure prior to implementing the intervention.

Coding and Inter-Coder Agreement

Each article was coded for the following information: participant characteristics (i.e., number, gender, age, and diagnoses), study characteristics (i.e., independent variable, dependent variable, focus of intervention, design, celeration, findings, and quality rating). Defining 10 aspects of the study that contribute to a quality research design determined the quality rating (Horner et al., 2005). Each aspect received a score of 1 for fully meeting the definition, 0.5 for partially meeting the definition when applicable, and 0 if the definition was not met. A partial definition was applicable for all aspects that included replicable descriptions. If the authors mentioned that aspect but did not provide sufficient detail to replicate, a score of 0.5 was provided. The definitions for each aspect were (a) describing the official diagnosis of the participant by referencing independent evaluators and/or assessment results, (b) objective definitions of target behaviors measured in the study, (c) replicable description of baseline conditions, (d) replicable description of intervention conditions, (e) collection of inter-observer agreement data, (f) collection of procedural integrity data, (g) replicable description of data collection, (h)
collection of maintenance data for at least one participant, (i) collection of generalization data for at least one participant, and (j) use of an experimental design that demonstrated experimental control. The highest possible score on the quality rating was 10.

A second coder randomly coded 30% of the articles on all information to determine inter-coder agreement (IOA). This was calculated by assessing point-by-point agreement on the coded variables related to participant and study characteristics. A total of 4 articles were coded. IOA was 100%.

Results

A total of 13 studies met the inclusion criteria for this review and included 22 participants. All participants in all included studies met the inclusion criteria. Males were disproportionately represented with 16 male participants and only 6 female participants. The majority of participants were in middle school and high school. Two participants were age 4 or younger, 14 participants were between the ages of 5 and 13, and 6 were between the ages of 14 and 17.

Autism was the most frequently described diagnosis with eight participants classified as having autism. One student was described as having mild mental retardation, one with severe mental retardation, two with profound mental retardation, two with mental retardation (with no level specified), one with Down syndrome and mental retardation (level not specified), and 6 were described as having IQs ranging between 64 and 76. See Table 1 for participant characteristics by study. Ten of the 13 studies were conducted in schools, one study was conducted in the student’s home, and two studies did not clearly describe where the research was conducted.
The earliest publication date was 1980 and the latest was 2010. More studies were conducted between 1990 and 1999, with six studies conducted during this 10-year period. Between 1980 and 1989 only three studies were published, and between 2000 and 2009 only two studies were published. Two studies were published in 2010, suggesting an increasing trend in the research for this decade. However, no studies were identified after 2010. The studies showed a trend with the earliest studies focusing solely on behavior reduction, the later studies focusing on both skill acquisition and behavior reduction, and the most recent studies focusing on skill acquisition.

A total of 10 independent variables were described. The most frequently evaluated independent variable was the use of precision teaching techniques with three studies broadly describing the independent variable as precision teaching. Additionally, two studies described using precision teaching to evaluate behavior reduction interventions and to modify the interventions throughout the course of the study. Functional communication training (FCT) was the next most frequently used intervention with three studies using this intervention. A total of 20 dependent variables were described in the studies. Four studies focused solely on reducing challenging behavior, six focused solely on acquiring new skills, and three focused on both reducing challenging behavior and acquiring new skills. See Table 2 for specific details about the independent and dependent variables for each study.

Variations of multiple baseline designs were the most commonly used experimental design, with four studies employing this design. Three studies used a reversal design and the remaining five employed a baseline measure and at least one
<table>
<thead>
<tr>
<th>Reference</th>
<th>n</th>
<th>Gender (M:F)</th>
<th>Age</th>
<th>Diagnoses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lessen (1980)</td>
<td>1</td>
<td>1:0</td>
<td>12</td>
<td>Severe retardation</td>
</tr>
<tr>
<td>Maechtlen &amp; McDowell (1984)</td>
<td>1</td>
<td>1:0</td>
<td>11</td>
<td>Profound retardation</td>
</tr>
<tr>
<td>Young &amp; West (1985)</td>
<td>2</td>
<td>1:1</td>
<td>15–16</td>
<td>IQ &lt;70 &amp; mental retardation&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Crawford &amp; Olson (1990)</td>
<td>6</td>
<td>2:4</td>
<td>12–13</td>
<td>IQ range: 64–76&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Cancio et al. (1991)</td>
<td>1</td>
<td>1:0</td>
<td>14</td>
<td>Autism and Visual impairment</td>
</tr>
<tr>
<td>Register et al. (1992)</td>
<td>1</td>
<td>1:0</td>
<td>13</td>
<td>Autism</td>
</tr>
<tr>
<td>Timmons et al. (1995)</td>
<td>1</td>
<td>1:0</td>
<td>17</td>
<td>Profound retardation&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Ashbaugh &amp; McLaughlin (1997)</td>
<td>1</td>
<td>1:0</td>
<td>17</td>
<td>Mild mental retardation &amp; IQ &lt;70</td>
</tr>
<tr>
<td>Simmons et al. (1998)</td>
<td>1</td>
<td>1:0</td>
<td>2</td>
<td>Confirmed diagnosis of Autism</td>
</tr>
<tr>
<td>Smyth &amp; Hardy (2002)</td>
<td>1</td>
<td>1:0</td>
<td>6</td>
<td>Autism</td>
</tr>
<tr>
<td>Cohen (2005)</td>
<td>1</td>
<td>1:0</td>
<td>16</td>
<td>Autism</td>
</tr>
<tr>
<td>Cavallini et al. (2010)</td>
<td>2</td>
<td>1:1</td>
<td>8</td>
<td>Down syndrome and mental retardation&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Twarek et al. (2010)</td>
<td>3</td>
<td>3:0</td>
<td>3–5</td>
<td>Autism</td>
</tr>
</tbody>
</table>

Table 1. Characteristics of participants in each study included in the review by reference.

<sup>a</sup>Diagnoses refer only to the specific description used for inclusion in this review; other diagnoses are not included here.
intervention condition. All of the studies reported that all of the participants acquired the skills, though one study reported that the participants did not generalize the skills (Ashbaugh & McLaughlin, 1997). The quality ratings of the studies ranged from 0 to 8.5 with most studies scoring either a 3 or 4. See Table 2 for specific characteristics of each study.

**Interventions Focused on Skill Acquisition**

Studies focused on skill acquisition were defined as those that aimed to increase the correct performance of a target skill. Each of the studies in this category targeted a different type of skill. Four studies focused on skills that could be classified as academic in nature. Young, West, and Crawford (1985) targeted the number of words signed and matched to pictures, Crawford and Olson (1990) targeted addition problems for numbers 0 to 10, Ashbaugh and McLaughlin (1997) targeted reading street names, and Cavallini, Berardo, and Perini (2010) targeted reading rate. One study focused on increasing fluency of component skills to impact performance on daily living skills (Twarek et al., 2010). This study assessed the effects of increasing the fluency of reaching, grasping, pulling, and/or placing on putting on socks, shirt, and/or underwear. The last study focused on improving head posture by using music as a reinforcer (Timmons, McLaughlin, & Kinakin, 1995).

A total of 15 participants received interventions focused solely on skill acquisition, which represents more than half of the total participants included in this review. The described diagnoses of the participants varied per study. Four of the studies
<table>
<thead>
<tr>
<th>Reference</th>
<th>IV</th>
<th>DV</th>
<th>Focus</th>
<th>Design</th>
<th>Celeration</th>
<th>Findings</th>
<th>QR</th>
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<td></td>
<td></td>
<td>x1.0 and</td>
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<td></td>
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<td></td>
<td></td>
<td>/1.2 and /1.1</td>
<td></td>
<td></td>
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<tr>
<td>Young &amp; West (1985)</td>
<td>Direct instruction</td>
<td>Words signed correctly</td>
<td>Acquisition</td>
<td>Multiple-probe across word lists</td>
<td>Intervention:</td>
<td>Positive</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Words matched to pic correctly</td>
<td></td>
<td></td>
<td>At or above x1.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crawford &amp; Olson (1990)</td>
<td>Precision Teaching (PT) techniques</td>
<td>Frequency correct on addition problems</td>
<td>Acquisition</td>
<td>Pre/Post</td>
<td>Positive 2.5</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 2. Description and results of each study.

*Note.* IV = independent variable. DV = dependent variables. Celeration = rate of acceleration (X) or deceleration (/). QR = quality rating.
<table>
<thead>
<tr>
<th>Reference</th>
<th>IV</th>
<th>DV</th>
<th>Focus</th>
<th>Design</th>
<th>Celeration</th>
<th>Findings</th>
<th>QR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cancio et al. (1991)</td>
<td>Functional analysis (FA) and use of PT techniques to evaluate blocking and reinforcement procedures</td>
<td>Eye gouging behavior</td>
<td>Reduction</td>
<td>ABC with micro-reversal</td>
<td>Intervention range: x1.05–x20 and /1.33–/2.75</td>
<td>Positive 5.5</td>
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<tr>
<td>Register et al. (1992)</td>
<td>FA and functional communication training (FCT)</td>
<td>Food stealing behavior Signing “eat” and “please”</td>
<td>Reduction</td>
<td>Reversal</td>
<td>Acquisition</td>
<td>Positive 1.5</td>
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<td>Timmons et al. (1995)</td>
<td>Head lift procedure and music as a reinforcer</td>
<td># of prompted head lifts Length tape played # head erect</td>
<td>Acquisition</td>
<td>ABCABC</td>
<td>Positive 7</td>
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<td></td>
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<td>Ashbaugh &amp; McLaughlin (1997)</td>
<td>PT techniques</td>
<td>Street names read Street names pointed to on map</td>
<td>Acquisition</td>
<td>ABCA</td>
<td>Mixed 3</td>
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Table 2 continued

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<th>Design</th>
<th>Celeration</th>
<th>Findings</th>
<th>QR</th>
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<td>Simmons et al. (1998)</td>
<td>FCT and PT techniques</td>
<td>Episodes of problem behavior</td>
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<td>AB</td>
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<td></td>
<td></td>
<td>Signing please</td>
<td>Acquisition</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Smyth &amp; Hardy (2002)</td>
<td>Functional assessment and use of PT to evaluate FCT, tolerating no and wait, and redirecting excitement</td>
<td>Hand biting behavior</td>
<td>Reduction</td>
<td>ABCD</td>
<td></td>
<td>Positive</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Acquisition</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Cavallini et al. (2010)</td>
<td>Sprints and other PT techniques</td>
<td>Words read correctly Syllables read correctly</td>
<td>Acquisition</td>
<td>Multiple baseline across participants</td>
<td></td>
<td>Positive</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Acquisition</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Twarek et al. (2010)</td>
<td>Fluency training with Big 6 + 6 skills</td>
<td>Big 6 movements Putting on socks Putting on underwear Putting on shirt</td>
<td>Acquisition</td>
<td>Delayed multiple baseline across participants</td>
<td>Intervention range: x1–x4</td>
<td>Positive</td>
<td>8.5</td>
</tr>
</tbody>
</table>
included one participant described as having profound mental retardation or an unspecified level of mental retardation (Ashbaugh & McLaughlin, 1997; Cavallini et al., 2010; Timmons et al., 1995; Young et al., 1985), one included a participant with an IQ less than 70 (Cavallini et al., 2010), one included a participant diagnosed with Down syndrome (Cavallini et al., 2010), one included three students with autism (Twarek et al., 2010), and one included six students with an IQ range between 64 and 76 (Crawford & Olson, 1990). Three studies included participants between the ages of 14 and 17 (Ashbaugh & McLaughlin, 1997; Timmons et al., 1995; Young et al., 1985), three included participants between the ages of 5 and 13 (Cavallini et al., 2010; Crawford & Olson, 1990; Twarek et al., 2010), and one included participants under the age of 5 (Twarek et al., 2010).

Variations of multiple baseline designs were the strongest experimental designs used in this category (Cavallini et al., 2010; Twarek et al., 2010; Young et al., 1985). One study used a pre/post design (Crawford & Olson, 1990), one used a baseline, intervention, follow-up ABC design (Timmons et al., 1995), and one study used a baseline, intervention one, intervention two, generalization probe ABCA design (Ashbaugh & McLaughlin, 1997).

The quality ratings of the studies in this category were low to moderately high with an average of 5.2 (range: 3–8.5). Twarek et al. (2010) had the highest quality rating with an 8.5. This study did not provide a confirmed diagnosis of the participants and, although there was a description of baseline conditions, there was not replicable detail. The quality ratings for the remaining studies varied with respect to the components that were present within the study. Experimental control and a clear description of data
collection methods were two components present most often. One study only showed partial experimental control (Crawford & Olson, 1990), and one did not clearly describe data collection procedures (Ashbaugh & McLaughlin, 1997). Providing a clear definition of the target behavior was the component present least often, with none of the studies scoring a 1 for this component. Collection of IOA and procedural integrity data were the next two components present least often, with only one study including both of these components (Twarek et al., 2010).

Three of the studies assessed the effectiveness of precision teaching techniques (Ashbaugh & McLaughlin, 1997; Cavallini et al., 2010; Crawford & Olson, 1990), one assessed the use of music as a reinforcer (Timmons et al., 1995), one assessed the effectiveness of direct instruction (Young et al., 1985), and one assessed the impact of building fluency on Big 6 skills on dressing skills (Twarek et al., 2010). Five of the six studies showed positive results for the interventions used in the study (Cavallini et al., 2010; Crawford & Olson, 1990; Timmons et al., 1995; Twarek et al., 2010; Young et al., 1985) and one study reported mixed results because of a lack of skill generalization (Ashbaugh & McLaughlin, 1997).

For example, Crawford and Olson (1990) compared the performance of students in a precision teaching group to a control group. The results showed three students in the group using the precision teaching techniques of 3-min timings, feedback, and charting performed better on an addition assessment than students who only did addition worksheets, scored the worksheets, and received feedback. The students in the precision teaching group gained between 7.2 and 12.2 points on the assessment, but the children in the control group only gained between 0.8 and 2.7 points.
In another example, Timmons et al. (1995) provides an example of incorporating precision teaching with a student diagnosed with a profound physical disability by showing the use of music contingent on head raising may increase head raising behavior and using the SCC to record data throughout the course of the study. The initial baseline measure for head raising was a mean length of 1.9 s. This behavior increased to a mean of 71.3 s during the first physical assistance phase but decreased to 5.6 s during the contingent music phase, in which physical assistance was not provided. The return to baseline mean was also low at 6.6 s. Physical assistance again increased the length to a mean of 52.6 s and the increase maintained during contingent music at 46.1 s. A higher length of head raising also continued during a follow-up baseline condition with a mean length of 29.7 s.

Interventions Focused on Behavior Reduction

Studies focused on behavior reduction were defined as studies that aimed to decrease the rate of a target behavior. The four studies in this category focused on reducing different responses. Lessen (1980) addressed a response that is a common issue in many classrooms: out of seat behavior. The other three studies focused on the more problematic behaviors of grabbing other people (Maechtlen & McDowell, 1984), eye gouging (Cancio, Young, Macfarlene, West, & Blair, 1991), and hand biting (Smyth & Hardy, 2002).

A total of four participants received interventions focused on behavior reduction. The described diagnoses of the participants in the studies were severe mental retardation (Lessen, 1980), profound mental retardation (Maechtlen & McDowell, 1984), and autism (Cancio et al., 1991; Smyth & Hardy, 2002). Three participants were between 5 and 13
years old (Lessen, 1980; Maechtlen & McDowell, 1984; Smyth & Hardy, 2002) and the fourth participant was 14 years old (Cancio et al., 1991).

Two studies used an ABAB reversal design. The baseline procedures for each study were the techniques that were already in place in the classrooms (Lessen, 1980; Maechtlen & McDowell, 1984). One study used a baseline, intervention, follow-up ABC design with a micro-reversal (Cancio et al., 1991). For the purposes of that study, a micro-reversal was a 30 min block where a return to baseline occurred in order to show the effects of the intervention condition. The last study used an ABCD design (Smyth & Hardy, 2002). The quality ratings of the studies in this category were low to moderate with an average of 2.9 (range: 0 to 5.5). Three of the studies demonstrated experimental control and provided sufficient information to replicate the intervention condition (Cancio et al., 1991; Lessen, 1980; Maechtlen & McDowell, 1984). Smyth and Hardy (2002) did not meet criteria for any of the items used in the quality rating.

The studies used precision teaching to assess the effectiveness of four different interventions. Lessen (1980) compared the rate of out of seat behavior during the baseline condition of verbal attention from the teacher to the intervention condition of non-verbal attention from the teacher. Maechtlen and McDowell (1984) assessed the effectiveness of an overcorrection procedure where the student was required to hold his arms out, down, and out for 10 s in each position to reduce grabbing behavior. Cancio et al. (1991) used the SCC to make intervention decisions about an intervention that included blocking, manipulatives, and differential reinforcement of other behavior (DRO). Smyth and Hardy (2002) focused on teaching replacement behaviors to reduce hand biting. All studies
showed positive results in reducing the target behaviors (Cancio et al., 1991; Lessen, 1980; Maechtlen & McDowell, 1984).

For example, the student’s out of seat behavior in Lessen (1980) reduced from 6 times per 10 min to 1 time in 10 min during the non-verbal attention condition. In the verbal attention condition, out of seat behavior had celeration rates of X1.0 and X4.5. However, in the non-verbal attention condition the celeration rates were /1.6 and /4. This indicates the out of seat behavior accelerated during the verbal attention condition and decelerated during the non-verbal condition. It should be noted that the behavior was so high during the second verbal attention condition that only 1 data point was collected because the rate of the behavior resulted in decreased learning opportunities for the participant and his peers.

Cancio et al. (1991) implemented 10 different phases of intervention during the course of the study. Each intervention change was decided upon by using the chart. The initial intervention consisted of blocking eye gouging behavior with glasses, the next phases incorporated additional techniques of providing manipulatives to engage the student’s hands and the use of a DRO procedure to reinforce absence of eye gouging. The last phases of the intervention focused on determining the most effective methods of fading the DRO procedure. In some of the intervention phases, the behavior accelerated and in some phases it decelerated. The third phase of the intervention had the highest deceleration of /2.75 and consisted of using glacier sunglasses, manipulatives, and a 1-min DRO with edibles as the reinforcer. The eye gouging behavior reduce to near 0 levels throughout the intervention and increased during the micro-reversal phase when the treatment was withdrawn.
Interventions Focused on Skill Acquisition and Behavior Reduction

Three studies targeted both skill acquisition and behavior reduction. Each of the studies in this category targeted a different behavior for reduction. One study focused on reducing aggression (Cohen, 2005), one focused on reducing loud vocalizations, hair pulling, squirming, and attempts to run away (Simmons, Derby, & McLaughlin, 1998), and one focused on reducing food grabbing (Register, Young, & Register, 1992). For skill acquisition, two studies focused on functional communication (Register et al., 1992; Simmons et al., 1998). The third study focused on increasing rate of clerical task completion (Cohen, 2005).

A total of three participants received interventions focused on skill acquisition and behavior reduction. All of the studies included participants diagnosed with autism and one study described the student as having an official diagnosis of autism (Simmons et al., 1998). One study included participants under the age of 5 (Simmons et al., 1998), one included participants between the ages of 5 and 13 (Register et al., 1992) and one included participants between the ages of 14 and 17 (Cohen, 2005).

The use of a reversal design and multiple baseline design across tasks were the two strongest designs used in this category (Cohen, 2005; Register et al., 1992). One study used an AB design (Simmons et al., 1998). The quality ratings of the studies in this category were relatively low to moderate ranging from 0 to 4 with an average of 1.9. All three studies identified the participants’ diagnoses, with one study providing an official diagnosis (Simmons et al., 1998) and provided at least partial description of the intervention. Two of the studies provided at least a partial description of the target behavior (Register et al., 1992; Simmons et al., 1998).
Two studies reported data on the use of functional communication training (FCT) to decrease the challenging behavior and increase the target replacement behavior (Register et al., 1992; Simmons et al., 1998). The third study used frequency building to increase the rate of the skill targeted for acquisition (Cohen, 2005). All three studies showed positive results for the interventions used in the study (Cohen, 2005; Register et al., 1992; Simmons et al., 1998).

The student in Register et al. (1992) decreased his rate of food grabbing behavior and increased his rate of pointing and signing “eat” and “please” to access more food. After a functional analysis was completed that indicated food grabbing was maintained by getting more food, an FCT procedure was used to teach the student to point and sign “eat” and “please” in the presence of additional preferred foods. The reversal design indicated food grabbing behavior was higher in baseline conditions than intervention conditions with a range of 0.1 to 0.7 occurrences per min in baseline and 0 to 0.3 occurrences per min during intervention. Data was not reported on the replacement behavior.

Simmons et al. (1998) used an AB design that consisted of using FCT to reduce problem behavior and increase the use of the sign “please”. The rate of problem behavior decreased from a mean of 0.78 per min in baseline to a mean of 0.13 per min during the FCT intervention. The use of signs increased from a mean of 0 during baseline to a mean of 1.04 per min during FCT. The signs were mostly prompted during the intervention.

Cohen (2005) used a multiple baseline design across tasks to assess the effectiveness of frequency-building exercises that consisted of daily timed practice of one to 10 sprints depending on if the student met his goal for the targeted clerical tasks. The
timings were short in duration and increased until the student met his aim. The rate of performance improved for all 3 tasks: trifolding, envelope stuffing, and mail sorting. As the rate of performance increased on each task, the rate of challenging behavior decreased. The rate of trifolding increased from a mean of 8.4 per min to a mean of 13 per min and challenging behavior during this task decreased from a mean of 8 per min to a mean of 0.2 per min. This result also maintained during retention tests but not during endurance and stability checks. Envelope stuffing increased from a mean of 4 per min to 13 per min and challenging behavior during this task decreased from 5 per min to 0 per min. This result maintained during retention tests. Mail sorting increased from a mean of 7 per min to a mean of 21 per min and challenging behavior decreased from a mean of 2 per min to a mean of 0 per min.

Discussion

*Literature Base for Applications of Precision Teaching*

The results of the current review suggest that the literature base for research on applications of precision teaching with students with moderate to severe disabilities is very small. Efforts were made to conduct a comprehensive search of the literature including hand searching the *Journal of Precision Teaching and Celeration*. However, only 11 articles were identified out of the hundreds of articles in this journal. This is striking considering the higher number of articles published in this journal focusing on learning disabilities and other mild disabilities. Additionally, only two articles met inclusion criteria for the study out of the 62 results identified in online databases. Most of these studies failed to meet inclusion criteria because the students did not have moderate to severe disabilities. Only two of the identified articles were published in journals other
than the *Journal of Precision Teaching and Celeration* (i.e., Cavallini et al., 2010; Twarek et al., 2010), suggesting that the research conducted in the area of precision teaching is limited to publication in the flagship journal of precision teaching.

High quality research is necessary for answering research questions related to special education (Odom et al., 2005). Even the articles that were identified did not meet high standards of rigor for single subject research (Horner et al., 2005). None of the articles scored a 10 out of 10 on the quality rating scale and most scored below 5. Many of the articles lacked detailed descriptions of the study, making them difficult to replicate. The research designs for the studies included in this review improve the overall picture, because more than half included either reversal or variations of the multiple baseline design. However, two of the studies barely met criteria for inclusion because they only used a pre/post or an AB design. An additional 17 articles were excluded from this review because they did not include a basic research design that incorporated baseline measures of performance. This means more publication results from the search did not include a research design than the number of publications that. These 17 articles were not included in the current review because they were case study chart shares published in the *Journal of Precision Teaching and Celeration* where the authors reported on the performance of one of their students but they did not have any comparative measures to show how the student was performing prior to the data collected on the SCC. The lack of comparison data makes it impossible to determine if the data being reported were due to the interventions discussed in the publication.
Effectiveness of Using Precision Teaching

The variety of applications, variety of described diagnoses, and consistency of positive results for skill acquisition and behavior reduction indicate that precision teaching can effectively be applied with students with moderate to severe disabilities to increase performance on skill acquisition goals and reduce challenging behaviors. However, the quality ratings of nine of these studies are a limitation to this finding (Ashbaugh & McLaughlin, 1997; Cavallini et al., 2010; Crawford & Olson, 1990; Lessen, 1980; Maechtlen & McDowell, 1984; Register et al., 1992; Simmons et al., 1998; Smyth & Hardy, 2002; Twarek et al., 2010; Young et al., 1985). This finding is especially promising for skill acquisition related to reading fluency, because three studies showed positive results with improving this skill (Ashbaugh & McLaughlin, 1997; Cavallini et al., 2010; Young et al., 1985) However, this is in relation to the limited research base, so additional research on this topic is still needed. Additionally, three studies successfully reduced target behaviors using FCT and the SCC to make decisions, which provides encouraging evidence of the effectiveness of these procedures to reduce challenging behavior.

Another strength with the current research is the efficiency of applying precision teaching to instruction. Three of the studies specifically discussed the efficiency of the interventions. The intervention of increasing rate on clerical tasks in Cohen (2005) was provided for 15 min per day and the results of increased fluency with each task were achieved in as little as 6 weeks. Even more impressive, students in Cavallini et al. (2010) made more improvement in an hour and a half of reading fluency practice than what is typically achieved by typically developing children in an entire school year. Twarek et al.
(2010) explained the Big 6 fluency procedure used in their study is so efficient it can be beneficial for practitioners who need to teach a lot in a little bit of time. This is especially true for intervention specialists, reading specialists, or other practitioners who may only see students for 10 to 15 min at a time.

Additional support for the efficiency of precision teaching is provided within the literature outside of moderate to severe disabilities that suggests huge cost/benefit savings when applying precision teaching to instruction. Binder and Watkins (1990) explain that the time allocated to precision teaching is usually small, with relatively few materials needed, and a gain in progress of two or more grade-levels per year. Additional research is needed to determine if these same benefits exist when applying precision teaching in classrooms of students with moderate to severe disabilities. However, the research included in this review suggests similar results could be obtained with this population.

**Limitations in Current Research Base**

Because the focus of precision teaching is more on sharing information than conducting controlled experiments (Binder & Watkins, 1990), most of the limitations in the current research base relate to this issue. As discussed previously, the studies included in this review did not frequently make use of strong experimental designs and did not include common elements found in single subject design research (Horner et al., 2005). This limits the ability to fully evaluate the effectiveness of the interventions studied in this review. Additional research is needed using experimental designs that show functional relationships between the independent and dependent variables, such as reversals or multiple baseline designs that also include the 10 elements used in the quality rating for this review. It is especially important for future studies to include the official
diagnoses of participants and clear descriptions of the target behaviors, baseline conditions, intervention conditions, and data collection methods, because this will assist in building a comprehensive research base that can be replicated.

Additionally, none of the studies directly replicated or extended previous research related to students with moderate to severe disabilities. Without multiple studies focused on answering specific research questions in this area, it is difficult to completely understand how the independent variables are most effectively applied with this population (Horner et al., 2005). Additional research is needed to replicate and extend the current research base. This is especially important with the current focus on evidence-based practices within the field of education. Given the current research base, precision teaching cannot be considered an evidenced based practice, which will likely further limit use of this system within the classroom. Lastly, research is typically only published when the results are effective. Even though all of the studies in this review showed positive results, it is possible that there are other studies that have been conducted without positive results that were not published. This research bias is an inherent limitation when reviewing the literature.

**Future Research and Conclusions**

The lack of controlled research on the application of precision teaching with students with moderate to severe disabilities means there are a lot of areas open for future research. One of these areas is to simply extend the current research base. For example, Twarek et al. (2010) showed with a controlled research design that focusing on improving fluency in Big 6 component skills can result in improved performance on dressing tasks without additional training for young children diagnosed with autism.
Future researchers should explore with what other populations and for what additional skills the Big 6 intervention can be effective.

Additionally, the use of the Big 6 represents a component-composite skill analysis. This analysis is not frequently used in typical instructional environments but is a major tenant of precision teaching (Twarek et al., 2010). The analysis involves breaking skills down into component behaviors or movements that are required in order to effectively perform the composite skill. For example, in the Twarek et al. (2010) study, the composite skill of putting on socks was broken down into the component skills of reaching, grasping, and pulling. A lack of fluency in these skills may make it difficult to perform the skill of putting on your socks, because you need to be able to reach for the sock, grasp the sock, and pull the sock over your foot.

Precision teachers already incorporate component-composite skill analyses with academic skills such as writing and math. Binder and Watkins (1990) provide an example of building fluency with reading and writing numbers to improve rate of completing of math problems. They go on to explain that just performing prerequisite skills successfully is not enough to result in the development of subsequent skills. Therefore, precision teachers use rate of correct responding in prerequisite skills as a primary factor for curriculum-based decision making. The failure of schools to work to measure and assess the fluency of these basic skills often results in children falling behind, because they are expected to perform composite skills when the component skills are not yet fluent (Binder, 1988). Given the slow progress that is often seen with students with moderate to severe disabilities, it is highly likely that part of the lack of progress relates to failure to incorporate component-composite skill analysis. Future research examining the
application of this analysis with students with moderate to severe disabilities could lead to greater and faster gains for this population.

Most of the studies incorporated in this review explained that the use of precision teaching informed their decision-making. Each of these studies showed that precision teaching resulted in effective decision-making but none of them directly compared decision-making using precision teaching versus without precision teaching. For example, Cancio et al. (1991) successfully reduced the eye gouging behavior to near 0 levels for a student who engaged in this behavior at high levels for more than 5 years. They concluded that the use of weekly and sometimes daily data analysis using the SCC allowed for quick recognition of mistakes and modification of intervention procedures. During one of the changes in intervention, eye gouging behavior spiked and the intervention was modified to return to the previous reinforcement schedule until the behavior decreased again and then a smaller step in changing the reinforcement schedule was taken for the next fading phase. However, this study does not prove the necessity for SCC to make these decisions. Future research should focus on how precision teaching uniquely improves decision-making compared to other data driven decision-making techniques.

In addition to general research investigating how precision teaching improves decision-making, precision teachers have identified several charting conventions and created decision-making rules based on chart performance. Future research could specifically focus on how these conventions and decision-making rules might improve the ability to modify interventions for students with moderate to severe disabilities and whether the same conventions and rules apply to this population. For example, precision
teachers will look at the learning picture made by a student on the chart and modify interventions based on this picture. White (1985) provides a thorough description for teachers on when and how to modify interventions based on chart performance. Future research could incorporate these recommendations with students with moderate to severe disabilities to determine the impact of using these guidelines on student outcomes.

Another area ripe for future research is examining how precision teaching improves already effective interventions. Several of the studies in this review used procedures with research to support their effectiveness, such as FCT and DRO. It is not clear if using these procedures without precision teaching would produce the same results. Crawford and Olson (1990) provided the closest attempt at answering this question, because they compared the performance of students in a precision teaching group to those in a control group. The students in the precision teaching group made larger gains than the control group, but the study only reports pre/post measures of performance. The focus on changes in rate of behavior and making decisions based on the use of the SCC likely improves the effectiveness of already effective interventions, but research investigating this question by implementing interventions with and without precision teaching.

A few studies suggested that the effectiveness of the intervention was due to the potential impact of the use of the SCC, because it could be motivating to the students and allowed them to manage their own learning (Crawford & Olson, 1990; Twarek et al., 2010). However, these studies did not investigate this suggestion. Another key component of precision teaching is to keep the learner informed of her progress. The learner should see the performance changes as well as the time and counts for the timing
Research investigating this component with students with moderate to severe disabilities is needed within the field of precision teaching. For some of these students, it may be difficult to keep them informed because of visual or other impairments. Researchers could explore how different impairments impact the feasibility of using charts and how this impacts student performance during timings.

Additionally, Crawford and Olson (1990) suggested that the students in their study were more motivated in the precision teaching group than the control group. As evidence for this, they note that students requested to take their charts home and reminded teachers to look at their learning pictures. Students in the control condition also requested charts and one said he needed to see a chart to know if he was improving. Research is needed to investigate the value of charting for students with moderate to severe disabilities. Movements in education currently focus on self-advocacy and the Individuals with Disabilities Improvement Act (IDEIA, 2004) requires individualized education plans (IEP) that promote independent living (Browder & Spooner, 2011). If charting is more motivating for students and increases their ability to manage their own learning, this could help teachers reach the goal of promoting independence and also improve performance on IEP goals. Future research investigating the use of charting with teachers charting compared to students charting and the use of charting compared to not charting could assist in determining the impact of charting on student performance.

Additional research could also focus on component skills and ceilings on performance. Children with disabilities may perform component skills less quickly than typically developing children, and the focus on free-operant responding inherent in precision teaching opens the door for precision teachers to remediate these deficits.
Strategies to prevent limiting a student’s performance already exist for measurement-defined, performance-imposed, and deficit-imposed ceilings on performance. However, a research base does not exist for removing handicap-imposed ceilings on performance. Future research should focus on determining how to address handicap-imposed ceilings. This research may focus on the component skills research discussed earlier but also should work to identify other differences in performance that exist between students with moderate to severe disabilities and typically developing children in order to address the ceiling effect of those differences as well. Additionally, research should focus on whether or not the techniques used to eradicate the other ceilings are as effective with students who have moderate to severe disabilities. It is possible that additional techniques will be needed with this population.

A few of the studies assessed whether fluent levels of performance were truly achieved. These studies showed mixed results relating to this area. All of the skills in Twarek et al. (2010) passed retention and endurance checks except reaching, and in Cohen (2005), the skills of trifolding and envelope stuffing retained but the endurance and stability checks conducted with trifolding failed. Binder (1988) explains skills are not truly mastered unless fluency is achieved and only fluency can result in useful performance as opposed to just skill acquisition. Unfortunately, the teaching methods frequently used in schools do not result in fluent performance and may prevent students from achieving fluency (Binder, 1988). Because of this, additional research needs to be done to determine interventions that achieve fluent performance for students with moderate to severe disabilities.
The lack of research in the field of precision teaching with students with moderate to severe disabilities indicates the components described in REAPS (i.e. retention, endurance, application, and performance standards) or MESsAGe (i.e., maintenance, endurance, stability, application, and generativity) have not been thoroughly evaluated with this population. Work of precision teachers with students with learning disabilities or typically developing students strongly suggests these components are necessary for fluent behavior with these populations. Additional research is needed to determine if these same components apply to students with moderate to severe disabilities. It is possible that additional components may be involved or different strategies may be needed to help this population achieve each of the components. This is an especially important area of future research, because students with moderate to severe disabilities frequently master skills only to lose them over time (Binder, 1996). Building truly fluent behavior for these students could improve learner outcomes.

Precision teaching is claimed to be effective every time it is used (Lindsley, 1991, 1992; White, 1986), because using data to make decisions will result in effective outcomes. The studies included in this review support this claim when applying precision teaching with students with moderate to severe disabilities because each of the 13 studies included in this review had positive results. However, a long road lays ahead to determine the real impact of precision teaching for this population. Studies replicating and extending the current research base and studies examining aspects of precision teaching that are already clearly understood with other populations are needed. The largest potential impact of applying precision teaching methods on a larger scale for children with disabilities is increasing teachers’ abilities to make decisions about intervention and
modify instruction to improve learner outcomes, but it remains to be determined if precision teaching is the most effective data-based decision making system to achieve this outcome.
Chapter 3: Research Paper

In this chapter, a research paper is presented in its entirety.

Abstract

Children diagnosed with autism spectrum disorders may have difficulty engaging in gross and fine motor movements compared to their typically developing peers (Fournier et al., 2010). This deficit can impact their performance on daily living and vocational tasks, which may limit their ability to fully participate in society. Limited research exists to suggest that developing fluency with fine motor movements can increase performance on these specific movements as well as other daily living and vocational tasks (Twarek et al., 2010). Using frequency building, 3 students diagnosed with autism were taught to perform fine motor tasks derived from the Big 6 + 6 at a faster rate to determine the frequencies of performance they would achieve. Additionally, performance on a vocational task was tested throughout the study to determine if increased frequencies on the component fine motor tasks would improve performance on the larger composite task of refilling soap bottles. Results indicated that 2 of the 3 students achieved frequency aims of 200 per min or higher and all three participants performed the fine motor skills at higher rates after the frequency building intervention.
The Effects of Frequency Building With the Big 6 + 6 Motor Movements on Motor Skill Performance for Students With Autism

Tiemann and Markle (1990) describe psychomotor learning as the level of learning necessary to engage in simple or advanced cognitive learning. Failure to move parts of the body results in difficulty engaging in tasks that require simple and advanced cognitive processes such as completing written math problems. Current research in autism spectrum disorders (ASD) indicates that a difference in motor functioning exists for this population. In a recent review of the literature related to motor coordination and ASD, Fournier, Hass, Naik, Lodha, and Cauraugh (2010) concluded that people diagnosed with ASD experience large deficits in motor functioning compared to neurotypical peers. The presence of a motor functioning deficit can impact performance in other skill areas such as imitation, social-communicative skills, daily living skills, vocational skills, and academics (McManus, n.d.; Rogers, 2009; Twarek, Cihon, & Eshelman, 2010). Therefore, it is important to identify interventions to address these deficits.

Imitation training and explicitly teaching skills using backward and forward chaining techniques are interventions commonly used by practitioners to improve performance on skills that require motor movements (Hepburn & Stone, 2006; Twarek et al., 2010). Current research aims to improve early motor development and speech production for children diagnosed with autism, but sufficient research does not exist at this time to categorize these interventions (i.e., PROMPT, tDCS/TMS, AMMT, ESDM, and RIT) as evidence-based (McCleery, Elliott, Sampanis, & Stefanidou, 2013). For example, reciprocal imitation training (RIT) focuses on increasing generalized
spontaneous imitation for children diagnosed with autism by focusing on naturalistic action imitation and recognizing the social-communicative functions of imitation. Several studies document the effectiveness of this intervention, but the direct impact on improving motor movement coordination has not been tested (McCleery et al., 2013).

Unfortunately, the techniques frequently described in the literature for addressing motor difficulties do not consistently result in improved performance on such skills and often focus on accuracy measures resulting in performance that is not fast enough for independent participation in society (Binder, 1996). In the late 1970s, after experiencing such drawbacks when teaching vocational skills to students diagnosed with autism, McManus (n.d.) describes how the use of errorless teaching techniques to teach vocational skills to his students only resulted in performances at a prevocational level. This resulted in difficulty placing the students at job sites. Focusing on building fluency in the Big 6 skills of reaching, touching, pointing, grasping, releasing, and placing resulted in improved performance of all of their students to the point where they outperformed all their peers at the job site.

The Big 6 skills described above have expanded within the field of precision teaching to include the additional fine motor skills of pushing, pulling, shaking, squeezing, tapping, and twisting and are now referred to as the Big 6 + 6. Although precision teachers describe these skills regularly within the literature and indicate that fluent performance of these skills is necessary to obtain functional performance in other skill areas such as self help skills, limited research exists to support the effectiveness of the Big 6 + 6 as an intervention (Twarek et al., 2010).

Eastridge and Mozzoni (2005) were the first to publish a study examining the
effectiveness of using the Big 6 + 6 as an intervention. Results of this study indicated that increasing the rate of fine motor movements for individuals with traumatic brain injury could improve use of both the impaired hand and the non-impaired, non-dominant hand, but this study was not a controlled experiment because there was no baseline or control condition. Twarek et al. (2010) conducted the first and only identified controlled experiment using the Big 6 + 6 as an intervention. In a multiple baseline design across participants, three children diagnosed with autism between the ages of 3 and 5 achieved fluent levels of performance on three Big 6 + 6 component skills and improved performance on putting on a shirt or underwear without additional training. The fluency aims chosen in the study were individually set and are much lower than those described in a Big 6 + 6 training manual by Fabrizio, Moors, and Pahl (2001). The fluency aims for each participant resulted in improved performance on the application task, but performance on some of the component skills did not retain during 1- and 2-week retention probes. It is possible that higher fluency aims may have resulted in retention of performance for all of the skills.

Fluency aims are determined by precision teachers in order to develop performance standards for their students. These aims are determined through research, an adult/child ratio, or sampling procedures (Kubina & Yurich, 2012). The development of fluency aims as performance standards is important because this informs practitioners of the frequency ranges necessary to produce retention, endurance, and application. Without identification of these aims, it is difficult to determine the performance standards for the Big 6 + 6 skills.

The initial fluency aims described for the Big 6 + 6 skills were determined by
sampling adults to determine performance for individuals with severe disabilities (Binder, 1996). Given the motor deficits identified for individuals diagnosed with autism, it is not clear if the fluency aims outlined by precision teachers for these skills are applicable for students diagnosed with autism. Fabrizio et al. (2001) provide fluency aims for each of the Big 6 + 6 skills for children diagnosed with autism but do not provide controlled research, a description of sampling procedures, or adult/child ratios to support development of these fluency aims.

Given the lack of research on the effectiveness of the Big 6 + 6 as an intervention to address component and composite skill performance for students with disabilities and the existence of fluency aims for these skills without research to support these aims, the purpose of the current study was two-fold. Primarily, this study set out to determine if students diagnosed with autism could obtain the fluency aims described by Fabrizio et al. (2001) for three of the Big 6 + 6 skills using frequency building to improve the rate of performance. Secondarily, this study sought to determine if improved frequency performance on these component skills could improve performance on a composite daily living skill without additional training.

Method

Participants

Three students between the ages of 12 and 18 diagnosed with autism were recruited to participate in this study. In order to be included, participants had to have a diagnosis of an autism spectrum disorder, be between 12 and 18 years old, be identified by their teacher as a student who needed to improve motor movement fluency in the arms and fingers, be assessed as performing 50% or more below the aim for each targeted
motor movement, and provide permission to participate (see Appendix A). Students who did not have full range of movement in their arms or fingers, who already fluently engaged in motor movements, who engaged in high rates of challenging behavior, and/or who had sensory impairments were excluded.

Adam was 17 years old and diagnosed with pervasive developmental disability not otherwise specified (PDD-NOS), attention deficit disorder, intellectual disability, and a language impairment according to his school file. Adam consistently followed directions within the classroom to complete academic, daily living, and vocational tasks. He responded to questions with short sentences, though he did not engage in spontaneous vocal language. Adam was identified for inclusion in this study to improve his writing and performance on daily living and vocational tasks that required fine motor movements. Adam did not have previous exposure to the Standard Celeration Chart (SCC) or timings prior to the start of the study.

Kallie was 12 years old and diagnosed with autism, selective mutism, and post-traumatic stress disorder as indicated in her school file. She readily followed instructions within the classroom to complete academic and daily living tasks, but she moved at a pace that was much slower than her peers when transitioning from one location to another. She did not respond vocally to questions from the researcher but followed receptive commands such as “if you are done, put your hand on the table.” Kallie engaged in reading, writing, and math as part of her daily classroom activities, but her teachers reported that improvement in fine motor movements would increase her speed with daily living tasks involving fine motor movements. Kallie’s teachers recently started using the SCC and daily timings with Kallie for math prior to the start of the study. She
was not exposed to timings for fine motor activities or daily living skills prior to the study or within her typical classroom routine while the study was occurring.

James was 15 years old and diagnosed with autism, epilepsy, and a visual impairment due to brain damage according to his school records. James had a history of not complying with demands throughout the school day, but with reinforcement and a visual schedule his level of compliance was acceptable for inclusion in the study. Throughout the school day, James worked on task completion activities such as putting lids on bottles and sorting items by color. He consistently answered vocal questions with one to two word responses. He also engaged in a high level of requesting and overly focused on certain aspects of the environment. For example, if the door was open, he would insist that someone close it. He was recommended for inclusion in the study because improving his fine motor movements could help improve his performance on writing and completion of activities he was required to do during the school day. James did not have previous exposure to the SCC or timings.

**Setting**

Students were recruited from a program within private autism school located in a large city in the Midwest. This program serves students with moderate to severe disabilities, ages 5 to 21, and focuses on teaching daily living and vocational skills. Each classroom has 6 to 8 students with a teacher and one to two aides. Sessions were conducted in the students’ classrooms, an empty cafeteria, or an empty life skills lab room at a desk or table that was positioned away from the other students in the classroom to avoid distractions. The researcher sat or stood next to the participant during the sessions.
**Materials**

The following materials were used to target motor fluency: preferred items as identified using an MSWO preference assessment (DeLeon & Iwata, 1996), a clothespin, a Bop It toy, and a foam ball. Preferred items for Andy were country music, silly putty, and a purple sensory ball. Preferred items for Kallie were a Disney princess book, a Frozen magnetic set, and Frozen activity books. Preferred items for James were Snickers, Reese Cups, Milky Way, 3 Musketeers, and Twix. A timer was used during baseline and intervention sessions to conduct the probes, frequency building timings, and to record the duration of each vocational task. During intervention sessions, the Standard Celeration Chart was used to chart the performance of each student. A large 40 ounce bottle of liquid hand soap and a small 7.5 ounce bottle of liquid hand soap were used for the vocational task.

**Experimental Design**

A multiple probe design across behaviors (Horner & Baer, 1978) was used in this study. Baseline data were collected on each student’s performance on pinching, squeezing, and turning, each of which is a Big 6 + 6 skill. One motor movement at a time was exposed to the intervention condition. The initial movement targeted for intervention was chosen by analyzing the baseline data to determine if responding was stable or had a flat or decreasing trend across three consecutive sessions. If more than one movement met these criteria, the movement with the highest level of stability or a larger decreasing trend was chosen. Criteria for starting intervention on each subsequent motor movement was an upward trend showing 25% improvement from baseline across three sessions for the motor movements in intervention and stable baseline responding with a flat or
decreasing trend across three consecutive probes for the motor movement about to go into intervention. An exception to this criterion was made for Kallie for turning and squeezing because each of these behaviors had slowly increasing trends toward the aim in baseline. To assess the impact of frequency building on these two behaviors, intervention was implemented first for the skill with the slowest growth trend as long as the skill(s) in intervention was(were) 25% higher than baseline with an increasing trend. The exit criterion from intervention for each motor movement was reaching aim for the motor movement as described by Fabrizio et al. (2001) for three consecutive sessions. The aims were 200 per min each for pinching, squeezing, and turning. Follow-up probes were conducted for movements in 1- to 2-week increments after the movement met the exit criterion.

**Dependent Variables**

Frequency of pinching, squeezing, and turning were the primary dependent variables. Pinching was defined as isolating and fully extending the thumb and index finger so that the two fingers were parallel to one another, touching the pad of the index finger to the pad of the thumb, and separating the index finger less than 1 in. from the thumb. Squeezing was defined as holding an object in the palm of one hand with the fingers wrapped around the object and pressing the fingers and thumb against the object until the object visually compressed. Turning was defined as grasping a stationary object with one hand, and turning the hand 90 degrees to either the left or right.

The vocational task of pouring soap was measured as a secondary dependent variable. This task was chosen because it was a skill that was not being targeted in the classroom, and it was identified as a potential skill that could be used in a vocational
setting. This task was not exposed to the intervention condition. The following task analysis was used to measure performance on this task: unscrew top of small soap, set top on table, flip lid open on large soap, hold small soap with one hand while picking up large soap and turning it so that the lid is parallel to the small soap, squeeze large soap so the soap comes out of the bottle without spilling, fill the small soap container until it is at least ¾ full, put large soap bottle on table, close lid on large soap bottle, and put small soap top into small bottle and screw top until it stops turning. If the student independently engaged in the target response for a step, a “+” was recorded. If the student engaged in a different response or did not respond within 5 s, the different response was blocked and a “-” was recorded. If the student spilled the soap outside of the container, a “-” was recorded (see Appendix B).

**Interobserver Agreement and Procedural Fidelity**

Reliability measurement occurred during each phase of the study and was calculated using total occurrence interobserver agreement (IOA) using the following formula: smallest total occurrence/largest total occurrence x 100 = total occurrence agreement IOA. IOA data were collected during at least 30% (range: 30–100%) of each phase of the study by a second observer trained by the experimenter. The training included practice recording the frequency of each motor movement during a timing. Upon reaching 90% agreement during the training sessions, the second observer began collecting IOA data. When agreement fell below 80%, an additional training session was conducted and agreement returned to acceptable levels.

During baseline sessions with Adam, mean IOA was 100% for both hands for pinching, squeezing, and turning. During intervention sessions, mean IOA was 97%
(range: 92–100%) for pinching with the left hand, 95% for pinching with the right hand (range: 86–100%), 91% for squeezing with the left hand (range: 63–100%), 90% for squeezing with the right hand (range: 77–100%), 91% for turning with the left hand (range: 87–94%), and 90% for turning with the right hand (range: 78–96%). During follow-up sessions, mean IOA was 97% for pinching with the left hand (range: 94–100%), 93% for pinching with the right hand (range: 89–97%), 94% for turning with the left hand (range: 89–97%), and 85% for turning with the right hand (range: 75–96%). One follow-up session occurred for squeezing and the IOA for this session was 87% for squeezing with the left hand and 95% for squeezing with the right hand.

During baseline sessions with Kallie, mean IOA was 100% for pinching with the left and right hands, 98% for squeezing with the left hand (range: 87–100%), 99% for squeezing with the right hand (range: 95–100%), 99% for turning with the left hand (range: 95–100%) and 99% for turning with the right hand (range: 98–100%). During intervention sessions with Kallie, mean IOA was 98% for pinching with the left hand (range: 90–100%), 96% for pinching with the right hand (range: 80–100%), 94% for squeezing with the left hand (range: 93–95%), 90% for squeezing with the right hand (range: 89–91%), 95% for turning with the left hand, and 94% for turning with the right hand. During follow-up sessions, mean IOA was 93% for pinching with the left hand (range: 89–96%), and 92% for pinching with the right hand (range: 87–96%). One follow-up session occurred for squeezing and turning and the IOA for this session was 96% for squeezing with the left hand, 95% for squeezing with the right hand, 97% for turning with the left hand, and 100% for turning with the right hand.
During baseline sessions with James, mean IOA was 97% for pinching with the left hand (range: 86–100%), 96% for pinching with the right hand (range: 88–100%), 88% for squeezing with the left hand (range: 75–100%), and 100% for squeezing with the right hand and turning with the left and right hands. During intervention sessions for James, mean IOA was 95% for squeezing with the left hand (range: 82–100%), 88% for squeezing with the right hand (range: 71–100%), 91% for turning with the left hand (range: 82–100%), and 90% for turning with the right hand (range: 80–97%). Pinching did not receive intervention so no IOA data were collected. Follow-up data were collected for one session for turning and IOA was 93% for the left hand and 96% for the right hand.

A procedural integrity checklist was used to monitor fidelity of implementation of all steps during each phase of the study (see Appendix C). Procedural integrity data were collected during at least 30% (range: 30–100%) of each phase of the study. The second observer was trained to record procedural integrity measurements. During training sessions, the experimenter and second observer each recorded implementation of the steps. Scores were compared and disagreements were discussed. Upon reaching 100% agreement during the training sessions, the second observer conducted fidelity measurements. For all participants in all phases and for all motor movements, treatment fidelity was 100%.

**Procedures**

**Preference Assessment**

A multiple stimulus without replacement (MSWO) preference assessment was conducted with each student using the procedures described by DeLeon and Iwata
(1996). The assessment was conducted at a table in the students’ classroom with the experimenter standing or seated next to the student. Prior to conducting the preference assessment sessions, the participants sampled each of the items used in the assessment for 30 s or by giving the participant a piece of the item if it was edible. Five to eight items identified by teachers and parents as potentially reinforcing on the Reinforcer Assessment Interview Survey for Individuals with Severe Disabilities (RAISD; Fisher, Piazza, Bowman, & Amari, 1996; see Appendix D) were placed in front of each student, and the student was told to, “pick one.” After picking an item, the student was given 30 s to engage with the item and the other items were removed from the table. After 30 s, the experimenter requested the item back and placed the remaining items on the table. These steps were followed until all items were chosen. Data were recorded by indicating the order in which the items were chosen (see Appendix E). Three to five trials were conducted per session and at least two sessions were conducted per student.

**Baseline**

Baseline sessions started with the experimenter providing the student a choice of three preferred items to engage with for 30 s. For James, all five items from the preference assessment were included as a choice, because he requested specific chocolates prior to the start of the first session that were not part of the top three on the preference assessment.

To conduct the timing probe, the experimenter positioned herself near the student so that she could clearly see the motor movements. The student sat at a desk or table in the classroom. The experimenter modeled the target movement and told the student to engage in the targeted motor movement until the experimenter said to stop (e.g., “pinch...
like this and keep going until I say stop”), then started a timer. When the time expired, the experimenter told the student to stop, thanked him for participating, and recorded the frequency on a data sheet (see Appendix F). All motor movements were measured during each baseline session with a 30 s break provided between timings.

The steps for measuring each motor movement differed depending on the movement. Pinching was measured by having the student pinch a wooden clothespin and the timer was set for 15 s. Squeezing was measured by having the student squeeze a soft ball in one hand and the timing for this movement was 10 s. Turning was measured by having the student turn the yellow turning knob of a Bop It toy by placing the fingers of one hand on the knob and turning it back and forth and the timer was set for 30 s. The timing lengths were different for each movement depending on the size of the movement. For example, a student can engage in a pinching motion many times in 15 s, but a turning movement is bigger and takes longer to complete. All data were converted to movements per min when graphed on the SCC, allowing for standardization across the movements even though the timing lengths were different.

**Intervention**

Prior to starting the intervention session, a X1.25 celeration line was drawn on the students’ SCC using their baseline data. This line was drawn by placing a chart finder at the highest data point from baseline, placing a dot on the chart at the X1.25 celeration line, and drawing a line connecting the two points. This line represented a weekly rate increase of 1.25. For example, if a student performed 10 movements per min during baseline, the line would be drawn from 10 to 12.5 for the week. The goal for the student would be to perform 12.5 movements by the end of the week.
After the initial intervention session, the X1.25 celeration line was determined by using the highest data point from the frequency building timings to determine the goal for the next session. An exception to this was made for James, because his performance during frequency building timings was highly variable. A X1.25 celeration line was drawn based on his average performance during his frequency building timings. For example, if his frequency was 20, 25, 30, 20, and 35 on his frequency building timings, a X1.25 celeration line was drawn from the frequency of 26, the average of the frequencies.

Intervention sessions started with the student engaging with a preferred item for the first 30 s of the session or consuming one piece of an edible item. Next, a timing probe was conducted using the same procedures described in baseline. Performance on this probe was graphed on an SCC. After 11 intervention sessions, the timing length for turning during the timing probe and frequency building timings was decreased from 30 s to 10 s for James, because he was turning for the first part of the timing but would stop performing after about 10 s.

After the timing probes, the experimenter conducted five frequency-building timings with the student. Prior to the frequency-building timings, the experimenter and student determined the daily goal using the X1.25 celeration line on the students’ SCC. For each frequency-building timing, the student received the same instructions as the timing probe, but the experimenter encouraged the student to go fast and provided verbal feedback during the timing. After the timing, the experimenter recorded the data (see Appendix G) and the experimenter and student charted the number of movements completed during the timing and the experimenter provided feedback to the student regarding his performance. During frequency-building timings for James, the
The experimenter counted out loud as part of the verbal feedback, because he did not attend to the verbal feedback provided between timings.

These steps were followed until five timings were completed. After the fifth timing, the students received access to a preferred item for 30 s for each time the goal was met. James received one piece of chocolate of his choice for meeting his goal one time and two pieces if he met his goal every time. James preferred large pieces of chocolate, making it infeasible to potentially give him five large pieces of chocolate for each frequency building session. If the student did not meet the daily goal, the experimenter thanked him for participating. All movements in intervention were targeted daily with 30 s breaks between timings.

**Follow-up Probes**

Follow-up timing probes were conducted to measure maintenance of performance on each of the movements after the student met the exit criterion. The procedures for these probes were identical to those used for timing probes in baseline and intervention.

**Assessment Probes**

Assessment probes were conducted for performance on the vocational task of pouring soap from a large soap container to a small soap container during baseline, prior to intervention for each motor movement, and after intervention was complete for all motor movements for a total of five assessment probes.

During these sessions, the experimenter modeled the task, then told the student to, “pour the soap.” If the student made an error during this probe or did not respond after 5 s, the experimenter turned the student away from the task and completed the step for the
student and then instructed the student to continue to perform the task by saying “keep going”. Upon completion of the probe, the student was thanked for participating.

Results

Adam

During baseline for pinching (see Figures 1, 2, and 3), Adam’s average rate of performance was 4 pinches per min for both hands. During intervention, he averaged 168 pinches per min for the left hand and 156 pinches per min for the right hand. Adam reached aim for pinching after the 10th intervention session for the left hand and the 11th intervention session for the right hand. During the 9th frequency building session (see Figure 4), Adam reached aim with his left hand and the highest performance achieved during frequency building was 220 pinches per min. Adam reached aim on the 12th frequency building session with his right hand and the highest performance achieved was 220 pinches per min. During five weekly follow-up probes, Adam’s average performance maintained with 204 pinches per min with his left hand and 200 pinches per min with his right hand. During the last follow-up session with his right hand, Adam’s performance was significantly lower at 156 pinches per min, but the clothespin was moving around more than usual in his hand.

Adam’s celeration for pinching during baseline was X1.0 for both hands. His celeration during intervention was X1.32 with the left hand and X1.31 with the right hand. During follow-up, celeration was X1.01 with the left hand and /1.03 with the right hand. Adam’s bounce during baseline was not calculated because there were not enough data points. His bounce during intervention was X42.7 with the left hand and X39.3 with the right hand, but there was an outlier of 4 pinches per min during one of the initial
Figure 1. Responses per minute during timing probes for Adam.
Figure 2. Standard Celeration Chart of responses per minute during timing probes for Adam’s left hand.
Figure 3. Standard Celeration Chart of responses per minute during timing probes for Adam’s right hand.
Figure 4. Highest response per minute during each frequency building session for Adam.
intervention sessions. Bounce during follow-up was X1.3 for the left hand and X1.4 with the right hand.

Average baseline performance for turning (see Figures 1, 2, and 3) was 2 turns per min for both hands. During intervention, average performance was 170 turns per min for the left hand and 190 turns per min with the right hand. Adam reached aim for turning for both hands after 3 intervention sessions. He reached aim during the 4th frequency building session (see Figure 4) for both hands and the highest performance achieved during frequency building sessions was 208 turns per min for the left hand and 250 turns per min for the right hand. Adam’s performance during three weekly follow-up sessions slightly decreased on the left hand with an average performance of 192 turns per min but maintained for the right hand with an average performance of 248 turns per min.

Adam’s celeration rate during baseline for turning was 1.36 for the left hand and X1.0 for the right hand. His celeration rate during intervention was X1.57 for the left hand and X1.8 for the right hand. During follow-up, the celeration rate was X1.01 for the left hand and /1.01 for the right hand. Adam’s bounce during baseline was X1.9 for the left hand and X1.0 for the right hand. His bounce during intervention was X1.6 for the left hand and X1.4 for the right hand. His bounce during follow-up was X1.5 for the left hand and X1.3 for the right hand.

During baseline for squeezing (see Figures 1, 2, and 3), Adam’s average performance was 18 squeezes per min for the left hand and 24 squeezes per min for the right hand. His average performance during intervention was 162 squeezes per min with his left hand and 180 squeezes per min with his right hand. Adam reached aim for his left hand after 11 intervention sessions and for his right hand after 9 intervention sessions and
exit criteria was achieved within the next 2 sessions. However, exit criteria for stopping intervention for squeeze with the left hand was not met until the 17th session. Adam met aim in the frequency building sessions (see Figure 4) for his left hand during the 8th session and the highest performance achieved was 222 squeezes per min. He met aim in the frequency building sessions for his right hand during the 6th session and the highest performance achieved was 252 squeezes per min. Adam’s performance during the 1-week follow-up probe was slightly lower for the left hand with 180 squeezes per min but maintained for the right hand with 222 squeezes per min.

Adam’s celeration for squeezing during baseline was X1.34 for the left hand and X1.04 for the right hand. His celeration during intervention was X1.18 for the left hand and X1.11 for the right hand. Adam’s bounce during baseline was X11.2 for the left hand and X17.9 for the right hand. During intervention, bounce was X2.1 for the left hand and X2 for the right hand.

For the secondary measure of pouring soap (see Figure 5), Adam’s performance was 100% during baseline, 78% prior to intervention for pinch, 89% prior to intervention for turn, 100% prior to intervention for squeeze, and 89% post intervention. The duration of completing the pouring soap task was 2 min and 5 s during baseline, 1 min and 57 s prior to intervention for pinching, 1 min and 48 s prior to intervention for turning, 1 min and 10 s prior to intervention for squeezing, and 1 min and 18 s post intervention.

Kallie

During baseline sessions for pinching (see Figures 6, 7, and 8), Kallie averaged 72 pinches per min for the left hand and 64 pinches per min for the right hand. Her pinching performance started at a rate of 32 pinches per min for both hands and the rate slowly
increased during baseline probes until it stabled out across 13 baseline sessions at 88 pinches per min for the left hand and 76 pinches per minute on the rate hand.

In intervention, Kallie’s average pinching rate was 176 pinches per min for the left hand and 144 pinches per min for the right hand. Her pinching performance reached the aim of 200 pinches per minute after 11 intervention sessions and she exceeded aim for her left hand with a performance of 240 pinches per minute during the 12th intervention session. Kallie reached aim for pinching during her 5th frequency building session (see Figure 9). The highest rate of pinching achieved during frequency building sessions was 332 pinches per min with the left hand and 304 pinches per min with the right hand. Kallie’s performance retained and continued to increase during two 1-week
follow-up probes with an average performance of 288 pinches per min with the left hand and 256 pinches per min with the right hand.

Kallie’s celeration rate for pinching during baseline was X1.19 for the left hand and X1.16 for the right hand. For the left hand, her celeration during intervention was X1.14 and X1.61 during the first 7 intervention data points as her performance approached aim. For the right hand, her celeration during intervention was X1.14 and X1.43 during the first 7 intervention data points as her performance approached aim.

Kallie’s bounce during baseline was X2 for the left hand and X1.9 for the right hand. Her bounce during intervention was X1.6 for the left hand and X1.5 for the right hand.

During baseline (see Figures 6, 7, and 8), Kallie’s average rate of squeezing was 78 per min for the left hand and 72 per min for the right hand. Her rate of squeezing slowly increased during baseline, with her highest squeezing performance at 138 squeezes per min for the left hand and 132 squeezes per min with the hand. During intervention, Kallie’s average rate of squeezing was 234 squeezes per min for the left hand and 219 squeezes per min for the right hand. Kallie exceeded the aim of 200 squeezes per min for both hands after 2 intervention sessions. She reached aim for squeezing during her 1st frequency building session for both hands (see Figure 9). The highest squeezing performance achieved during frequency building was 378 squeezes per min with the left hand and 312 squeezes per min with the right hand. Kallie’s performance during a 1-week follow-up probe retained and continued to increase with a rate of 276 squeezes per min for the left hand and 252 squeezes per min for the right hand.
Kallie’s celeration rate for squeezing during baseline was X1.1 with the left hand and X1.11 with the right hand. Her celeration rate during intervention was X1.13 for both hands. Her bounce during baseline was X1.6 for the left hand and X1.7 for the right hand. Kallie’s bounce during intervention was X1.2 for the left hand and X1.3 for the right hand.

For turning (see Figures 6, 7, and 8), Kallie’s average rate was 120 turns per min with the left hand and 90 turns per min with the right hand during baseline. Her initial performance during baseline was 56 turns per min with the left hand and 34 turns per min with the right hand. Her performance increased across 17 baseline sessions to 220 turns per min with the left hand and 180 turns per min with the right hand. Her performance decreased during the last baseline session to 186 turns per min with the left hand and 122 turns per min with the right hand. Kallie’s average rate of performance during intervention was 312 turns per min with the left hand and 332 turns per min with the right hand. She reached and exceeded the aim of 200 turns per min after the first intervention session for both the timing probe and the frequency building sessions (see Figure 9). The highest performance achieved during frequency building sessions was 410 turns per min with the left hand and 412 turns per min with the right hand. Kallie’s performance retained during the 1-week follow-up probe with 380 turns per min with the left hand, which was a slight decrease from her last intervention session but still above the aim for this skill. She also performed 400 turns per min with her right hand, which was the same as her performance the previous week and double the aim for this skill.

Kallie’s celeration rate during baseline for turning was X1.1 for the left hand and X1.12 for the right hand. Her celeration rate during intervention was X2.21 for the left
Figure 6. Responses per min during timing probes for Kallie.
Figure 7. Standard Celeration Chart of responses per minute during timing probes for Kallie’s left hand.
Figure 8. Standard Celeration Chart of responses per minute during timing probes for Kallie’s right hand.
Figure 9. Highest response per minute during each frequency building session for Kallie.
hand and X2.11 for the right hand. Kallie’s bounce during baseline was X2 for both hands. Bounce during intervention could not be calculated because there were too few data points.

Kallie’s performance on the secondary dependent variable of pouring soap (see Figure 10) was 78% during baseline and prior to starting intervention for pinching, 89% prior to starting intervention for squeezing, and 78% prior to starting intervention for turning and post completion of intervention for all tasks. Kallie’s duration of pouring soap increased from 2 min and 23 s at baseline to 3 min post intervention. Prior to reaching aim for squeezing, Kallie spilled the soap during the probe but she did not spill the soap during the last 2 probes.

Figure 10. Percentage correct and duration of pouring soap for Kallie.
James

During baseline sessions for turning (see Figures 11, 12, and 13), James’ average rate of performance was 28 turns per min for the left hand and 26 per min for the right hand. James average rate of performance during intervention was 76 turns per min for the left hand and 112 turns per min for the right hand. James achieved the aim of 200 turns per min after 10 intervention sessions for both hands and after the timing was changed from a 30 s timing to 10 s timing. James continued to perform at aim or higher for the right hand but required a total of 18 intervention sessions to meet the exit criterion of performing at aim or higher for 3 sessions in a row on the left hand. James reached aim with his left hand during the 14th frequency building session (see Figure 14) and during the 12th frequency building session for his right hand. The highest performance achieved during the frequency building sessions was 204 turns per min with the left hand and 258 turns per min with the right hand. During a 1-week follow-up session, James’ performance maintained with a slightly higher performance of 240 turns per min with the left hand and a slightly lower performance of 312 turns per minute with the right hand. Both of these were above the aim for this skill.

James’ celeration rate during baseline for turning was 1.15 with the left hand and 1.38 with the right hand. His celeration rate during intervention was 1.19 with the left hand and 1.16 with the right hand. James’ bounce during baseline was not calculated because there were not enough data points. His bounce during intervention was 2.2 for both hands.

During baseline for squeezing (see Figures 11, 12, and 13), James’ average rate of performance was 18 squeezes per min with the left hand and 24 squeezes per min with
Figure 11. Responses per minute during timing probes for James.
Figure 12. Standard Celeration Chart of responses per minute during timing probes for James’ left hand.
Figure 13. Standard Celeration Chart of responses per minute during timing probes for James’ right hand.
Figure 14. Highest response per minute during each frequency building session for James.

the right hand. James average performance during intervention was 54 squeezes per min with the left hand and 78 squeezes per min with the right hand. After 16 intervention sessions, James did not reach the aim of 200 squeezes per min for this skill prior to the termination of the study. James did not reach aim during the frequency building sessions (see Figure 14) for his left hand and his highest performance achieved was 168 squeezes
per min. James performed at aim during the 5\textsuperscript{th} frequency building session with the right hand and his highest performance achieved was 222 squeezes per min.

James’ celeration during baseline for squeezing was /1.23 with the left hand and X1.17 with the right hand. His celeration during intervention was /1.11 with the left hand and X1.36 with the right hand. James’ bounce during baseline was X2.6 with the left hand and X3.6 with the right hand. His bounce during intervention was X8.5 with the left hand and X4.4 with the right hand. A median level analysis was also conducted for squeezing to determine the change in level for this skill. During baseline, the median performance for both hands was 18 squeezes per min and for the right hand. During intervention, the median performance was 60 squeezes per min for the left hand and 63 squeezes per min for the right hand.

James’ average performance for pinching during baseline was 20 pinches per min with the left hand and 68 pinches per min with the right hand. Intervention was not implemented with this skill because the study terminated before the skill met criteria for receiving intervention. His celeration rate during baseline was /1.16 with the left hand and X1.07 with the right hand. James’ bounce during baseline was X13.1 with the left hand and X1.09 with the right hand.

James’ performance on pouring soap (see Figure 15) remained at 0% during baseline, prior to starting intervention for turning, and prior to starting intervention for squeezing. James performed this task in 1 min 49 s during baseline, 1 min 50 s prior to turning, and 1 min 51 s prior to squeezing.
Discussion

This study produced mixed results, with two of the three participants performing the targeted fine motor skills at increased rates on all three skills during the frequency building intervention. All three participants performed the fine motor skills at higher rates after the frequency building intervention than during baseline. Although James’ rate of performance did not increase as dramatically during the frequency building intervention, all three participants met the aims listed by Fabrizio et al. (2001) for at least one skill. Additionally, all three participants had a long history of performing each of the fine motor skills at low rates. However, in as little as one intervention session and less than 20
intervention sessions, all three participants performed the skills at rates that were at least double their baseline performance. Kallie and Adam met or exceeded aims for all three of the targeted skills, which lends support for the aim of 200 to 300 responses per min as described by Fabrizio et al. (2001) for pinching, turning, and squeezing. The results of this study support the research conducted by Eastridge and Mozonni (2005) and Twarek et al. (2010), because the participants in all three studies performed Big 6 + 6 movements at higher rates after a frequency building intervention. However, this study failed to replicate these results for all participants. This study is counter to the findings of Twarek et al. (2010) because higher rates of performance on the targeted Big 6 + 6 component skills did not result in obvious improvements of performance on the composite skill of pouring soap.

Experimental control for the effect of the frequency building intervention on the rate of performance of squeezing, pinching, and turning was demonstrated most convincingly with Adam, because his performance for each skill occurred at low rates during baseline and did not increase to a higher rate of performance until the frequency building intervention occurred. However, Adam’s performance of pouring soap had no room for improvement because he performed this skill at 100% during baseline. The amount of time to complete the task decreased over the course of intervention from 2 min and 5 s to 1 min and 18 s but his performance on the task analysis also decreased from 100% to 89% correct. There was no room for growth on this skill besides decreasing the amount of time it took Adam to complete the task while maintaining his performance. It is possible that targeting a different skill would have been more appropriate. Additionally, the steps that Adam missed during the probes did not relate directly to the
fine motor skills targeted. For example, during the last probe, he did not put the large bottle back on the table after pouring the soap. It is plausible that the decrease in time to complete the task occurred because of his increased rate of performance for the component skills. However, similar performance on additional tasks with the same component skills would provide a more convincing demonstration.

Kallie’s performance on the fine motor tasks showed improvement with the one timing probe that occurred each day and during baseline probes, thus experimental control is not as convincing for her data. These results suggest that for some students, a higher rate of performance may occur with only one timing per day and warrants further study. Even though Kallie’s performance increased during baseline and did not stabilize for squeezing and turning prior to intervention, her rate of learning, the variability of her performance decreased, and her performance during frequency building intervention on each skill far surpassed the aims listed by Fabrizio et al. (2001). For example, her celeration rate during baseline for turning was X1.1 for the left hand and X1.12 for the right hand over 79 days. This means her performance grew weekly by 10% for her left hand and 12% for her right hand during baseline. Her celeration rate during intervention for turning was X2.21 for the left hand and X2.11 across 3 days. This means after frequency building was implemented, her turning behavior grew by 120% for the left hand and 111% for the right hand, which is a significantly higher rate of growth.

The occurrence of this pattern for each skill from baseline to intervention, suggests frequency building consistently increased Kallie’s rate of performance beyond what she would have achieved if baseline procedures continued. Although Kallie may have reached the aim eventually for each of these skills with one timing per day, she
obtained the aim after 12 intervention sessions for pinching and immediately after the first intervention session for squeezing and turning. Efficient achievement of goals is critical for students with disabilities who frequently perform below grade level (Browder & Spooner, 2011). Kallie’s performance suggests that even for students who are making progress with a skill, frequency building may accelerate that progress.

Kallie’s performance on pouring the soap did not improve based on the data that were collected for this task. Her percentage of correct responses remained about the same throughout the study with a performance of 78% during baseline and post-intervention. However, the steps that Kallie missed during these probes changed from spilling the soap while squeezing it from the large bottle to the small bottle and not flipping the cap of the large bottle closed to not putting the large bottle down and not flipping the cap closed. Squeezing the soap without spilling did not improve until Kallie met aim on squeezing. Therefore, it is possible that the increased rate of performance for squeezing improved Kallie’s ability to squeeze the soap without spilling it. The other missed step of flipping the large cap closed was not related to the component skills targeted in this study. Kallie’s duration on the pouring soap task did not decrease throughout the study but during the first 3 probes, she did not complete pouring the soap herself because she spilled the soap. The duration on the last two probes is likely higher because Kallie poured the soap by herself the entire time as opposed to the researcher finishing that step for her when she had an incorrect response in the previous probes.

Frequency building produced a demonstration of behavioral change for James for the two skills that received intervention but the rate of performance was not as high as Adam and Kallie’s. His performance was highly variable during baseline and intervention
sessions but visual analysis indicates a difference in performance for both turning and squeezing after intervention was implemented. For example, the level analysis for squeezing indicates that James’ performance during baseline for both hands had a median level of 18 squeezes per min. After intervention, the median level increased to 60 squeezes per min on the left hand and 66 squeezes per min with the right hand, which is three times his performance at baseline. James’ performance on the pouring soap task was 0% throughout the study and the duration ranged from 1 min 48 s to 1 min 51 s.

James only reached aim for one skill and this did not result in a change in his performance. James had a history of engaging in task refusal as evidenced by refusing to perform classroom activities that involved sorting, putting lids on containers, and matching. He also frequently engaged in perseverative behavior during timings where he would make a comment to the researcher and continue to repeat it until she repeated what he said. This often resulted in James not responding consistently during the timing and is a possible explanation for his variable performance. Despite this history, James engaged in a higher number of responses during his sessions for this study than he did for tasks throughout the skill day. James was often observed to complete about 10 responses per 5 min during the school day, but during his timings he was engaging in upwards of 50 responses per min or more.

James performed at higher rates when the timing interval was shortened for turning from 30 s to 10 s. After 10 intervention sessions of not meeting aim with the 30 s timing, he met aim during the first 10 s timing session. This timing length was chosen for James because he would often turn the knob quickly during the first part of the timing and then engage in perseverative behavior. The shorter duration decreased the likelihood
of this happening. It is possible that different timing lengths would improve James’
performance for the other skills as well.

Additionally, James frequently requested access to the chocolate he was earning
for meeting his goal. Due to his history of task refusal and engaging in escape-maintained
behavior, it is possible that providing reinforcement for meeting his goal and then ending
the frequency building timings would have improved his performance. For the purposes
of this study, the timings were done 5 times each session regardless of performance.

James’ performance may have improved if tool skills for timings were identified
and targeted. A tool skill is a basic skill that is necessary for completing a larger skill. An
example of a tool skill for writing math facts is holding the pencil because you cannot
write math facts if you are not able to hold a pencil. A tool skill for timings specific to
James, would be engage in simple behavior multiple times in a row without engaging in
perseverative behavior. For example, James could receive reinforcement for engaging in
a simple high probability response quickly without making comments for a very short
timing duration and then the duration could increase to higher durations. This would help
James learn how to respond during a timing and could improve his ability to engage in
the targeted fine motor responses without commenting during frequency building timings
and timing probes.

Lastly, a finding of this research is that the frequency building procedure as
conducted in this study may not work well for students like James who are motivated
who engage in escape-maintained challenging behaviors. It is possible that providing
access to a tangible reinforcer and escape from the task upon meeting the goal during the
frequency building session would increase performance outcomes for learners like James.
This would provide the learner with immediate access to reinforcement as opposed to requiring the learner to engage in five timings regardless of performance.

*Limitations*

Several limitations were present in this study. The first limitation is that clear experimental control was only demonstrated for one participant. For James, experimental control was not clearly demonstrated because only two of the three fine motor skills received intervention. For Kallie, experimental control was not as clear because completing the timing probes in baseline resulted in practice effects and increased responding throughout baseline. This limitation could be addressed in future research by determining prior to the start of the study a set number of baseline sessions for each skill such as five, seven, and nine data points. This could limit the occurrence of increased rates during baseline but may result in implementing the intervention without stable data in baseline. However, measures of celeration and bounce during baseline and intervention could be used to determine the impact of the intervention on performance. If a participant’s responding accelerates more quickly with less variability during intervention, this would provide evidence of experimental control. Additionally, a different research design could be used, such as an alternating treatments design, where timing probes are used as the dependent variable for two similar Big 6 + 6 skills but different interventions are used to increase the rate of performance of the skill. Comparisons in rate of performance and celeration could then be made between the skill exposed to frequency building and the skill exposed to no intervention or a different intervention such as fine motor imitation trials presented in a discrete trial format.
The materials used in the study could be another limitation. The results achieved may be different with the use of different materials. Future research should explore performance of these skills using materials other than a clothespin, soft ball, and knob on a Bop It. All of the materials allowed for free operant responding but there were issues with each item. The clothespin sometimes slipped out of the students’ hand, the ball started to deteriorate and crack, and the knob on the Bop-it may have been too small for Adam and James’ hands. Future researchers might try to use medicine droppers for pinching, rubber balls for squeezing, and a door knob mounted to wood for turning.

The lack of change in performance for the pouring the soap task for both Adam and Kallie is also another limitation. Both students reached aim on the targeted Big 6 + 6 skills but did not show significant improvement on the composite task of pouring soap. For Adam, this may be due to him performing at 100% on the task during baseline so there was no room for growth in accuracy of performance. Unfortunately, other skills that Adam had not yet mastered were being targeted in his classroom, so were not appropriate to use in this study. Future research should investigate probing performance on several composite tasks and only measuring performance on the steps that directly relate to the component skills being targeted in order to address this limitation. This performance could also be measured using timing probes instead of just accuracy in order to determine if improved fluency in the component skills increases fluency of the composite skills. Future research could also focus on only using composite skills where the student is not performing with a high level of accuracy so that there is room for growth.

Another limitation is that only three of the Big 6 + 6 movements were targeted. It is not clear if similar results in changes of performance rate would be obtained for the
remaining skills. It is also possible that meeting frequency aims for all of the Big 6 + 6 skills is necessary before seeing improved performance on composite skills that involve fine motor movements. Future research should explore how performance on composite skills changes as frequency aims are met for each of the Big 6 + 6 skills.

Lastly, social validity of the study procedures and outcomes was not measured using survey or interview methods with the teachers, participants, or parents, but evidence of acceptable social validity was present during the study. The teachers of the students were supportive of the study and readily accommodated the needs of the researcher for space and time to work with the students. All three participants readily joined the researcher upon arrival in the classroom. Kallie initially took 5 min or longer to transition from her desk in the classroom to the table where sessions were conducted. After the first few sessions, she immediately transitioned to the table within 15 s or less suggesting her preference for the procedures being implemented. James frequently requested to work with the researcher on days when she was not at the school, greeted her with a smile, and transitioned from task refusal to task acceptance upon arrival of the researcher. The methods used during James’ sessions resulted in a significantly higher number of responses than his typical work activities. This suggests that timings with immediate access to a reinforcer effectively increase James’ rate of responding over his typical rate and could be adapted to his other work tasks to produce more responses throughout the school day.

Future Research

In addition to the future research recommended above to address the limitations, many options exist for continuing to examine the use of the Big 6 + 6 skills as an
intervention for children with autism or other disabilities. Given the lack of research in this area, the procedures used in this study or previous studies (Eastridge & Mozzoni, 2005; Twarek et al., 2010) should be replicated with additional participants, populations, and Big 6 + 6 skills. Building on the existing research base is a necessary first step for conducting additional research on the Big 6 + 6 skills, but modifications related to the frequency building intervention in the current study are also necessary. This includes comparing changes in performance rate using one timing per day versus multiple frequency building timings per day, ending the frequency building timings after meeting a goal versus conducting a set amount of frequency building timings, and continuing frequency building intervention until performance stabilizes in order to develop a clearer understanding of potential aims.

Additional research is also necessary to determine how to clearly demonstrate a relationship between the performance on component Big 6 + 6 skills and composite skills. Using a single opportunity task analysis method where the composite skill is probed and the session ends upon the student engaging in an error or not responding may more clearly represent the student’s performance on the task, because the time engaged in the task would represent only steps performed by the student. Additionally, the calculation of the duration for skills assessed with multiple opportunity probes could be changed to a proportion where the number of steps completed by the student is divided by the time the student engaged in the task. This would provide a more consistent measure of performance. The use of timing probes could further standardize the measurement system. If the student could already perform the task independently but the rate of completion was not fast enough, a timing probe could be used to measure how
many times the student completes the task during the timing. If the rate of completion during timing probes increases as the rate of performance on the Big 6 + 6 skills increase, this would provide evidence that intervention using the Big 6 + 6 is effective at improving performance on composite skills.

Conclusion

This research study examined the impact of frequency building timings on rate of performance of pinching, squeezing, and turning for three students diagnosed with autism. Additionally, the study sought to evaluate change in performance on the vocational task of refilling a soap bottle as the students performed the fine motor tasks at higher frequencies. Two of the three participants met frequency aims as described by Fabrizio et al. (2001) for all three skills and the third participant achieved the frequency aim for turning during 10 s timing probes. However, performance on the vocational task for the students who met aim did not change throughout the study. Future research is needed to address the limitations within this study and to develop a larger research base for the use of the Big 6 + 6 as an intervention for students with autism and other disabilities.
Chapter 4: Practitioner Paper

This chapter presents a practitioner paper for teachers on how to use frequency building to improve learning outcomes for students with disabilities. The procedures presented in this chapter were based on the previous research included in the literature review (Chapter 2), and the research study (Chapter 3) conducted within this dissertation that incorporated frequency building as the intervention.

Abstract

Frequency building is an intervention commonly used within the field of precision teaching to rapidly improve the performance of students who are performing below grade level on basic skills (Binder, 1996). Frequency building has also been applied successfully with skills related to academics and independent living for students with disabilities. This paper describes how teachers can incorporate frequency building within their classroom schedule to increase student progress in math, reading, and fine motor skills.
Practice Makes Perfect: Using Frequency Building to Enhance Student Performance

Mrs. Hayes, an elementary school special education teacher, realized recently the rate of progress for the students in her classroom will continue to put them further behind for their grade-level. Students in her classroom often come to her performing more than two grade levels behind in all academic areas. Each school year she closely tracks their progress and is pleased with the skills that they master, but she would like to incorporate additional interventions within her classroom to help her students make faster progress on basic skills so they will learn complex skills more quickly. There is also not much room in the classroom schedule to spend time on these skills, so she is hoping to find an evidence-based intervention that only takes a few minutes each day.

The importance of mastering basic skills to fluent levels in order to engage in complex and abstract academic tasks is well recognized within the field of precision teaching (Binder, 1996; Johnson & Layng, 1992, 1996; Kubina & Morrison, 2000). Students with disabilities typically have not mastered these basic component skills, which may result in a failure to make progress on the composite skills that are being taught in the classroom (Binder, 1996). For example, a student who struggles to accurately and quickly identify math facts will also have difficulty completing math word problems because the student has not mastered the component skill (i.e., math facts) necessary to perform the composite skill (i.e., math word problems). Failure to develop fluent skill repertoires can also reduce skill acquisition rate and maintenance of skills taught during the school year, resulting in the repetition of IEP goals from year to year for students with disabilities (Binder, 1996; Weiss, Pearson, Foley, & Pahl, 2010).
Frequency building procedures can be used with students with disabilities to enhance basic skills to high frequencies to develop fluent performance and to monitor progress (Binder, 1996; Johnson & Street, 2013; Weiss, Fabrizio, & Bamond, 2008). Frequency building focuses on practicing component skills in a student’s repertoire that are not performed in an effortless and automatic manner (Binder, 1996; Johnson & Layng, 1992, 1996; Kubina & Morrison, 2000). The skill is performed for a specific timing period (usually 1 min or less), and data are collected on the frequency of correct and incorrect responding. After the timing, the student receives performance feedback and coaching, and the performance is charted on a Standard Celeration Chart. Multiple timings occur during each frequency building session until the student beats his goal or completes the targeted number of timings (e.g., 5 timings each session). Upon beating the goal, the student receives access to a reinforcer.

This paper will provide examples of how to use frequency building procedures with students with disabilities by providing suggestions for how to set-up frequency building within the classroom and by providing examples for math, reading, and fine motor skills. Information regarding basic skills that should be taught to fluency is also provided. The paper concludes with an explanation of how to use peer coaches during frequency building.

Setting Up Your Classroom

Frequency building procedures should take 10 min or less to complete per subject area targeted. The procedures should flow smoothly and effortlessly, but this requires preparation. For a comprehensive overview of how to incorporate procedures
In the late 1970s, precision teachers started focusing on developing fluency in basic skills (Johnson & Layng, 1992). Frequency building has been used to improve performance for students performing below grade level in mathematics (Brady & Kubina, 2010), reading (Cavallini & Perini, 2009; Hughes, Beverly, & Whitehead, 2007), spelling (Kubina, Young, & Kilwein, 2004), and writing (Dermer, Lopez, & Messling, 2009; Datchuk, Kubina, & Mason, 2015). Binder, Haughton, and Van Eyk (1990) provided initial evidence for the effectiveness of frequency building for students with disabilities with case studies of two elementary students who achieved higher motor performance responses and compliance using 15 s frequency building timings. Students with moderate to profound disabilities have benefited from frequency building procedures used to improve reading rate (Cavallini, Berardo, & Perini, 2010), basic math fact computation (Moors, Weisenburgh-Snyder, & Robbins, 2010), fine motor skills for dressing (Twarek, Cihon, & Eshleman, 2010), and clerical skills (Cohen, 2005). A collateral effect of decreased aggression as performance rate on clerical skills increased was also observed in one of these studies (Cohen, 2005).

Grey Box 1. What does the research say?

into a school day, see Johnson and Street (2013) and Kubina and Yurich (2012). Two of their recommendations will be discussed in detail in this section.
Prior to starting frequency building, it is important to determine what basic skills to target within the academic area. Kubina and Yurich (2012) provide three guidelines for choosing frequency building targets. The first is to determine the component or element skills that are critical for the development of the composite or compound skills. They recommend doing this by closely examining the scope and sequence of the curriculum to determine which skills overlap with other skills. For example, prior to engaging in the compound behavior of sounding out words, a student should fluently identify letter sounds. The second step is to choose behaviors that will have far-reaching effects. This means the behavior provides the learner with access to new reinforcers and learning experiences, is socially valid, leads to generalization, replaces inappropriate behaviors when applicable, and affects a number of people. Lastly, the target should be a skill that is beyond the acquisition stage of learning. This means the skill has already received instruction and the student is performing the skill correctly (90–100%) but not fluently.

The 10-step workflow presented by Kubina and Yurich (2012) should also be incorporated when implementing frequency building procedures, because it will help to ensure they occur in a smooth and organized fashion. The steps are (a) gather materials for frequency building, (b) place learners individually or in pairs, (c) activate timing device and give a signal to start the timing, (d) timing device indicates when to stop, (e) provide brief feedback to students after the trial ends, (f) count corrects and incorrects, (g) record data, (h) chart data, (i) use chart to make decision to continue with frequency building or make a change, and (j) return materials to storage location. Frequency building materials typically consist of file folders with the student’s graph stapled to the
outside and materials (i.e., worksheets, data sheets) required for the timing inside the folder.

Prior to implementing frequency building procedures in the classroom, teachers should also identify how they will determine terminal and daily goals for each skill being targeted so the students have access to this information when the procedures are implemented. Teachers can determine terminal goals by looking up aims for the targeted skill (see Johnson & Street, 2013; Kubina & Yurich, 2012 for a list of aims) or sampling students or adults who perform the skill fluently and using their rate of performance. For each skill that is targeted, the terminal goal for the aim is listed on the worksheet or data sheet and the student marks this goal on his graph so that he can see his progress toward achieving the goal. One of the simplest ways to determine daily goals is to set the daily goal as one or two correct responses higher than the highest performance from the previous frequency building session. How many responses the student performs above the previous session’s performance should be high enough to result in efficient learning but not so high that the student does not achieve his goal. Teachers can also use acceleration lines to determine daily goals. The process for doing this is beyond the scope of this paper; see Johnson and Street (2013) and Kubina and Yurich (2012) for a detailed description of this process.

Lastly, teachers should determine how many frequency building timings they will have students complete for each skill prior to implementing frequency building procedures. Most precision teachers will conduct 5 or 10 timings. The number of timings should provide sufficient practice opportunities for the students and should be balanced with the time allotted for frequency building in the classroom schedule. If the timings are
1 min in length, it should take 15 min to complete 10 timings – allowing for time to record data and provide feedback. After determining the number of timings that will occur daily, this information is given to the students so they know how many timings they will complete daily for each skill.

**General Frequency Building Procedures**

After setting up the classroom, it is important to know the procedures to follow when using frequency building. The procedures are typically the same regardless of the content area so this section focuses on describing those procedures. Prior to implementing frequency building with students, it is helpful to explain the process to them. Students are instructed that they will complete timings to help them become experts in the targeted skill area. The data sheet, graph, and worksheets or physical materials for the timing are also explained to the student. The easiest way to do this is using direct instruction. The teacher shows the students the materials and models how to conduct a timing, then the students do a timing using the materials with the teacher, and then the students try to use the materials to complete a timing on their own. During this process, the teacher provides feedback to the students to help them use the materials correctly.

During the first frequency building session for a targeted skill, the students are instructed to complete three timings by responding as quickly as possible during the timing. After each timing, the student records and graphs the data but no feedback is provided. The data from these three timings are used to determine the initial daily goal. For example, if the daily goal is to perform one response higher than the previous
sessions’ highest performance, and the student performed 5 problems, 8 problems, and 6 problems during the initial timings, her first daily goal is 9 problems.

When it is time to conduct the frequency building session, the students are instructed to get their frequency building materials or the teacher passes out the materials. The teacher tells the students it is time to practice the targeted skill and assists the students in preparing the materials. The teacher tells the student how many timings they will do during the session, encourages the students to respond quickly, reminds the students to stop their timings if they reach their goal, and to ask for assistance if they are not making progress toward their goal after a few timings.

Prior to completing the first timing of the day, the students are reminded to look at the data from the previous day to determine the daily goal for the frequency building session based on the method being used by the teacher. This goal is recorded on the data sheet and the teacher provides assistance as needed. To conduct the frequency building practice, place the worksheet on the student’s desk, set the timer, tell the student “ready”, wait for the student to put his pencil near the first problem or hold the item being used for the timing, and tell the student “please begin” while starting the timer. When the timer beeps, tell the student to stop and then have the student check his work for accuracy by referring to an answer key if applicable, record data on the data sheet, and plot the data on his graph. Teachers may choose to assist their students with checking work but this should be done independently or in student pairs.

Prior to starting the next timing, check to see if the student met his goal for the day. If the goal was met, provide praise and move to the next frequency building activity. If the goal was not met, provide feedback to the student to help him improve his
performance on the next timing. Feedback is provided based on the type of content being targeted and examples of feedback are provided in the sections that follow. Feedback should provide the student with encouragement by acknowledging the aspects of responding that will help the student reach his goal. For example, if the student responds too quickly toward the beginning or end of the timing but not during other parts of the timing, the teacher points out to the student the problems that he completed quickly and encourages him to perform the rest of the problems as quickly. The feedback should also provide the student with information about how to correct errors during the timing. For example, if the student consistently engages in the same error, the teacher reviews this error with the student and practices the correct response before the next timing. Feedback may also focus on responses that are not related to the content of the timing but are slowing the student down. For example, if the student lifts her pencil too high in between problems, the teacher encourages the student to keep the pencil close to the paper.

If the student does not make progress toward her goal after the first couple of timings, the student requests assistance from the teacher to help identify additional strategies to use to meet her goal. If the student reaches the terminal goal during a timing, the teacher observes the student complete a timing to verify the terminal goal is met and moves the student to the next skill in the sequence. If the student does not need assistance or has not met the daily or terminal goal, he continues to complete frequency building timings until he completes the designated number of timings for the day.

*Frequency Building in Math*

Frequency building is most often used to improve performance on basic math skills such as writing digits, identifying fact families, and completion of addition,
subtraction, multiplication, and division problems. It is important to ensure students with disabilities perform these basic skills fluently because research has shown failure to fluently perform these skills impacts one’s ability to understand more complex problems and concepts (Gersten, Jordan, & Flojo, 2005). Even if students with disabilities perform at an accuracy level suggesting mastery of these skills, this does not guarantee that they will perform the skills at the same rate as their peers without disabilities (Garnett & Fleischner, 1980), and this could impact their retention of these skills and performance on more advanced skills (Binder, 1996).

A student who has demonstrated fluency in counting, number reading, number writing, place value, and math fact families is ready to begin frequency building on basic computation skills. The student starts with single-digit addition problems. Worksheets initially are created by fact families and are made more difficult by combining fact families until the worksheet contains addition problems from all fact families (see Johnson & Street, 2013). The worksheet contains more problems than the student can complete in a minute and the problems are arranged in clear rows and columns. The goal for performance on this activity is to correctly complete 80 to 100 problems in 1 min (Johnson & Street, 2013).

Frequency building practice for math follows the procedures described earlier. However, it is important to explore some examples of feedback the student described above may receive if he is not reaching his goal for single-digit addition problems. The student may engage in a specific error pattern, such as consistently putting the wrong number in the blank for the fact family when the problem is \(2 + 2 = \____\). The teacher may have the student rehearse the correct number that should be written in the blank prior
to starting the next timing. Another issue may be the student’s speed of writing. If the student is completing the problems quickly but writing the numbers slowly and very neatly, the teacher may give the student feedback to write faster and may model this for the student. Lastly, the teacher praises the student for responding that is likely to help him reach his goal such as transitioning quickly from one problem to the next. The teacher tells the student she likes how quickly he is moving his pencil to the next problem and looking ahead to process the next problem while he is writing the number for the current problem. These same procedures can be used for the math skills identified in Table 3 and all additional skills that students are performing accurately but not fluently.

**Frequency Building in Reading**

Frequency building procedures in reading often focus on improving fluency in basic reading skills such as letter sounds, blending, segmenting, and reading words in passages. The importance of fluency in reading passages was recognized over 10 years ago as one of the five essential components for reading programs (National Reading Panel, 2000). Students who do not read fluently have difficulty comprehending what they are reading and this puts them at risk of falling behind in other subjects (Cavallini et al., 2010).

A student who fluently performs phonemic awareness skills and word fluency skills (see Table 3) is ready to begin frequency building practice with passage reading (Johnson & Street, 2013). Developing fluency with passage reading focuses on reading passages and using appropriate rhythm and intonation. Students who read without this prosody are stopped and provided with feedback. The passage is also different during each timing so the student does not just memorize the passage. To ensure the student is
<table>
<thead>
<tr>
<th>Subject Area</th>
<th>Skill</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Math</td>
<td>Counting</td>
<td>Say numbers from 1 to 100</td>
</tr>
<tr>
<td>Math</td>
<td>Number Reading</td>
<td>Reading numbers from 1 to 100</td>
</tr>
<tr>
<td>Math</td>
<td>Number Writing</td>
<td>Writing numbers from 1 to 100</td>
</tr>
<tr>
<td>Math</td>
<td>Place Value</td>
<td>Say place value of bolded number</td>
</tr>
<tr>
<td>Math</td>
<td>Math Facts</td>
<td>Fill in the missing number for the fact family 2, 2, 4</td>
</tr>
<tr>
<td>Math</td>
<td>Computation Skills</td>
<td>Write answers to subtraction problems for fact family 2, 2, 4</td>
</tr>
<tr>
<td>Math</td>
<td>Word Problems</td>
<td>Read a word problem, write the equation, and solve the problem</td>
</tr>
<tr>
<td>Pre-reading</td>
<td>Blending</td>
<td>Hear the sounds of a CVC word and say the word</td>
</tr>
<tr>
<td>Pre-reading</td>
<td>Segmenting</td>
<td>Hear a CVC word and say the sounds in the word</td>
</tr>
<tr>
<td>Pre-reading</td>
<td>Rhyming</td>
<td>Say “rhyme” or “not” when presented with 2 words</td>
</tr>
<tr>
<td>Reading</td>
<td>Letter Sounds</td>
<td>Read letter sounds and blends</td>
</tr>
<tr>
<td>Reading</td>
<td>Words</td>
<td>Read 1 to 3 syllable words without decoding</td>
</tr>
<tr>
<td>Reading</td>
<td>Passages</td>
<td>Read a 1st grade level passage with prosody</td>
</tr>
<tr>
<td>Reading</td>
<td>Vocabulary</td>
<td>Read words and write definitions</td>
</tr>
<tr>
<td>Reading</td>
<td>Retelling</td>
<td>State points about a story in sequence</td>
</tr>
<tr>
<td>Writing</td>
<td>Write Letters</td>
<td>See letters and write them</td>
</tr>
<tr>
<td>Writing</td>
<td>Write Words</td>
<td>See words and write them</td>
</tr>
<tr>
<td>Writing</td>
<td>Dictation</td>
<td>Hear letters or words and write them</td>
</tr>
<tr>
<td>Writing</td>
<td>Sentences</td>
<td>Compose or edit sentences</td>
</tr>
<tr>
<td>Writing</td>
<td>Paragraphs</td>
<td>Compose or edit paragraphs</td>
</tr>
</tbody>
</table>

Table 3. Sample list of academic skills to target with frequency building developed from Johnson and Street (2013).
not just saying the words quickly without comprehending them, teachers can ask comprehension questions at the end of each passage. The recommended goal for passage fluency is 180 to 220 words per min (Johnson & Street, 2013).

The frequency building practice passage reading is conducted by having the student read a passage from a worksheet or a book and by following the procedures previously described. A modification to these procedures is that a teacher or peer coach follows along on a copy of the passage and marks a line on any words that were said incorrectly. Feedback provided during this activity might include reminding the student to use her finger to follow along while reading, because this helps the student keep her place. If the student is saying the words so fast that he is not understood, the teacher reminds the student to articulate words clearly. If a student guesses on words that she does not know, the teacher encourages the student to either sound out or skip the word. Lastly, the teacher praises responding that supports meeting the goal, such as showing the student the sections of the passage he read at a fast pace with proper intonation and encouraging him to read the entire passage in this manner. These same procedures can be used for reading skills that develop prior to reading passages and for more advanced skills such as comprehension (see Table 3).

**Frequency Building in Fine Motor**

Developing fluency in the fine motor skill repertoire is often overlooked. However, this skill area consists of basic component skills that are required for performance of a wide range of composite skills including writing, daily living skills, and vocational skills (Binder, 1996). Students who have weak fine motor skills will likely struggle with any task that involves coordination of finger and hand movements.
Literature within the field of precision teaching documents the Big 6 + 6 skills (i.e., reach, touch, point, place, grasp, release, push, pull, shake, squeeze, tap, and twist) as the necessary fine motor movements to teach to fluency in order to see progress in other skill areas (Binder, 1996; Twarek et al., 2010). Research regarding the direct impact of increased fluency of these skills on the larger composite skills is limited even though precision teachers regularly focus on developing fluency of these skills within applied settings (Twarek et al., 2010).

When choosing Big 6 + 6 targets for frequency building, any of the skills can be targeted and multiple skills can be targeted at one time. If there are certain composite skills that a student is having difficulty mastering, target the Big 6 + 6 skills involved with that composite skill as the first frequency building targets. For example, if a student is not making progress with washing his hands, turning (to turn on and off the water), reaching (to reach hands into the water or to the soap), and grasping (to hold the soap) could be targeted. Prior to starting frequency building with Big 6 + 6 skills, materials for engaging in the fine motor movement should be acquired (see Table 4) and the student should be shown how to engage in the movement with the material. If the student does not engage in the movement, teaching trials should be done to teach him how to do the movement first.

Frequency building timings for fine motor skills are slightly different than the general procedures described previously. For a student who needs to grip her pencil for writing, frequency building timings are done with pinching. To start a timing, provide the student with a clothespin, model pinching the clothespin quickly, hand the clothespin to...
<table>
<thead>
<tr>
<th>Skill</th>
<th>Goal per min</th>
<th>Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reach</td>
<td>90–150</td>
<td>Preferred items, items that make noise or light up</td>
</tr>
<tr>
<td>Touch</td>
<td>200–300</td>
<td>Pictures on a table/wall, buttons that make a sound, drum</td>
</tr>
<tr>
<td>Point</td>
<td>200–300</td>
<td>Sticker on a notecard, object in front of student</td>
</tr>
<tr>
<td>Place</td>
<td>200–300</td>
<td>Items in a container, stack items, deal playing cards</td>
</tr>
<tr>
<td>Grasp</td>
<td>200–300</td>
<td>Rubber ball, hand spring, spray bottle</td>
</tr>
<tr>
<td>Release</td>
<td>200–300</td>
<td>Open a closed hand, hand flat on surface and raise fingers up</td>
</tr>
<tr>
<td>Push</td>
<td>200–300</td>
<td>Door that swings open, punching bag, pegs into a hole</td>
</tr>
<tr>
<td>Pull</td>
<td>200–300</td>
<td>Toy with a string, pegs out of a hole, door that pulls open</td>
</tr>
<tr>
<td>Shake</td>
<td>200–300</td>
<td>Maraca, container with beans</td>
</tr>
<tr>
<td>Squeeze</td>
<td>200–300</td>
<td>Rubber ball, hand spring, spray bottle</td>
</tr>
<tr>
<td>Tap</td>
<td>200–300</td>
<td>Pictures on a table/wall, buttons that make a sound, drum</td>
</tr>
<tr>
<td>Twist</td>
<td>200–300</td>
<td>Door knob, handles, large nuts and bolts</td>
</tr>
</tbody>
</table>

Table 4. Sample goals and materials to use for Big 6 + 6 skills developed from Fabrizio et al. (2001) and McManus (n.d.).

the student, set a timer for 10 s, and tell the student “pinch this as fast as you can.” As the student pinches the clothespin, count out loud enthusiastically. When the timer beeps, tell the student to stop, tell her how many pinches she completed, have her record her data on the data sheet, and graph the data. The goal for pinching is 200 pinches per min (Fabrizio,
Moors, & Pahl, 2001). If the student meets her goal for the day, provide access to a reinforcer and move on to another activity. If the student does not meet her goal, provide feedback such as encouraging her to pinch quickly during the entire timing, modeling fast pinching for her, physically prompting her to pinch the clothespin quickly, modifying how she is holding the clothespin, and praising performance that will help achieve her goal. Frequency building timings should occur until she reaches her goal for the day or completes the designated number of timings for the day. These same procedures with different goals and materials can be used for the other Big 6 + 6 skills (see Table 4).

Using Peer Coaching With Frequency Building

Practicing basic skills during repeated timings should result in higher skill acquisition for students (Binder, 1996) but there are additional strategies to incorporate when using frequency building as an intervention that can enhance the effectiveness of the intervention. Precision teachers incorporate peer coaching during frequency building to help increase student independence during timings and improve student performance (Johnson & Street, 2013). Coaching and providing feedback is a necessary step within frequency building. Teaching peers how to provide coaching and feedback greatly reduces the amount of time the teacher has to spend with each student during frequency building timings and allows for frequency building to take up a smaller chunk of time. When using peer coaches, the teacher still organizes and gathers the necessary materials for frequency building sessions, determines the timing lengths, determines the terminal goal for the skill, determines the learning pairs, ensures the students are filling out the data sheets and graphs correctly, provides assistance as needed when a student is not making progress, and reviews the data daily to determine if changes need to be made.
Peers are paired based on equal skill level for high performers. Low performers are paired with medium performers, because low-performing students will have difficulty providing feedback to high-performing students and two low-performing students will have difficulty providing feedback to one another about errors (Johnson & Street, 2013).

After determining the goal, the student completes frequency building timings until he meets his goal for the day. The peer coach or the student operates the timer depending on student preference. After each timing, the peer coach provides the student with feedback about the timing and encouragement for the next timing. If the student reaches the terminal goal for the skill during peer coaching, the teacher should observe an additional timing to verify this performance and indicate mastery of the skill. After the first student reaches his goal for the day or completes the designated number of timings for the skill, the peer coach and student switch roles. At any point during peer coaching, if the student is not making progress toward his daily goal, the students should ask the teacher for help (Johnson & Street, 2013).

**Conclusions**

Frequency building procedures can increase the rate of learning for students with and without disabilities (Binder, 1996). The procedures can be implemented in a relatively brief time frame and students can learn to work together to coach each other during the frequency building timings (Johnson & Street, 2013). The benefit for students with disabilities is two-fold, because the increased rate of learning for basic skills impacts the learning rate of more complex skills and the students practice coaching and giving feedback to peers.
Mrs. Hayes implemented frequency building procedures for her students for 10 minutes per day during math, reading, and writing. Her students learned to track their progress throughout the school year and were excited each time they met their goal during frequency building sessions. The students also learned to help each other and provide encouragement to one another. Progress monitoring for both the basic skills being taught during frequency building and the more advanced skills the students were required to learn showed that all of her students made more progress this year than they have in years past. Mrs. Hayes is excited to continue using these procedures with her new students next year.
Chapter 5: Research Statement

Prior to entering the doctoral program at The Ohio State University, I practiced as a behavior analyst providing behavioral intervention services to children with autism and other developmental disabilities. The majority of my clients made tremendous progress in all skill areas. However, some clients plateaued in some or all skill areas, regardless of whether they were diagnosed with a mild, moderate, or severe disability. Two of the areas where I encountered the most difficulty were increasing attending and responding for clients with severe disabilities and improving imitation skills for children diagnosed with autism. This led me to search for additional effective procedures to implement with these clients.

To address the first area, I consulted with a colleague who provided me with information about precision teaching and the Big 6 + 6. I implemented his recommendations with a client who was not making progress on basic skills, such as completing a 3-piece puzzle, and the child made substantial progress on multiple skills within a few weeks of improving her performance on reaching and placing. I received additional exposure to precision teaching when I attend a conference during my first year in the doctoral program. Several of the presentations at this conference focused on the effectiveness of precision teaching as a system of measurement and decision-making. However, the most profound moment for me at this conference was during a panel when
Kent Johnson, an expert in the field of precision teaching, was asked how he uses the Standard Celeration Chart (SCC) to chart data for task analyses for daily living or vocational skills. His response was that he and his colleagues always focused on teaching the basic motor skills necessary to complete the task and then they never had to implement chaining procedures to teach the responses involved within the task analysis. In that moment, I was determined to learn more about precision teaching and focus on this as part of my line of research.

Frequently encountering clients who had difficulty making progress with developing imitative repertoires was an area that I encountered early on in my career. I used my understanding of the science of behavior analysis to develop programs that eventually resulted in acquisition of the imitative repertoire, but I was certain there had to be a better way. After reading about the teaching procedures used in the Early Start Denver Model (ESDM; Rogers & Dawson, 2010), I started to incorporate these procedures with my younger clients. The procedures were unique to me as a behavior analyst because they were based on developmental milestones and a socio-communicative understanding of imitation. The initial steps for teaching imitation were broken down into much smaller components than typical behavior analytic programs for imitation, and my younger clients made faster progress using these procedures. This discrepancy between what is typically taught as the recommended procedure for teaching imitation within the field of behavior analysis and the procedures recommended within the ESDM motivated me to learn more about the research related to developing imitative repertoires for children diagnosed with autism.
These two areas of interest converged for me over the last few years as I conducted literature reviews and developed research studies. My interest in imitation led to two literature reviews. The first focused on identifying effective interventions for developing imitative repertoires, and the main finding was that there is limited research documenting effective procedures for teaching imitation to children diagnosed with autism. Reciprocal imitation training (RIT) and video modeling (VM) were the only interventions out of eight identified interventions that had multiple studies published to form a small research base supporting the effectiveness of these interventions.

The second literature review focused on understanding the relationship between the development of imitative repertoires and socio-communicative skills. This literature review revealed a larger research base, with 20 studies included, and a clear indication that there is a relationship between imitative and socio-communicative behavior. However, not enough of the research studies replicated or extended previous research to draw firm conclusions about the exact nature of this relationship.

Even though the research regarding interventions for developing imitative repertoires is limited, my search of the literature related to using precision teaching with students with moderate to severe disabilities, specifically the use of the Big 6 + 6 as an intervention for improving motor movement fluency, resulted in only a few articles. Because of this, I decided to focus my initial research on application of the Big 6 + 6 as an intervention for students with moderate to severe disabilities.

I initially wanted to determine if the procedures recommended by precision teachers for developing fluency with Big 6 + 6 motor movements could be successfully applied to students with moderate to severe disabilities and physical impairments. I
conducted a study with 4 students that focused on improving reaching fluency. I chose this as the first skill to target because the students had severe physical impairments that limited their fine motor performance and they had limited communication. My goal was to improve their ability to reach because this should impact their ability to make requests by reaching and to perform composite skills that involve reaching such as washing their hands. Three out of the four students who participated in this study improved their reaching performance and performed reaching at a higher frequency with prompting. However, only one student engaged in a higher rate of reaching without prompting. The results for the composite tasks were mixed. One student improved on performance in selecting items during a preference assessment from selecting four items prior to the intervention to 11 items after the intervention. A different student slightly improved in performance on a vocational task of putting two crayons and stickers into a baggie from 33% prior to the intervention to 50% after the intervention. This student also improved on a daily living skill of reaching for a towel to dry her hands from 0% at pre-intervention to 100% at post-intervention. Her performance on the preference assessment had a longer latency, but the results post-intervention had a higher level of discrimination. The other two participants did not improve on these measures.

This initial study raised more questions than it answered. This study also helped me realize I needed to learn more about how to increase the fluency of a targeted skill, so I attended a training institute at Morningside Academy in Seattle, WA. During this two-week training, I learned how to implement the Morningside Model of Generative Instruction, which included using frequency building to a performance criterion with skills students already performed accurately but needed to perform fluently. I
incorporated what I learned during this training to develop the methodology for the research study presented in Chapter 3 of this dissertation.

Prior to conducting this study, I completed the review of the literature as Chapter 2 of this dissertation regarding the use of precision teaching with students with moderate to severe disabilities. Only 13 studies met criteria for inclusion in this literature review and the quality rating of the majority of the studies was considerably low. The main finding was that there is limited research to support the effectiveness of using the system of precision teaching to improve outcomes for learners with moderate to severe disabilities and the research that does exist is missing key components such as detailed descriptions for replication or extension of the study, measures of reliability and fidelity, and measures of maintenance and generalization.

The results of this literature review were at odds with the information I encountered during discussions with precision teachers and when attending the annual precision teaching conference. I found published literature that reported highly positive and impactful results of using precision teaching with students with moderate to severe disabilities (e.g., Binder, 1996; Lindsley; 1992) and referenced case studies or the work of specific precision teachers. However, these results were not published as controlled research studies. Because of this, I decided the research study for my dissertation needed to focus on adding to the research base directly within precision teaching before expanding to include an imitation component.

The results of the study presented in Chapter 3 support and contradict the limited research published about the Big 6 + 6. Two of the participants greatly improved on rate of performance for the targeted fine motor movements, but one participant did not make
progress. Additionally, none of the participants showed improvement on the larger composite skill that was assessed throughout the study. This study indicated to me that frequency building to a performance criterion could effectively increase frequency of responding for most students with moderate to severe disabilities. Because of this I wrote a practitioner paper for Chapter 4 to help other teachers learn how to use frequency building to increase frequency of responding on basic skills. From this study, I was also able to develop several research questions for conducting future research that expands on the findings of the study.

My 5-year research plan is to begin to address the future research questions discussed in Chapter 3 of this dissertation and begin to pull in the research regarding developing imitative repertoires for children with autism. I have combined these two areas to form three main focal points of this future research. I think that approaching the research in the sequence described below will contribute greatly to the research base for both precision teaching and imitation.

Because the study discussed in Chapter 3 showed that the component fine motor skills could increase in frequency but this did not impact the composite skill of pouring soap, I plan to explore this area first. If improvement in frequency of basic component motor skills does not impact the larger composite skills, then it would not be effective to focus on building up rates of performance for these skills as opposed to teaching the composite skill directly. This research would focus on the direct impact of building fluency in the Big 6 + 6 skills on composite skills by assessing multiple composite skills and adjusting how the performance of the composite skills are measured. In addition to this, I would compare student performance on skills that are exposed to the Big 6 + 6
intervention versus skills that are exposed to traditional teaching methods of chaining and reinforcement to determine if one of these approaches is more effective and efficient than the other. Lastly, I would examine the impact of targeting only the Big 6 + 6 skills compared to targeting all of the component skills that form the composite skill to determine if it is sufficient to build the Big 6 + 6 skills to fluency or if non-Big 6 + 6 component skills must also be brought to fluency to see growth.

An example of an initial study that I would conduct in this area would be to replicate the research presented in Chapter 3 but assess correct and incorrect performance on timing probes of completion of three different composite skills as chosen by the teachers or parents. If the student did not complete the composite skill accurately, the response would be scored as incorrect. The composite skills could be analyzed to determine if the steps that were missed were related to the Big 6 + 6 skills being targeted or if they were related to different component skills. If the incorrect steps were made up of different component skills, these skills could be taught to fluency and the composite skills could be reassessed. If performance on the composite skill timing probes improves only when the frequencies of performance increase for the component skills, this would suggest that building fluency in the basic component skills could improve performance on the composite skills. Additional research would be conducted within this area based upon the results of this initial study.

The second area that I would like to explore is the impact of motor movement fluency on developing imitative repertoires for children diagnosed with autism. The research base on developing imitative repertoires suggests that there are some children who do not respond to the targeted interventions (e.g., RIT, VM). Additional research
suggests that children with autism have difficulty with motor coordination (Fournier, Hass, Naik, Lodha, & Cauraugh, 2010). Because of this, I would like to examine the impact of improving motor movement fluency for both gross and fine motor skills on developing imitative repertoires for children diagnosed with autism. It is possible that gross motor movements, such as kicking, raising an arm, putting an arm out to the side and fine motor movements such as pointing, pinching, and shaking, are basic component skills for the larger composite skill of imitating. If a student does not fluently move his body, it could be more difficult for him to observe a model and move his body to match that model.

The research I would conduct in this area would also focus on comparing building fluency in motor movements as an intervention to other interventions such as RIT and VM to determine if one is more effective than the other. It is also possible that motor movement fluency and an effective imitation intervention are necessary for developing imitative repertoires, so I would conduct research to compare outcomes after the use of an effective imitation intervention for students who engage in fluent motor movements to students who do not engage in fluent motor movements. Lastly, I want to determine if improving motor movement fluency improves outcomes for the children in other skill areas, especially for children who receive early intervention. It is likely that children who engage in fluent motor movements will learn more from their environment, because it is easier for them to interact with the environment.

After (hopefully) establishing the effectiveness of incorporating precision teaching to develop motor movement fluency to impact performance on composite skills, I would like to apply what was learned in the research discussed above to other
component and composite skill areas for students with moderate to severe disabilities to determine if the same techniques are effective for academic, communication, and social skills. There is research documenting the effectiveness of bringing basic component skills in math, reading, spelling, and writing to fluency to improve the performance of composite skills for students with mild learning disabilities without additional training (e.g., Hughes, Beverly, & Whitehead, 2007; Datchuk, Kubina, & Mason, 2015), but more research is needed to determine if the same outcomes occur for students with moderate to severe disabilities. Improving the effectiveness of interventions for students who are behind both developmentally and academically is extremely important. If interventions can be discovered that increase the rate of learning for students with moderate to severe disabilities, this could greatly improve the long-term outcomes for this population.

Even though I have plans for future research drawn from this dissertation, my main goal is to disseminate information to teachers and practitioners about how to more effectively break skills down using a component/composite analysis to improve outcomes for students with moderate to severe disabilities. Now that I have received training and conducted research related to using this specific technique and using precision teaching as a measurement and decision-making system, every problem I encounter when teaching a student results in thinking about what basic skills are absent or not fluent within the student’s skill repertoire that are preventing her from performing the composite skill we are teaching. Even if I think we are already teaching a basic skill such as holding a pencil, and the student has difficulty, I will analyze what skills are involved in holding a pencil that the student may need more training on in order to better hold his pencil.
Exposure to this process has greatly contributed to ensuring I am analyzing and assessing for the problem impeding learning as opposed to what initially appears to be the problem and has resulted in making faster progress for my students. However, my experience is not sufficient for encouraging teachers and practitioners to use these procedures. Developing a strong research base to support the effectiveness of these procedures for students with moderate to severe disabilities is the first step in achieving my ultimate goal of disseminating strategies to teachers and practitioners about the effectiveness of these procedures.
References


McManus, R. Building vocational skills with the Big Six. Retrieved online on 12/03/2012 from: http://www.fluencyfactory.com/big_six.htm


Appendix A: Consent Form
The Ohio State University Parental Permission
For Child’s Participation in Research

Study Title: The impact of improving fluent reaching movements on the ability to express preference for students with severe to profound intellectual and physical impairments

Researcher: Megan Miller

Sponsor: Dr. Helen Malone

This is a parental permission form for research participation. It contains important information about this study and what to expect if you permit your child to participate.

Your child’s participation is voluntary.

Please consider the information carefully. Feel free to discuss the study with your friends and family and to ask questions before making your decision whether or not to permit your child to participate. If you permit your child to participate, you will be asked to sign this form and will receive a copy of the form.

Purpose: The purpose of this research is to determine the impact of teaching students with moderate to intensive disabilities to fluently engage in motor movements.

Procedures/Tasks: Students will be assessed on their performance of object imitation, motor imitation, and a daily living or vocational skill. Students will be assessed on their ability to engage in 6 motor movements: reaching, pointing, shaking, squeezing, turning, and pinching. Training will be done to teach students how to engage in each of these movements more quickly. After training on each motor movement, students will be re-assessed on their performance of object imitation, motor imitation, and a daily living or vocational skill.

Duration: The anticipated length for this study is 3 months.

Your child may leave the study at any time. If you or your child decides to stop participation in the study, there will be no penalty and neither you nor your child will lose any benefits to which you are otherwise entitled. Your decision will not affect your future relationship with The Ohio State University.
Risks and Benefits:

Benefits
- Increased ability to indicate preferences for items by reaching
- Increased ability to communicate with others in environment by reaching
- Increased ability to participate in tasks or activities that require the targeted motor behaviors
- Increased understanding for professionals and parents regarding the impact of increasing motor movement

Risks
Due to the fact that an outside interventionist (i.e., PI or key personnel) who does not regularly work with the participants will be implementing the intervention, there is a slight possibility that the participants might be a little anxious when the research begins.

Confidentiality:
Efforts will be made to keep your child’s study-related information confidential. However, there may be circumstances where this information must be released. For example, personal information regarding your child’s participation in this study may be disclosed if required by state law. Also, your child’s records may be reviewed by the following groups (as applicable to the research):
- Office for Human Research Protections or other federal, state, or international regulatory agencies;
- The Ohio State University Institutional Review Board or Office of Responsible Research Practices;
- The sponsor, if any, or agency (including the Food and Drug Administration for FDA-regulated research) supporting the study.

Incentives:
No incentives are offered for this study.

Participant Rights:
You or your child may refuse to participate in this study without penalty or loss of benefits to which you are otherwise entitled. If you or your child is a student or employee at Ohio State, your decision will not affect your grades or employment status.

If you and your child choose to participate in the study, you may discontinue participation at any time without penalty or loss of benefits. By signing this form, you do not give up any personal legal rights you or your child may have as a participant in this study.

An Institutional Review Board responsible for human subjects research at The Ohio State University reviewed this research project and found it to be acceptable, according to
applicable state and federal regulations and University policies designed to protect the rights
and welfare of participants in research.

Contacts and Questions:

For questions, concerns, or complaints about the study you may contact Helen Malone at 614-
286-4515 or malone.175@osu.edu.

For questions about your child’s rights as a participant in this study or to discuss other study-
related concerns or complaints with someone who is not part of the research team, you may
contact Ms. Sandra Meadows in the Office of Responsible Research Practices at 1-800-678-
6251.

If your child is injured as a result of participating in this study or for questions about a study-
related injury, you may contact Helen Malone at 614-286-4515 or malone.175@osu.edu.
Signing the parental permission form

I have read (or someone has read to me) this form and I am aware that I am being asked to provide permission for my child to participate in a research study. I have had the opportunity to ask questions and have had them answered to my satisfaction. I voluntarily agree to permit my child to participate in this study.

I am not giving up any legal rights by signing this form. I will be given a copy of this form.

Printed name of subject

Printed name of person authorized to provide permission for subject
Signature of person authorized to provide permission for subject

Relationship to the subject
Date and time

Investigator/Research Staff

I have explained the research to the participant or his/her representative before requesting the signature(s) above. There are no blanks in this document. A copy of this form has been given to the participant or his/her representative.

Printed name of person obtaining consent
Signature of person obtaining consent

Date and time
Appendix B: Task Analysis Data Sheet for Pouring Soap
Task: Refilling Soap

Student: _____________________

<table>
<thead>
<tr>
<th>Instruction: Fill the soap</th>
<th>Data:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Unscrews top of small soap</td>
<td>1+ 0 1+ 0 1+ 0 1+ 0 1+ 0</td>
</tr>
<tr>
<td>2. Sets top on table</td>
<td>1+ 0 1+ 0 1+ 0 1+ 0 1+ 0</td>
</tr>
<tr>
<td>3. Flips lid open on large soap</td>
<td>1+ 0 1+ 0 1+ 0 1+ 0 1+ 0</td>
</tr>
<tr>
<td>4. Holds small soap with one hand, picks up large soap, turns it at least parallel to the table, and aligns the opening with the opening of the small soap</td>
<td>1+ 0 1+ 0 1+ 0 1+ 0 1+ 0</td>
</tr>
<tr>
<td>5. Squeezes the large soap as needed so the soap comes out of the bottle</td>
<td>1+ 0 1+ 0 1+ 0 1+ 0 1+ 0</td>
</tr>
<tr>
<td>6. Fills the small soap container until it is at least ¾ full and stops filling as it reaches the neck of the bottle</td>
<td>1+ 0 1+ 0 1+ 0 1+ 0 1+ 0</td>
</tr>
<tr>
<td>7. Puts the large soap bottle on the table</td>
<td>1+ 0 1+ 0 1+ 0 1+ 0 1+ 0</td>
</tr>
<tr>
<td>8. Closes the lid on the large soap bottle</td>
<td>1+ 0 1+ 0 1+ 0 1+ 0 1+ 0</td>
</tr>
<tr>
<td>9. Puts the small soap top into the bottle and screws the top on until it stops turning</td>
<td>1+ 0 1+ 0 1+ 0 1+ 0 1+ 0</td>
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</tbody>
</table>

Date/Phase

Initials

Percent Correct

Duration

IOA Initials

Percent Correct

1+: Correct
0: Incorrect
Appendix C: Treatment Integrity Data Sheets
### Timing Probe Baseline Treatment Inegrity

**Student:** _______________________

<table>
<thead>
<tr>
<th>Step</th>
<th>Session Number:</th>
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<tbody>
<tr>
<td>Thanks the participant for coming and allows access to a preferred item for 30 seconds</td>
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<tr>
<td>Sets timer to designated time</td>
<td>Y   N   N   Y   N   Y   N   Y   N   Y   N   N   N   N   N   N</td>
</tr>
<tr>
<td>Sets material in designated location</td>
<td>Y   N   N   Y   N   Y   N   N   N   Y   N   N   N   N   N   N</td>
</tr>
<tr>
<td>Tell student <em>(movement)</em> until I say stop and starts timer</td>
<td>Y   N   N   Y   N   Y   N   Y   N   Y   N   N   N   N   N   N</td>
</tr>
<tr>
<td>Stops the session when the timer beeps</td>
<td>Y   N   N   Y   N   Y   N   Y   N   Y   N   N   N   N   N   N</td>
</tr>
<tr>
<td>Records the duration and number of movements on the data sheet</td>
<td>Y   N   N   Y   N   Y   N   Y   N   Y   N   N   N   N   N   N</td>
</tr>
<tr>
<td>Date:</td>
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<td>Percent Y's</td>
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<td>OA Data Collector</td>
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## INTERVENTION TIMING PROBE TREATMENT INTEGRITY

### Student: _________________________

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<th>Step</th>
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### Step 1: Sets timer to designated time
- Y: Yes
- N: No
- FP: Fading Prompting
- PP: Partial Prompting
- S: Support

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### Step 2: Places material in front of student
- Y: Yes
- N: No

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### Step 3: Tell student "(movement) until I say stop" and starts timer

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### Step 4: Participant not responding:

| a.  Uses the targeted prompting technique to assist the participant in engaging in the movement until the timer beeps

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| b.  Stops the session when the timer beeps

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### Step 7: Thanks the participant for participating and allows access to a preferred item for 30 seconds if the participant meets criteria for reinforcement

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### Step 8: Records the duration and number of movements on the data sheet

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<thead>
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### Percent Y’s

### Experimenter

### OA Data Collector
### INTERVENTION FREQUENCY BUILDING TREATMENT INTEGRITY

**Student:_______________________**

<table>
<thead>
<tr>
<th>Step</th>
<th>Session Number:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Shows student daily timing chart, tells student the goal, and reminds student to go fast</td>
<td>Y N Y N Y N Y N Y N Y N Y N</td>
</tr>
<tr>
<td>2. Sets timer to designated time</td>
<td>Y N Y N Y N Y N Y N Y N Y N</td>
</tr>
<tr>
<td>3. Places material in front of student</td>
<td>Y N Y N Y N Y N Y N Y N Y N</td>
</tr>
<tr>
<td>4. Tells student while modeling “[movement] until I say stop” and starts timer</td>
<td>Y N Y N Y N Y N Y N Y N Y N</td>
</tr>
<tr>
<td>5. Participant not responding:</td>
<td></td>
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<tr>
<td>a. Uses the targeted prompting technique to assist the participant in engaging in the movement until the timer beeps</td>
<td>Y N Y N Y N Y N Y N Y N Y N</td>
</tr>
<tr>
<td>b. Stops the timing when the timer beeps</td>
<td>Y N Y N Y N Y N Y N Y N Y N</td>
</tr>
<tr>
<td>6. Records the duration and number of movements on the data sheet and charts the data on the SCC</td>
<td>Y N Y N Y N Y N Y N Y N Y N</td>
</tr>
<tr>
<td>7. Provides the student with feedback based on performance</td>
<td>Y N Y N Y N Y N Y N Y N Y N</td>
</tr>
<tr>
<td>8. Completes 5 timings as described in steps 2 to 8</td>
<td>Y N Y N Y N Y N Y N Y N Y N</td>
</tr>
<tr>
<td>9. Thanks the participant for participating and allows access to a preferred item for 30 seconds for each timing where the participant meets criteria for reinforcement</td>
<td>Y N Y N Y N Y N Y N Y N Y N</td>
</tr>
</tbody>
</table>

**Date:**

**Percent Y’s**

**Experimenter**

**OA Data Collector**
Appendix D: Reinforcement Assessment for Individuals with Severe Disabilities (RAISD)
Reinforcement Assessment for Individuals with Severe Disabilities (RAISD)

Student’s Name: ____________________________________________
Date: _________________________________________________________
Completed by: ________________________________________________

The purpose of this structured interview is to get as much specific information as possible from the informants (e.g., teacher, parent, caregiver) as to what they believe would be useful reinforcers for the student. Therefore, this survey asks about categories of stimuli (e.g., visual, auditory, etc.). After the informant has generated a list of preferred stimuli, ask additional probe questions to get more specific information on the student’s preferences and the stimulus conditions under which the object or activity is most preferred (e.g., What specific TV shows are his favorite? What does she do when she plays with a mirror? Does she prefer to do this alone or with another person?)

We would like to get some information on the child’s preferences for different items and activities.

1. Some children really enjoy looking at things such as a mirror, bright lights, shiny objects, spinning objects, TV, etc. What are the things you think he/she most likes to watch?

2. Some children really enjoy different sounds such as listening to music, car sounds, whistles, beeps, sirens, clapping, people singing, etc. What are the things you think he/she most likes to listen to?

3. Some children really enjoy different smells such as perfume, flowers, coffee, pine trees, etc. What are the things you think he/she most likes to smell?

4. Some children really enjoy certain food or snacks such as ice cream, pizza, juice, graham crackers, McDonald’s hamburgers, etc. What are the things you think he/she most likes to eat?

5. Some children really enjoy physical play or movement such as being tickled, wrestling, running, dancing, swinging, being pulled on a scooter board, etc. What activities like this do you think he/she most enjoys?

6. Some children really enjoy touching things of different temperatures, cold things like snow or an ice pack, or warm things like a hand warmer or a cup containing hot tea or coffee. What activities like this do you think he/she most enjoys?

7. Some children really enjoy feeling different sensations such as splashing water in a sink, a vibrator against the skin, or the feel of air blown on the face from a fan. What activities like this do you think he/she most enjoys?

8. Some children really enjoy it when others give them attention such as a hug, a pat on the back, clapping, saying “Good job”, etc. What forms of attention do you think he/she most enjoys?

9. Some children really enjoy certain toys or objects such as puzzles, toy cars, balloons, comic books, flashlight, bubbles, etc. What are his/her favorite toys or objects?

10. What are some other items or activities that he/she really enjoys?

Appendix E: Multiple Stimulus Without Replacement Data Sheet
MULTIPLE STIMULUS WITHOUT REPLACEMENT PREFERENCE ASSESSMENT DATA SHEET

DATE:____   PARTICIPANT:_______________   ASSESSOR/IOA:_______________

STIMULI

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<tr>
<th></th>
<th>A = _________________</th>
<th>B = _________________</th>
<th>C = _________________</th>
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<tbody>
<tr>
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<td>D = _________________</td>
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<td>F = _________________</td>
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<td></td>
<td>G = _________________</td>
<td>H = _________________</td>
<td>I = _________________</td>
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Session | A | B | C | D | E | F | G | H | I |
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Directions:
In each row record the position in which the item was chosen (1<sup>st</sup> – 9<sup>th</sup>) and the latency to respond. Each row represents a MSWO session. Not all 5 rows need to be filled in. For example if stimuli A was chosen during the first presentation of the stimuli, you would put 1 and if stimuli H was chosen in the 2<sup>nd</sup> presentation, you would record 2.
Appendix F: Timing Probe Data Sheet
Motor Movement Data Sheet

COUNT DOWN

Student: __________________________

<table>
<thead>
<tr>
<th>Date:</th>
<th>Movement:</th>
<th>Duration:</th>
<th>Number of Movements:</th>
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</table>

**Intervention Phase:**
- BL, FP, PP, S, I
- BL, FP, PP, S, I
- BL, FP, PP, S, I
- BL, FP, PP, S, I
- BL, FP, PP, S, I

**Primary**

**Secondary**

**IOA %**

Directions: Record the date in the first row. Record the item used in the second row. Set the timer to the target duration. Start the timer to count down as soon as you present the item. In the 4th row circle the intervention phase: BL = baseline, FP = full physical, PP = partial physical, S = shadow, and I = independent.

Please see the methods document for information about the phases. The person running the session should put their initials for primary and the person collecting IOA data should put their initials for secondary. Record the IOA% in the final row.

---

COUNT DOWN

Student: __________________________

<table>
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<tr>
<th>Date:</th>
<th>Movement:</th>
<th>Duration:</th>
<th>Number of Movements:</th>
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**Intervention Phase:**
- BL, FP, PP, S, I
- BL, FP, PP, S, I
- BL, FP, PP, S, I
- BL, FP, PP, S, I
- BL, FP, PP, S, I

**Primary**

**Secondary**

**IOA %**

Directions: Record the date in the first row. Record the item used in the second row. Set the timer to the target duration. Start the timer to count down as soon as you present the item. In the 4th row circle the intervention phase: BL = baseline, FP = full physical, PP = partial physical, S = shadow, and I = independent.

Please see the methods document for information about the phases. The person running the session should put their initials for primary and the person collecting IOA data should put their initials for secondary. Record the IOA% in the final row.
Appendix G: Frequency Building Data Sheet
### Motor Movement Data Sheet

**COUNT DOWN – Frequency Building Trials**

Student: ________________________

<table>
<thead>
<tr>
<th>Date:</th>
<th>Movement:</th>
<th>Duration:</th>
<th>Number of Movements:</th>
<th>Intervention Phase:</th>
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<tbody>
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<td>BL, FP, PP, S, I</td>
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**Intervention Phase:** BL = baseline, FP = full physical, PP = partial physical, S = shadow, and I = independent.

**Primary**

**Secondary**

**IOA %**

Directions: Record the date in the first row. Record the item used in the second row. Set the timer to the target duration. Start the timer to count down as soon as you present the item. In the 4th row circle the intervention phase: BL = baseline, FP = full physical, PP = partial physical, S = shadow, and I = independent. Please see the methods document for information about the phases. The person running the session should put their initials for primary and the person collecting IOA data should put their initials for secondary. Record the IOA% in the final row.

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**COUNT DOWN – Frequency Building Trials**

Student: ________________________

<table>
<thead>
<tr>
<th>Date:</th>
<th>Movement:</th>
<th>Duration:</th>
<th>Number of Movements:</th>
<th>Intervention Phase:</th>
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<td>BL, FP, PP, S, I</td>
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<td>BL, FP, PP, S, I</td>
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</tbody>
</table>

**Primary**

**Secondary**

**IOA %**

Directions: Record the date in the first row. Record the item used in the second row. Set the timer to the target duration. Start the timer to count down as soon as you present the item. In the 4th row circle the intervention phase: BL = baseline, FP = full physical, PP = partial physical, S = shadow, and I = independent. Please see the methods document for information about the phases. The person running the session should put their initials for primary and the person collecting IOA data should put their initials for secondary. Record the IOA% in the final row.