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The Effects of Fluency-Based Instruction on Skill Acquisition in Children Diagnosed with Landau Kleffner Syndrome

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THE EFFECTS OF FLUENCY-BASED INSTRUCTION ON SKILL ACQUISITION

IN CHILDREN DIAGNOSED WITH LANDAU KLEFFNER SYNDROME

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EFFECTS OF FLUENCY BASED INSTRUCTION ON SKILL ACQUISITION IN CHILDREN DIAGNOSED WITH LANDAU KLEFFNER SYNDROME

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ABSTRACT

THE EFFECTS OF FLUENCY BASED INSTRUCTION ON SKILL ACQUISITION IN CHILDREN DIAGNOSED WITH LANDAU KLEFFNER SYNDROME

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Landau Kleffner Syndrome, or acquired epileptic aphasia, is an epileptic syndrome involving a neurological impairment related to the appearance of paroxysmal (i.e., sudden intense) electroencephalograph (EEG) activity (Pearl, Carrazana & Holmes, 2001). Landau Kleffner syndrome results from an epileptogenic lesion arising in the speech cortex during a critical period of development, which may interfere with the establishment of satisfactory and functional circuits for normal language function (Morrell et al., 1995). LKS is a complex and severe syndrome that affects all aspects of a child's life, including communication, socialization, and the everyday ability to function within the environment.

An option for treatment of LKS is Multiple Subpial Transection Surgery (MST). MST surgery is a surgical procedure designed to eradicate the capacity of cortical tissue

to generate seizures or subclinical epileptiform activity, while maintaining the cortical functions of the remaining tissues (Grote, Van Slyke, & Hoeppner, 1999). Once surgery is complete, it is necessary to provide direct, intensive instruction to rebuild language skills starting from very basic (preverbal) components (Vance, 1991). The Morningside Model of Generative Instruction is a model of selected basic psychomotor component skills (e.g., point, pinch, reach, turn, squeeze, & shake) that are explicitly taught in a hierarchical sequence. These skills are built to a fluent level, and then sequenced into complex behavioral repertoires (Johnson & Street, 2004).

The examination of the relationship between fluency-based instruction and skill acquisition for children diagnosed with LKS will contribute to the literature by extending and clarifying the role of fluency-based instruction (and specifically Morningside Model of Generative Instruction) for use with children with LKS.

The current study used a changing criterion design to measure rates of responding in identified basic and combined psychomotor skills. A pre-existing data set was utilized to examine the effects of fluency-based instruction in basic psychomotor skill acquisition, maintenance, and generalization to an identified set of combined skills. Results indicated overall increases in basic psychomotor skill acquisition, and confirmation of fluency-based instruction as an efficacious, research based treatment for children.

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CHAPTER I

INTRODUCTION

Landau Kleffner Syndrome (LKS), or acquired epileptic aphasia, is an epileptic syndrome involving a neurological impairment related to the appearance of paroxysmal (i.e., sudden intense) electroencephalograph (EEG) activity (Pearl, Carrazana & Holmes, 2001). LKS is also characterized by an acquired epileptic aphasia (AEA), referring to prolonged receptive language deterioration. The major component of aphasia is the acquired impairment in symbolic language processing that is not characterized by a perceptual disorder (Baron, 2004). LKS is a complex and severe syndrome that affects all aspects of a child's life, including communication, socialization, and an everyday ability to function within the environment. The purpose of this study is to demonstrate the effectiveness of an intensive sequenced intervention for children with LKS.

Landau and Kleffner were the first to report a correlation between EEG activity and language deterioration (Pearl et al., 2001). Their landmark observations lead to identifying and terming the syndrome known as LKS. LKS typically appears in children between the ages of three and seven years of age, which is also a critical period for language development (Buelow, Aydelott, Pierz, & Heck, 1996). As with most developmental disorders, children with an earlier age of onset have a poorer prognosis in terms of long-term language outcomes (Pearl et al., 2001).

Surgical Intervention

Historically there have been very few treatment options for LKS. Previously, LKS has been treated pharmacologically using immunoglobulin (IVIG) therapy, anticonvulsant medications, and corticosteroids; however more recently a surgical procedure known as Multiple Subpial Transection (MST) has been developed and used as a treatment for LKS.

At present, MST is considered an experimental surgery designed to eliminate the capacity of cortical tissue to generate seizures or subclinical epileptiform activity, while preserving the cortical functions subserved by the tissues (Grote, Van Slyke, & Hoeppner, 1999). Specifically, the goal of MST surgery is to disrupt the horizontal synaptic communications between the neurons in the cerebral cortex, and preserve the vertical neural fibers necessary for speech. The MST procedure involves the selective interruption of intracortical horizontal fibers while maintaining the vertical columnar organization, as well as the similarly vertically oriented incoming and outgoing nerve fibers. Notably, there is no removal of tissue. The rationale behind this procedure is based on two experimental facts: (1) the bulk of the normal physiological transactions depend upon the vertically oriented cortical organization and (2) while the synchronization necessary for epileptic discharge requires side-to-side horizontal linkages. The MST procedure only interrupts the side to side horizontal connections necessary for epileptic discharge (Beaumanoir, Bureau, Deonna, Mira, & Tassinari, 1995). Those neural fibers provide the input and output of neural messages (Buelow et al., 1996) used in speech production. Thus, researchers describe the ideal candidate for MST surgery is one with a classic form of LKS, where a well-localized epileptic area unilaterally in the intra- and/or perisylvian cortex is identified (Irwin et al., 2001).

In 2002, a meta-analysis was conducted to determine the success rate of MST surgery, as initially proposed by Morrell, Whisler, et al. (1995), for medically uncontrollable seizures (Spencer et al., 2002). A total of 211 patients were analyzed;

however for the purpose of this study only the 54 patients who received pure MST surgery will be reported. Multiple factors were used in collecting data for each patient to assess outcomes, including attaining the average monthly frequencies of simple partial, complex partial, and generalized seizures pre- and post-surgery (Spencer et al., 2002). Authors defined outcomes by the reduction in seizure-frequency with the following scale: >95% reduction is excellent; 75-95% reduction is good; 50-75% reduction is fair; and <50% reduction is poor.

Ten of the fourteen patients with generalized seizures demonstrated excellent outcomes in the reduction of frequency of those seizures. Twelve of the nineteen patients with simple, partial seizures resulted in seizure-frequency reduction; however, three experienced an increase in seizure-frequency in patients with simple partial seizures (Spencer et al., 2002). Thirteen of the twenty-one patients with complex, partial seizures resulted in excellent seizure-frequency reduction. Thus, twenty-five patients of the 40 total patients with simple and complex partial seizures reported excellent outcomes in the reduction of seizure activity. This meta-analysis confirmed that MST surgery is a practical option for uncontrollable seizures developing in functionally critical cortical areas (Spencer et al., 2002). None of the patients who received pure MST surgery developed language or sensory deficits. Persistent and previously confirmed deficits did occur post-surgery, such as memory decline, hemiparesis, and visual field compromise (Spencer et al., 2002). These results are commensurate with previous findings, such that MST shows promise for the treatment of LKS for some; however this procedure is not an option when the focal epileptic cluster is centered in the language function of the cerebral cortex (Buelow et al., 1996). Based on surgery outcomes of patients whose language was intact prior to surgery, the operation did not interfere with the inter-ictal speech functioning, thus can be concluded that the selection of the intracortical horizontal fibers does not impact the bulk of normal cortical actions (Morrell et al., 1992).

Morrell, Whisler, et al. (1995) reported 14 cases of LKS, where patients were treated with MST surgery. Seven of these recovered age-appropriate speech; four improved but required continuing speech therapy programs, and the remaining three individuals showed no improvement. In Grote et al. (1999) a review of their own patients found expressive and/or receptive language gains were reported over a period of years rather than months after MST surgery.

Once the cortical tissue is removed and the seizures cease, an intense intervention should be introduced to begin to develop the skills that were lost or unable to be attained during the time of onset of LKS (Vance, 1991). Intense, step-wise communication therapy is important to preserve the child's functional communication skills and preserve language-based learning pathways (Vance, 1991). There are several types of skill acquisition therapy that provide intensive sequential instructions. Based on the literature, most of these models are built on the foundation of providing information in discrete component parts and delivery of that information in a consistent, systematic and cumulative manner.

The Morningside Model of Generative Instruction

The Morningside Model of Generative Instruction can be described as a model of instruction, which centers on the theory that complex behavioral repertoires emerge without explicit instruction only when well-selected component skills are appropriately sequenced and carefully instructed (Johnson & Street, 2004). Thus, the Morningside

Model of Generative Instruction is consistent with the type of intervention likely to be effective for children with LKS who have undergone MST surgery and are in need of intensive interventions that break down skills into component parts necessary for successful skill acquisition.

The Morningside Model of Generative Instruction effectively combines precision teaching techniques and timed fluency-based instruction. Precision teaching is identified as one of the most critical tools in monitoring instructional program effectiveness, as well as the use of the Standard Celeration Chart (Lindsley, 1972). The Standard Celeration Chart was designed by Ogden Lindsley (Pennypacker, Koenig & Lindsley, 1972) as well as the standards for using the chart to graph and make decisions about an individual's behavioral and curriculum interventions. Precision Teaching is believed to be a necessary tool in The Morningside Model of Generative Instruction. Primarily, precision teaching emphasizes the speed and accuracy of responding, and mastery criteria which are stated in terms of the rate of correct and incorrect responses on tasks, specifically rates of responding.

This model has been used to successfully remediate adult literacy difficulties, as well as childhood learning and attention problems. Positive outcomes are also associated with fluency-based learning alone, such as those from a study conducted by Bucklin, Dickinson, & Brethower (2000), comparing fluency trainees and accuracy trainees. Fluency trainees completed increasingly more items correct per minute than accuracy trainees did with similar accuracy. This supports the claim that fluent component skills lead to more fluent composite skills. Other positive outcomes include a fluency-based study conducted with a 9-year-old child with ADHD. Prior to intervention, only 50% of each intervention session was on-task. Measurements from baseline showed 50-60% of each session on task, after the intervention, the child remained on-task 100% of the sessions. It was also reported that the child remained fluent and endurance increased at the completion of the study (McDowell & Keenan, 2001).

Precision Teaching and Fluency-based Instruction

In practice, fluency is defined as a behavior that is flowing, effortless, practiced, and accurate (Johnson & Layng, 1996) and is often described as mastery in the literature. By using this definition of fluency, clinicians seek to ensure that the child will be able to perform tasks easily in the presence of distraction, retain newly-learned skills and knowledge, and apply what the student has learned to acquire new skills or to real-life situations (Johnson & Layng, 1996). In the literature this process is referred to as ‘second-nature’ knowledge, or automatic performance without hesitation (Binder, 1988).

Fluency-based instruction uses an acceleration model for determining the type and rate of instruction delivered. For example, the therapist determines if a skill is known and mastered by the child. Successful skill performances determine the rate of progress through the instruction. Fluency-based instruction is informed by two dependently related theoretical assumptions; precision teaching and timed performance. Precision teaching instructional method assumes that in order to acquire and smoothly attain competence on any given composite skill or knowledge task, one must achieve both accuracy and speed on its component parts. Skills that are performed rapidly are assumed to have moved from discrete to automatic and thus are considered learned. Thus, the technical definition of fluency is accuracy plus speed sometimes described as quality plus pace (Binder, 1988; Binder, 1993). When a skill is non-fluent, or the learner demonstrates a lack of automaticity of the skill, that individual will show increased error rates in their performance (Binder, Haughton, & Van Eyk, 1990).

Five fluency-based criteria have developed, and have been empirically linked to various frequency aims (Johnson & Layng, 1996). The frequency aims are selected to ensure that the learner will: (a) remember and perform the desired skill at the frequency aim after a significant period of no practice; (b) demonstrate performance endurance, which is performing the skill at the frequency aim for periods of time that are longer than the practice timing; (c) perform the skill with stability, such that performance will not be easily distracted; (d) apply the skill as a component of a more complex performance to be learned; (e) demonstrate the capacity to learn skills instantly and independently as they move through their environment, which is defined as contingency adduction (Johnson & Layng, 1996). Contingency adduction was applied through the work of Dr. Paul Andronis, Joe Layng and Israel Goldiamond (Johnson & Street, 2004). Through their efforts, contingency adduction can be defined as having new contingencies or performance requirements that will construct performances learned under other contingencies. In other words, when under the right circumstances, a learner engages in a behavior in a new setting that has earned reinforcement in a previous scenario (Johnson & Street, 2004). The performance of the learner is then reinforced in the new setting, often by a different type of reinforcement. This moment of reinforcement marks a moment of contingency adduction (Johnson & Street, 2004). For this study, contingency adduction will be examined through the generalizibility of the component skills within the Big 6+6 skill acquisitions, which is the skill of Reach, Grasp, Place, and Release (RGPR).

Big 6 + 6 Skills

The component skills consist of the following: point, touch, reach, grasp, place, release, push, pull, twist, squeeze, tap and shake (Johnson & Layng, 1994). The developments of these basic psychomotor skills, the Big 6 Skills, are necessary for all individuals at fluent performance rates in order to be successful at nonverbal communication, mobility, and self-help skills. For the purpose of this study, the Big 6 skills include point, reach, pinch, turn, shake, and squeeze. Carl Binder, along with Beatrice Barrett discovered the importance of establishing basic component motor skills before the training of more complex composite skills, while doing work with developmentally disabled adults (Johnson & Layng, 1994). This hypothesis was also previously observed by Eric and Elizabeth Haughton (Johnson & Layng, 1994). These basic component motor skills are now referred to as the 'Big 6 + 6'. The (+6) skills include movements such as pull, push, touch, grasp, place and release tap, and twist.

These basic fine motor movements are essential for effective communication and understanding of the environment. An intervention that is simply trying to produce a desired result for the issue at hand is not addressing the core of the problem. Rather, the true problem is the fact that the underlying component parts of the skill are not intact (Johnson & Layng, 1992) causing a manifest of behaviors as a result of frustration within the individuals environment.

The Big 6 + 6 skills are the component skills that are a part of everyday behaviors. It is these Big 6 + 6 skills that are necessary for children with disabilities to acquire in order to maintain a level of success within the community environment. Throne (1975) believes that typical environments fail to provide what individuals with severe and complex disabilities require to be successful citizens in society. Further, the typical environment can limit individuals with severe disabilities because it neglects to provide the support necessary for their optimal functioning (Bricker, Ruder, & Vincent, 1976; Haughton, 1972). In fact, accounting for in greater detail the characteristics of typical behavior in order to help individuals with severe disabilities become more skilled so that they are more likely and better able to engage with their peers may be effective (Bricker, Ruder, & Vincent, 1976; Haughton, 1972). Judging skill acquisition from a non-normative real-life perspective has profound implications for interventions. The implications of non-referred norms include instructional outcomes, the adjustment of instructional procedures, and a choice of approach for evaluating progress toward typical behavior should be based on what is considered typical in their community (Barrett, 1979).

Instructional outcomes refer to those skills that are the result of instructional interventions that the learner is expected show. Instructional outcomes should be quantifiable performances that occur under specific conditions and that meet predetermined criteria (Barrett, 1979). The assumption of typical achievement for individuals with severe disabilities often emphasizes self-help skills without the a real focus on academic skills such as numerical skill acquisition, sight vocabulary, the development of handwriting skills, or other forms of communication necessary to be successful in the community environment (Barrett, 1979). If instructional objectives are arranged such that low level skills facilitate the acquisition of skills at a higher level, the result would be a hierarchical arrangement of the curriculum (Resnick, Wang, & Kaplan, 1973) that would be more consistent with skills learned by typical peers.

For example, typical peers regularly engage in previously mastered complex behaviors, (Resnick et al., 1973). Based on these findings, Barrett (1979) concluded that the systematic measurement of behaviors is the best way to improve communication. Barrett (1979) describes measurement that is based on human behavior as a universal language, especially for those individuals who are nonverbal.

Since community behavior norms guide the training of individuals with severe disabilities to the extent that we implicitly or explicitly compare student accuracy (Barrett, 1979) it is difficult to measure this complex behavioral sequence. Further, this comparison may be too limited due to the fact that typical outcome variables (e.g., identifying the percentage of correct actions) is a highly restrictive measurement of their overall behavior, which generates little information about a student's performance (Barrett, 1979).

By adding time to the measurement of skills, clinicians can now understand student performance and examine their skill growth with the use of standardized charts, often represented in a celeration chart. The celeration chart allows for data-based decision making on student performance.

Current Study

The current study examines the effects of fluency-based instruction, and MST surgery on skill acquisition for two children with LKS. Specifically, baseline learning and skill acquisition data will be analyzed to determine psychomotor skill acquisition during fluency-based instruction.

Since there is a limited amount of information regarding effective interventions for LKS, this study seeks to clarify which Big 6 skills, and those in combination, effect skill acquisition.

Research Questions and Hypotheses

(1) When implementing fluency-based instruction, will the posed intervention increase the acquisition of the Big 6 + 6 skills?

Hypothesis: It is hypothesized that fluency-based instruction will increase the acquisition of all Big 6 + 6 skills.

(1A): When implementing fluency-based instruction, will the skill of pointing increase in acquisition of skills?

Hypothesis (1A): It is hypothesized that the skill of pointing will increase when fluency-based instruction is implemented.

(1B): When implementing fluency-based instruction, will the skill of pinching increase in acquisition of skills?

Hypothesis (1B): It is hypothesized that the skill of pinching will increase when fluency-based instruction is implemented.

(1C): When implementing fluency-based instruction, will the skill of reaching increase in acquisition of skills?

Hypothesis (1C): It is hypothesized that the skill of reaching will increase when fluency-based instruction is implemented.

(1D): When implementing fluency-based instruction, will the skill of turning increase in the acquisition of skills?

Hypothesis (1D): It is hypothesized that the skill of reaching will increase when fluency-based instruction is implemented.

(1E): When implementing fluency-based instruction, will the skill of shaking increase in the acquisition of skills?

Hypothesis (1E): It is hypothesized that the skill of shaking will increase when fluency-based instruction is implemented.

(1F): When implementing fluency-based instruction, will the skill of squeezing increase in the acquisition of skills?

Hypothesis (1F): It is hypothesized that the skill of squeezing will increase when fluency-based instruction is implemented.

(2) When implementing fluency-based instruction, will the participant maintain the acquisition of the Big 6 + 6 skills?

Hypothesis: It is hypothesized that the participant will maintain the skill acquisition of the Big 6 + 6 skills.

(2A): When implementing fluency-based instruction, will the participant maintain the skill of pointing?

Hypothesis (2A): It is hypothesized that the participant will maintain the skill of pointing.

(2B): When implementing fluency-based instruction, will the participant maintain the skill of pinching?

Hypothesis (2B): It is hypothesized that the participant will maintain the skill of pinching.

(2C): When implementing fluency-based instruction, will the participant maintain the skill of reaching?

Hypothesis (2C): It is hypothesized that the participant will maintain the skill of reaching.

(2D): When implementing fluency-based instruction, will the participant maintain the skill of turning?

Hypothesis (2D): It is hypothesized that the participant will maintain the skill of turning.

(2E): When implementing fluency-based instruction, will the participant maintain the skill of shaking?

Hypothesis (2E): It is hypothesized that the participant will maintain the skill of shaking.

(2F): When implementing fluency-based instruction, will the participant maintain the skill of squeezing?

Hypothesis (2F): It is hypothesized that the participant will maintain the skill of squeezing.

(3) When implementing fluency-based instruction, will the participant demonstrate generalization of the acquisition of all Big 6 + 6 as demonstrated in the task reach, grasp, place, release?

Hypothesis (3): The participant will demonstrate generalization of the Big 6 + 6 skills as demonstrated in the task reach, grasp, place, release.

CHAPTER II

LITERATURE REVIEW

Historical Background and Significance

Landau Kleffner Syndrome

Landau Kleffner Syndrome (LKS), or acquired epileptic aphasia, can be described as an epileptic syndrome that involves a neurological impairment, which is correlated to the appearance of paroxysmal electroencephalograph (EEG) activity (Pearl, Carrazana & Holmes, 2001). LKS is also characterized by an acquired epileptic aphasia (AEA), referring to prolonged receptive language deterioration. The major component of LKS aphasia is the acquired impairment in symbolic linguistic processing that is not due to a perceptual disorder (Baron, 2004), or as acquired aphasia with convulsive disorder and acquired receptive aphasia (Vance, Dry, & Rosen, 1999). LKS has been included in the International Classification of Epileptic Syndromes since 1985 (Pearl et al., 2001). According to the National Institute on Deafness and Other Communication Disorders, more than 160 cases have been reported between 1957 and 1990.

Landau and Kleffner were the first to report this correlation between paroxysmal EEG activity and language deterioration, which predominantly occurs over the temporal or parieto-occipital regions of the brain (Pearl et al., 2001). Landau and Kleffner (1957) reported on five children with AEA and convulsive disorder. It was suggested that language improvement was reflected with EEG improvement. These findings suggest a loss of language where there are persistent, convulsive discharges as a pathophysiology (Pearl et al., 2001). Children with early onset LKS have a devastating long-term language outcome, as opposed to a child with a later onset of LKS (Pearl et al., 2001). LKS has lasting effects on children who achieve early developmental milestones (Pearl et al., 2001).

LKS develops during the critical period of language development (Morrell, Whisler, et al., 1995) when the basic neural units of language are also being developed. During this time, neural circuitry is being developed that will establish a foundation for language. This process, synaptogenesis, involves an abundant growth of axonal processes that maintain contact with specific target cells. This process provides children with two times the number of target cells as compared to adults (Morrell, Whisler, et al., 1995). After the outgrowth of cells occurs, neural pruning begins. Neural pruning is a competitive process in which the synaptic contacts compete for synaptic space (Morrell, Whisler, et al., 1995). These neural circuits will either make a synaptic connection or will be eradicated. Morrell, Whisler, et al. (1995) suggests the thought of neural pruning also applies to language development.

During the time of language development and neural pruning, epileptic discharges occur, causing the brain to develop and maintain synaptic arrangements that are functionally unnecessary and inappropriate (Morrell, Whisler, et al., 1995). Thus, these inappropriate neural connections become permanent during the critical period of development. Once these neural arrangements are established and permanent, and the window of language development has passed, restoration of these arrangements, even after epileptic discharges cease in early adolescence (Morrell, Whisler, et al., 1995) is impossible.

Characteristics of LKS

The characteristics of children with Landau Kleffner Syndrome include language deterioration, seizure disorders, and severe EEG abnormalities (Buelow, Aydelott, Pierz, & Heck, 1996). Secondary to language deterioration are behavioral issues, acute psychiatric disorders, as well as epilepsy with seizure control (Pearl et al., 2001). LKS occurs predominantly in males, with a ratio of 2:1 (Pearl et al., 2001). LKS appears in children between the ages of three and seven years of age, during a critical period of language development (Buelow et al., 1996). LKS occurs from an epileptogenic lesion in the speech cortex at this critical period of development, interfering with the establishment of satisfactory and functional circuits for normal language development (Morrell, Lewine, & Squires, 1995). Language regression in children with LKS is reported between the ages of 5-7 years (Pearl et al., 2001). The initial onset of language difficulties begin with the loss of receptive understandings and is followed by the loss of speech output (Morrell, Whisler, et al., 1995).

These defining characteristics of LKS, in addition to continuous spikes and waves during slow wave sleep are similar in children with epilepsy. It was suggested that these conditions lie within the spectrum involving a common pathophysiology (da Silva, Chugani, Muzik, & Chugani, 1997).

Clinical Seizures

Clinical seizures are reported for 70% of the children with LKS. The type of seizure varies; however most can be described as eye blinking, ocular deviations and head dropping (Pearl et al., 2001). Seizure activity may begin at the onset of a child’s language loss, or may have gone unnoticed in early childhood (Buelow et al., 1996).

EEG Patterns

EEG abnormalities appear most frequently during sleep states (Vance et al., 1999). The EEGs typically document bilateral spike and wave activity focused in the posterior temporal and/or parietal regions of the brain (Buelow et al., 1996; Vance et al., 1999). The epileptic dysfunction is localized in cortical areas devoted to auditory and speech sound-processing (Metz-Lutz, De Saint Martin, Hirsch, Maquet, & Marescaux, 1996; Morrell, Whisler, et al., 1995; Pateau, 1994). Language deficits result from the bilateral and sustained epileptic dysfunction (Buelow et al., 1996; Vance et al., 1999).

SPECT studies and PET scans measure cerebral blood flow and have shown metabolic disturbances over the temporal lobes (da Silva & Chugani, 1995; Intenzo, Kollros, Kim, Stefanos, & Zhang, 1996; Maquet et al., 1990). The epileptic dysfunction is localized to cortical areas devoted to auditory and speech sound-processing (Metz-Lutz et al., 1996; Morrell, Whisler, et al., 1995; Pateau, 1994). Magnoencephalography (MEG) scans have allowed researchers to locate more precise locations of epileptiform discharges (Vance et al., 1999). These neurological investigations, however, have not identified a consistent lesion site (Deonna, 1991; Gordon, 1990). Epileptomologists have reported that the constant abnormal electrical activity during sleep also disturbs normal language development (Buelow et al., 1996).

When examining EEG topographic mapping, it was revealed that the majority of patients have bilateral spike-and-wave activity over 85% of non-REM sleep (Pearl et al., 2001). During sleep states these continuous discharges are focused in the tempropariet al regions, illustrating the importance of using long-term EEG monitoring to detect this activity (Pearl et al., 2001).

Misdiagnosis

LKS is a rare syndrome that has been misdiagnosed as Pervasive Developmental Disorder (PDD), acquired deafness, and elective mutism due to the presence of cognitive and behavioral concerns (da Silva et al., 1997). It is likely that this misdiagnosis will continue until further research is conducted surrounding the psychopathology of this disorder.

Language Deficits in LKS

Global aphasia is characterized by limited speech, impaired comprehension, impaired repetition with or without right hemiplegia, and separate frontal and temporoparietal lesions without hemiplegia (Baron, 2004), all of which can be associated with the symptoms of LKS. Such symptoms also can extend to a complete loss of the auditory/verbal comprehension and expression. Notably, the child's non-verbal cognitive capacity is integral, however behavioral issues such as hyperactivity, inattentiveness, or withdrawal can occur (Perez et al., 2001).

Children who lose previously acquired speech and language abilities show epileptiform abnormalities on the electroencephalogram (EEG) (da Silva et al., 1997). A clinical presentation of this syndrome is one of normal development with a loss of language skills. These symptoms indicate auditory verbal agnosia coupled with expressive language deterioration (Vance et al., 1999).

A comprehensive review by Deonna (1991), found a strong causal relationship between language disorders and epilepsy discovered in LKS. With the lack of knowledge of any consistent pathology in LKS, it is suggested that the aphasia arises from the epileptic cluster and foci within the brain (Morrell, Whisler, et al., 1995).

Vance et al. (1999) indicated that auditory processing difficulties experienced by children with LKS are pervasive, impairing their perception and discrimination of linguistic and non-linguistic sounds. Thus, their findings would provide evidence that neurological disturbances could possibly disrupt the functioning of the auditory cortex. This would also suggest that the use of auditory training programs, in cases such as LKS, would be beneficial (Vance et al., 1999). Some children do recover minor language ability; however most children diagnosed with LKS continue to have significant language impairments (Grote, Van Slyke, & Hoeppner, 1999).

Pearl et al. (2001) described the relationship between epileptic activity and language as the pathology of the cortex concerned with speech, rather than the cause of aphasia. This is supported by the following: EEG abnormalities suppressed through the use of benzodiazepines does not improve aphasia; changes in the EEG may not result in a change in aphasia; and the use of anticonvulsants to control seizure activity do not improve aphasia (Pearl et al., 2001). However, disappearance of spike-wave activity may improve aphasia, thus termination of the spike-wave activity may serve as a successful treatment of LKS (Pearl et al., 2001). A significant limitation exists throughout the literature surrounding the absence of psychometric data of language functioning from the time of diagnosis and after the treatment (Grote et al., 1999). Thus, strong and reliable conclusions about the impact of an intervention are difficult to make.

Word deafness is usually the first visible sign of a language disturbance. Word deafness is also known as auditory verbal agnosia, which can be observed when a child no longer responds to outside stimuli, including raised voices, bells, whistles, a barking dog, or a phone ringing (Pearl et al., 2001). Word deafness also includes receptive aphasia, which is when a child does not respond appropriately to language, such as responding to parent commands (Buelow et al., 1996). Word deafness also can lead to complete unresponsiveness and impaired expressive communication (Pearl et al., 2001). The child may communicate using crude signs or gestures. More importantly, adverse behaviors can begin to develop due to frustrations and anxiety caused by the aphasia. A necessary treatment goal is the introduction of an effective communication system focusing on the child's language-based strengths, to assist in alleviating the negative behaviors surrounding the child's inability to effectively communicate (Pearl et al., 2001).

Perez et al. (2001) states language improvement is variable, even with epileptic activity in control using prescribed medications. With this in mind, it remains difficult to know if the child will recover language or remain severely impaired (Deonna, Peter, & Ziegler, 1989). Thus, a major goal and focus of all therapies and interventions are to preserve the child's communication and skill building (Vance, 1991).

Previous Treatments for LKS

Traditionally LKS has been treated using intravenous immunoglobulin (IVIG) therapy, anticonvulsant medications, and corticosteroids (Buelow et al., 1996). When treating LKS with antiepileptic medications, continuous spike and wave activity of EEGs continues, leading to no improvement in the language (Buelow et al., 1996).

The traditional use of medications, such as anticonvulsants, although used to treat LKS, has an insignificant effect on the improvement of speech (Buelow et al., 1996). The outcomes of language and behaviors based on pharmacological treatments are variable (Grote et al., 1999). The continuous, long-term use of these pharmacological treatments is not only erratic and unpredictable (Grote et al., 1999), but also has serious side effects which include height retardation, insatiable appetites, the development of steroid-induced diabetes and obesity, osteoporosis, and the development of myopathy and cataracts (Buelow et al., 1996). When these drugs are decreased due to the negative impacts of the drug's side effects, language skills are also reported to deteriorate (Buelow et al., 1996).

Multiple Subpial Transection Surgery

Another option in treating LKS that has been slowly adopted is Multiple Subpial Transection Surgery (MST). MST surgery is a surgical procedure designed to eliminate the capacity of cortical tissue to generate seizures or subclinical epileptiform activity, while preserving the cortical functions subserved by the tissues (Grote et al., 1999).

Upon consideration of MST surgery, the child must go through days of preoperative evaluations to determine the appropriateness of the surgery, as well as to determine the focal points of the epileptic clusters (Buelow et al., 1996). The child also will undergo clinical electrical brain activity recordings, which are usually, prolonged-sleep EEGs. There is also a gradual withdrawal of the child's antiepileptic medication to enhance the seizure activity (Buelow et al., 1996). The EEG monitoring is usually 24 hours, where the epileptologists can view the child's EEG recordings to help determine the spike-wave activity and its focus (Buelow et al., 1996). If, through the EEG monitoring, it is determined the child has bilateral epileptic discharges, methohexital suppression testing is performed. This allows the epileptologists to determine an epileptic focus, as well as determine if the EEG abnormalities originate from one unilateral focal point and if that focal point drives the epileptic activity at the other regions of the brain (Buelow et al., 1996).

Criteria of MST Candidate

A preoperative neuropsychological evaluation, as well as a speech/language evaluation, is conducted to determine the first set of specific criteria. This criterion is based on LKS and MST surgery candidacy, which is to differentiate global cognitive delays from language related deficits as seen in children with LKS, and to determine the existence of an acquired aphasia, as opposed to speech delays related to other disorders seen in childhood (Buelow et al., 1996). Other preoperative tests are conducted to provide further evidence on the location of the epileptic cluster. These tests include magnetic resonance imaging (MRI), single photon emission computed tomography (SPECT), and positron emission tomography (PET) scans.

The next set of specific criteria for MST surgery is defined as: acute onset of acquired aphasia, age-appropriate language developed before onset of LKS, and slow-wave sleep patterns existing in the temporoparietal regions of the brain (Buelow et al., 1996).

Goals of MST Surgery

Grote et al. (1999) described the rationale behind this procedure as based on two experimental facts: 1) the bulk of the normal physiological transactions depend upon the vertically oriented cortical organization and 2) while the synchronization necessary for epileptic discharge requires side-to-side horizontal linkages. The MST procedure only interrupts the side to side horizontal linkages necessary for epileptic discharge (Beaumanior, Bureau, Deonna, Mira, & Tassinari, 1995). The horizontal neural units generate epileptic clusters, thus breaking the epileptic activity and conserving the vertical neural units that provide pathways for input and output messages. The MST procedure involves the selective interruption of intra-cortical horizontal fibers while preserving the vertical columnar organization, as well as the similarly vertically oriented incoming and outgoing nerve fibers. There is no tissue that is actually removed (Beaumanior et al., 1995).

In 2002, a meta-analysis was conducted to determine the success rate of pure MST surgery. A total of 211 patients were analyzes; however for the purpose of this study only 54 patients who received pure MST surgery will be reported. An excellent outcome was defined as >95% seizure-frequency reduction; good outcomes were defined as 75-95% seizure-frequency reduction; fair outcomes were defined as 50-75% seizure-frequency reduction; and poor outcomes were defined as <50% seizure-frequency reduction (Spencer et al., 2002).

Ten or 71% of the fourteen patients with generalized seizures demonstrated excellent outcomes in the reduction of frequency of those seizures. Twelve or 63% of the nineteen patients with simple, partial seizures resulted in seizure-frequency reduction; however, three experienced an increase in seizure-frequency in patients with simple partial seizures (Spencer et al., 2002). Thirteen or 62% of the twenty-one patients with complex, partial seizures resulted in excellent seizure-frequency reduction. Thus, twenty-five patients of the 40 total patients with simple and complex partial seizures reported excellent outcomes in the reduction of seizure activity. This meta-analysis confirmed that MST surgery is a practical option for irrepressible seizures developing in functionally critical cortical areas (Spencer et al., 2002). Of the patients who received pure MST surgery, no one developed language or sensory deficits (Spencer et al., 2002). Deficits such as such as memory decline, hemiparesis, and visual field compromise did occur post-surgery; however were confirmed and previously diagnosed (Spencer et al., 2002).

Morrell, Whisler, et al. (1995) reported 14 cases of LKS, in which the patients were treated with MST surgery. Seven of the 14 patients recovered age-appropriate speech; four improved but continued in speech therapy programs, and the remaining three patients showed no improvement. It can be concluded that early diagnosis and treatment of LKS will have optimal outcomes. It can also be concluded that gains in language, expressive and/or receptive, can be seen years rather than months after surgery (Grote et al., 1999).

Fluency-Based Instruction in relation to LKS

The Morningside Model of Generative Instruction

Upon removal of the cortical tissue and the seizure activity is terminated, an intense, step-wise intervention should be established to begin to develop skills that were previously lost or unattainable during the onset of LKS (Vance, 1991). This is important to preserve the child's functional communication skills and sustain language-based learning pathways (Vance, 1991). As demonstrated in the literature, there are several models that focus on skill acquisition, most of which are founded on breaking skills into their component parts for effective and consistent delivery of skills.

The Morningside Model of Generative Instruction is an approach utilized to address adult literacy, as well as childhood learning and attention problems (Johnson & Layng, 1992). The Morningside Model of Generative Instruction was introduced in Seattle, Washington in 1980 by Kent Johnson. The students were offered a wide variety of academic and training services. This establishment soon became sought after by parents whose children had learning as well as attention problems in school. The program offered by Morningside was one that taught students the component skills or pre-requisite skills to successfully learn (Johnson & Layng, 1994). Currently, the Morningside Academy provides opportunities for children in elementary and middle school to advance in their learning. Students entering the Morningside Academy typically score within the first and second quartiles on standardized achievement tests in reading, language, and mathematics. Students typically enroll for approximately 3 years in order to move ahead to grade level. The Morningside Academy teaches behavioral repertoires to address students' deficiencies in basic academic skills, in areas of reading, writing, and mathematics, and also address learning skills, such as goal setting, listening, noticing, reasoning, thinking, studying, and organizing and performance skills (Johnson & Street, 2004). Johnson & Street (2004) define the Morningside model as follows:

> The Morningside model of teaching and learning is a research-based system that has components of curriculum and instruction combined into a generic model of instruction and learning, known as The Morningside Model of Generative Instruction. This model searches for effective research based materials to use for instruction, practice, assessment, and measurement of performance.

The Morningside model is an instructional method that provides a stepwise progression through an instructional sequence from entry to true mastery of an objective. The model also aligns classroom practices with each step of the progress, and tries to incorporate student self-correcting procedures throughout the progression (Johnson & Layng, 1994; Johnson & Street, 2004). The instruction of this method contains three phases: acquisition or establishment, practice for fluency, and application (Johnson &

Street, 2004). This method of instruction uses frequency data to measure the responses or the time between responses of the learner. The data collected on the individual learner gives the teachers a tool to direct their students to the next academic/curriculum level. The Morningside Model of Generative Instruction measures the frequency of accurate responses, and increases accurate performances. This is referred to as fluency building (Binder, 1988). True mastery of the performance is defined as accurate, smooth, useful, and speedy (Johnson & Street, 2004).

There are seven tenets of the Morningside Model of Generative Instruction. These are not concrete steps or procedures, rather a set of possible procedures that can be used to achieve the next step in fluent performance frequencies in learning and attaining a skill (Johnson & Layng, 1994). The tenets are as follows: 1) Identify the component elements of instructional objectives; 2) Measure the frequency until true mastery (RESAA: Retention, Endurance, Stability, Application, and Adduction) is reached (Binder, 1988); 3) Establish a component behavior through interactive, contingent exchanges between the learner and the teacher; 4) Build the component skills to fluency aims; 5) Build the endurance of the component skills that are repeated in the environment; 6) Include application activities that allow multiple component skills to combine in such a way that defines the higher-level complex activities; 7) Alter procedures for implementing model based on the collected data.

Morningside Academy's adult literacy programs have been reported as being successful (Bucklin, Dickinson, & Brethower, 2000). In the first literacy program, 29 out of 32 participants entered the program with skills ranging from 2^{nd} to 8^{th} grades, and exited with skills at or above national 8^{th} grade literacy standards. This is a reported overall gained average of 1.7 grades per 20 hours of instruction. In the second program, 19 out of 20 students successfully finished the program, and were reported as gaining an average of 2.0 grades per 20 hours of instruction. This is the US government standard of one grade level per 100 hours of instruction (Johnson & Layng, 1992).

The Malcolm X College also adopted the Morningside Model of Generative Instruction. The purpose of the program was to remediate skill deficits of high school graduates, enabling success in college students who entered the program with reading or math skills below 6^{th} grade level. It was reported that the students gained an average of 2.0 grade levels for 20 hours of instruction (Johnson & Layng, 1992). This acquired proficiency was within 1-2 semesters, thus lowering dropout rates of the students.

Theoretical Background

The foundation of the Morningside Model of Generative Instruction began with the selectionist approach to understanding human behavior, which was advocated by B.F. Skinner and philosopher Dr. John Dewey. B.F. Skinner promoted a selectionist approach to understanding human behavior in his writings *Contingencies of Reinforcement: A Theoretical Analysis* (Johnson & Street, 2004). This approach places emphasis on the function of the targeted behavior in meeting environmental contingencies, as opposed to the structuralist approach which emphasizes form and process (Johnson & Street, 2004).

B.F. Skinner attempted to draw a parallel between the emergence of complex behavioral repertoires and the emergence of more complex functional forms in evolutionary biology (Johnson & Street, 2004). Hence, in evolutionary biology, the environment selects simple forms, and from that a more complex form transpires. When applied to human behavior, reinforcement selects the specific element. In the evolutionary biology sense, natural selection is accountable for the selection. In relating these thoughts collectively, The Morningside Model theory emerges (Johnson & Street, 2004). The Morningside Model builds complex intellectual skills from the combination of elements or component skills (Johnson & Street, 2004).

Dr. John Dewey, a progressive philosopher as well as American pragmatism and philosophy of education, described the selectionist approach that transpired during emergence of the Morningside curriculum and instruction (Johnson & Street, 2004). It was Dewey that emphasized the importance of natural influences over learning, emphasizing current student activities, goals and value system (Johnson & Street, 2004). It is within these natural situations that the students select subject matter to learn, as opposed to teacher imposed subject matter from a pre-assembled curriculum package (Johnson & Street, 2004). Dewey also initiates student driven research ideas and topics. This process, according to Dewey, is naturalistic and evolving, leading the students to individual and functional paths for real world application (Johnson & Street, 2004).

Skinner's thoughts on education, as pronounced in *Walden II*, are drawn from Dr. John Dewey's work (Johnson & Street, 2004). During the 1950s and 1960s, Skinner transformed his view on education, and put emphasis on the need for a more technical approach to education, which he referred to as a technology of teaching (Johnson & Street, 2004). The Morningside Model of Generative Instruction emulates this, with a technological approach to learning, the teacher being fully in charge of beginning the repertoires of the learner, with generalized imitative repertoires in reading, reasoning, writing, mathematics, learning, studying, and problem solving. After the students master the beginning foundations, there is a switch to a more Deweyian approach, in which students apply their foundational skills in a naturalistic, and reinforcing setting (Johnson & Street, 2004).

In relation to Skinner and Dewey's philosophic beliefs, there are two derivatives that have greatly benefitted from The Morningside Model. These derivatives can be characterized as instructivism and contructivism (Johnson & Street, 2004). These beliefs are generally conceptualized as two very opposing views concerning the nature of knowledge (Johnson & Street, 2004).

Instructivism is defined as a set of educational practices consistent with the philosophy of behavioral psychologists (Johnson & Street, 2004). This is an approach in which the teacher is the director of instruction and learning. This approach favors comprehensive content analysis, the identification of component skills, and carefully designed educational sequences which build fundamental knowledge into complex wholes, with an emphasis on building fluency in the component skills (Johnson & Street, 2004). This emphasis on building fluency is a way to generate the emergence of untaught skills and behaviors into everyday situations. It is thought that students receive intentional instruction in the conventions of the culture, such as using the symbolic code, to produce oral language into written language (Johnson & Street, 2004).

Instructivists will accept that these symbolic systems stand for natural processes, but do not share the view that the symbolic systems themselves are natural or undiscovered (Johnson & Street, 2004). This is a narrow view on educational practices (Johnson & Street, 2004).

Contructivism can be defined as a set of educational practices that are consistent with the philosophy and findings of developmental psychologists, and some cognitive psychologists (Johnson & Street, 2004). This approach is also credited with Piaget and Vygotsky, which facilitates student exploration of content and processes in original contexts (Johnson & Street, 2004). The students are encouraged to assemble their own knowledge base by testing ideas and integrating new knowledge with pre-existing intellectual constructs (Johnson & Street, 2004). Knowledge is considered to be temporary, developmental, subjective, internally constructed, and socially mediated. Knowledge is attained through cooperative social activity, and communication. This is considered a molar approach to education (Johnson & Street, 2004).

Independently, constructivists and instructivists view education in very differently (Johnson & Street, 2004). Constructivists believe that instructivists supply conservatism, and discourage conventional thoughts and formal knowledge (Johnson & Street, 2004). Instructivists believe constructivists provide no foundation upon which the learner can explore their world, and leave the student to discover only subjective codes that have no basis within their natural environment (Johnson & Street, 2004). Despite their apparent differing views, the Morningside Model of Generative Instruction has efficiently blended their ways of thinking and teaching. The model favors the instructivist view to build a foundation on which to learn, as well as favors the constructivist view to build reflective, and socially conscious learners with a Deweyian view of natural reinforcement (Johnson & Street, 2004).

One of the earliest influences on The Morningside Model of Generative Instruction originated from Dr. Charles Ferster. His ideas on verbal behavior stated that new learning and novel behavior is a direct result of the rearrangement of existing repertoires, with each new and increasing complex behavior emerging in an evolution from previous learning (Johnson & Street, 2004). Two important terms, described as generativity and contingency adduction have been associated, and applied with this naturally occurring event (Johnson & Street, 2004). A student of Skinner, Dr. Robert Epstein, used the term generativity to describe an event during the laboratory experiment, which was intended to provide some insight on a behavioral interpretation (Johnson & Street, 2004). Pigeons that were taught to push a small box around the experimental chamber, step on the box, and then peck at an object, were thought to be able to problem solve this pecking problem when the object was out of reach. Each of the behaviors in this series was taught in separate training sessions (Johnson & Street, 2004). Birds were presented with the problems, and they demonstrated a series of behavior patterns to solve the problem, often ascribed as insight. Only the birds that gained instruction in all three component skills were able to successfully solve the problem (Johnson & Street, 2004). Dr. Epstein reported this event to be defined as generativity, a spontaneous interconnection of existing repertoires to solve a problem (Johnson & Street, 2004). This theory was later evolved to show the emergence of novel behaviors in humans (Johnson & Street, 2004).

B.F. Skinner considered his most important contributions to be the use of response rate as the basic measure of behavior and the cumulative response recorder, which was a tool for moment-to-moment analysis of changes in response rates (Binder, 1993). Skinner and his colleagues made discoveries in basic research labs using single-subject design where experimenters directly measured response rates (Johnson & Street, 2004).

Most of the principals were a derivative of an experimental analysis of behavior and then applied in classrooms (Johnson & Street, 2004). This includes schedules of reinforcement, extinction, response shaping, stimulus fading and discrimination (Johnson & Street, 2004). However, when others followed this application, the response rates were dropped in favor of a more conventional percentage correct or accuracy-only assessment. The exceptions to this rule included typing and reducing the frequency of problem behaviors in classroom settings.

Johnson and Street (2004) indicated contingency adduction was applied through the work of Dr. Paul Andronis, Joe Layng, and Israel Goldiamond. Efforts of their work indicated that contingency adduction is defined as new contingencies or performance requirements that will stimulate performances learned under other contingencies. Further Johnson and Street (2004) indicated, when under the right circumstances, a learner engages in a behavior in a new setting that has earned reinforcement in a previous situation. The performance of the learner is then reinforced in the new setting, often by a different type of reinforcement. This moment of reinforcement characterizes the moment of contingency adduction.

The Morningside Model uses the term contingency adduction to include all generative processes and the occurrence of novel behavior (Johnson & Street, 2004). Dr. Alessis wrote an essential paper on the importance of generativity for the design and power of the instructional technique. He theorized that the curricular strands, segments of knowledge and skills within a larger content area, have an infinite number of set relationships, with the inability to directly teach each strand (Johnson & Street, 2004). Instead, children should be taught a general pattern of responding which will produce effective responding during inexperienced problems (Johnson & Street, 2004). The complexity of instruction depends on the teacher's ability to identify and teach a minimum generative set of responses which can combine into a universal set of possible relationships (Johnson & Street, 2004). In essence, the teacher is searching for the exponential value of key instructional factors, through which behaviors that emerge are relative to the component skills taught (Johnson & Street, 2004). For example, a successful sight reading curriculum will reliably produce and create a performance of reading sight words as they arise in future text; however, a successful pseudoword and sight word program reliably produce a combination of reading behaviors, ensuring successful reading of words beyond the original lesson (Johnson & Street, 2004). Thus, instructional programs that instruct minimal response sets are considerably more efficient than programs attempting to teach every stimulus-response relationship (Johnson & Street, 2004).

The Morningside Model of Generative Instruction designs instructional programs on the basis that learners experience contingency adduction daily (Johnson & Street, 2004). It was noted that such programs build on empirical analyses of knowledge, skills, and relationships in the field of instruction. More specifically, each skill is introduced precisely; such that previously learned skills will be called upon to meet the new and increasingly complex requirement or task (Johnson & Street, 2004).

Notably, the Morningside Model of Generative Instruction uses features of Siegfried Engelmann's direct instruction program, with the added level of fluency building practices. The goal of this practice is to build vigorous academic behaviors, in which these behaviors are resistant to distraction, and are easily accessible in novel situation (Johnson & Street, 2004).

Instructional Sequence

The Morningside Model of Generative Instruction adopted a systematic and scientific approach to instruction, which was built by Dr. Susan Markle and Philip Tiemann at the University of Illinois, Chicago. Instructional programs have been developed based on a set of principals, where by these principals and programs are tested on naïve learners to ensure maximum quality and results (Johnson & Street, 2004). Johnson and Street (2004) discussed Markle and Tiemann's instructional system, which is a system that is divided into six components. The first component is to provide clear and precise goals and objectives in which the learner is expected to achieve. The second component, based on the intentional outcomes, is content and task analysis. The third component, which is the construction of criterion tests represent defined outcomes, also defining a measure of social validity (Johnson & Street, 2004). These criterion assessments are designed pre-instruction to assure that the succeeding instructional design is directly based on expected posttest performance (Johnson & Street, 2004). The fourth component is the entry repertoire the learner must possess in order to be successful with the program. The fifth component is the instructional sequence, which is designed to establish the minimum set of instructional tasks within which the learner must proceed through to achieve the pre-stated outcomes (Johnson & Street, 2004). The sixth component is performance data. The performance data is collected during the instruction, and based on the data the program is adjusted as deemed necessary (Johnson & Street, 2004). Current literature indicates this instructional system as an evolutionary system that has potential to produce competent learners who are naturally reinforced by their progress (Johnson & Street, 2004). When this does not happen, the procedures are changed. Thus, when an instructional method is deemed ineffective an inherent motivational problem is produced which becomes more difficult to adjust; however, The Morningside Model of Generative Instruction produces instruction that avoids negative associations with a set of tasks, and strives to make each task a successful task (Johnson & Street, 2004). The underlying theme is it does not matter how much higher-level instruction occurs; that if the learner does not have the component skills necessary to acquire the skill, maximum learning does not occur (Johnson & Street, 2004).

Content Analysis

As per Johnson and Street (2004), content analysis occurs in two types: content-dependent analysis and content-independent analysis. Content-dependent analysis starts with a general understanding of the knowledge that is going to be acquired, the linear relations to each other, and the ways in which the subject field is socially validated. This understanding provides a foundation from which to establish instructional sequences, as well as prerequisite skills on which content mastery is dependent. Johnson and Street (2004) indicated complete content-dependent analyses cover the full set of real world tasks that are characteristic of the field, and then analyze those tasks into their most fundamental units or elements. These fundamental skills are organized to uncover common basic skills that will uncover a hierarchy of foundational skills. When those skills are mastered, they will facilitate the acquisition of a number of higher-level skills. Those mastered skills will also disclose where a particular skill set should be inserted into the scope and sequence, and clarify when the order of presentation of skills is critical (Johnson & Street, 2004).

When the process is finalized, the content area is identified as a set of tool skills, the minimal response sets that strengthen all other skills in the content area (Johnson & Street, 2004). Component skills or elements are identified as the second level of building blocks needed, which depend on one or more tool skills. The compounds or composite repertoires are the higher-level response sets that socially validate the learner in that specific content area (Johnson & Street, 2004). It is assumed in the Morningside Model that the compound repertoires are generative, such that they begin from combinations and re-combinations of component skills and emerge when the skills that comprise them are well-established (Johnson & Street, 2004).

Content-independent analysis arises from two primary ideas that form the basis of this analysis: learning channel analysis and learning outcome analysis (Johnson & Street, 2004).

Learning Channels and Learning Outcomes

Learning Channels were first applied by Dr. Eric Haughton, and are a method of explaining objectives on the basis of their stimulus-response attributes (Johnson & Street, 2004). Stimulus characteristics are defined in terms of through which sensory organ a stimulus is experienced. A stimulus can be experienced through any of the five senses. Haughton defined them in terms of sight, hearing, touch, smell, and taste. The term thinking was later added to represent a stimulus not present in the external environment, but in relation to the learner (Johnson & Street, 2004). The response characteristics were illustrated on the basis of common movements, for example say, write, point and do. A learning channel is basically a stimulus-response pairing; a learning channel precedes each objective. For example, to ensure that a learner is fluent in his numbers for early arithmetic, you might include see/say numbers, see/write numbers, hear/say numbers, hear/write numbers, free/say numbers, and free/write numbers (Johnson & Street, 2004).

Despite the fact that learning channels seem similar to learning styles, they are different in the approach (Johnson & Street, 2004). Learning styles assume that an ability or disability of a skill is due to a function of hard wired differences between individuals, where a learning channel proponent assumes that the ability or disability is a function of the learner's history or past learning experiences (Johnson & Street, 2004). Learning channels assess activity-specific channel competencies and diagnose skill and fluency deficits that need to be treated to improve task performance (Johnson & Street, 2004). When a learning channel is weak, interventions are developed according to baseline rates to systematically and directly improve those channels to improve performance. On the contrary, learning style proponents feel as though the learner should be provided a modification to translate from a strong modality to a weak modality (Johnson & Street, 2004). When learners are first introduced to a modality in which they have past histories of being unsuccessful, there is a resistance; however, this resistance is short lived (Johnson & Street, 2004).

Haughton developed a learning channel matrix that is helpful in being able to ensure that an educational program is providing adequate opportunities for students to practice in a wide variety of channels (Johnson & Street, 2004). Through the use of learning channels, defined by sensory inputs and physical outputs, you can increase the probability of a student engaging in an activity (Johnson & Street, 2004). When using the learning channels matrix, you are able to identify a student's learning preference, thus increasing the child's learning potential (Kubina & Cooper, 2000). The learning channels are pathways to increase the opportunities for all students to learn within the classroom (Johnson & Street, 2004). The uses of learning channel matrixes are also important when you are working with children with special needs. By being able to identify the sensory inputs and physical outputs that are essential for that individual child, you are introducing innovative ways to present new skills and activities for that child to be successful (Kubina & Cooper, 2000).

Learning outcomes, as defined to be a part of content-independent analysis, originate from the work of Tiemann and Markle (Johnson & Street, 2004). Learning outcomes are differentiated among five different types of learning, which include verbal information, intellectual skills, cognitive strategies, motor skills and attitudes (Johnson & Street, 2004). There are nine learning outcomes recommended which include three psychomotor skills, three simple cognitive skills, and three complex cognitive skills (Johnson & Street, 2004). The psychomotor skills are those skills in which the learner learns how to respond. These responses occur at the musculature level and emphasize the precise form of the response (Johnson & Street, 2004). These responses are referred to as the Big 6+6 skills, which are fine motor movements all individuals must have at regular performance rates if they are to be proficient at manipulating objects in their environment, performing self help skills, using non-verbal communication, and being mobile (Johnson & Street, 2004). The Big 6 refers to movements such as reach, point, turn, pinch, shake, and squeeze. The other six (+6) are movements such as pull, push, touch, grasp, place and release tap, and twist. These skills are essential in isolation, and in compound forms. When working with children or adults with developmental delays, it is critical to practice these basic psychomotor skills to enhance fluent performance (Johnson & Street, 2004). The skills include tying shoelaces, moving a mouse for the computer, or identifying a desired object or picture.

Implications of the Big 6+6 on Children with LKS

Typical environments fall short of what severely handicapped persons require (Throne, 1975). The discrepancy between typical and appropriately adapted environments become more obvious in direct relationship to the escalating literature describing new habilitative developments designed to bridge the gap (Barrett, 1979).

The typical environment limits those with severe handicaps as it fails to provide the remedial assistance necessary for their optimal functioning. If the goal is to help severely low-functioning individuals become more competent and thus more acceptable to and better merge with their peers, it should be examined at greater detail the characteristics of typical behavior (Bricker, Ruder, & Vincent, 1976; Haughton, 1972). The implications of community norms include instructional outcomes, the modification of instructional procedures, as well as a choice of methods for evaluating progress toward behavioral normalization. The discrepancy between typical and appropriately adapted environments becomes more obvious in direct relationship to the increasing literature describing new habilitative developments intended to bridge that gap (Barrett, 1979).

Instructional outcomes are products of instruction, in which the skill the learner is expected to have as a result of instruction, ideally are quantifiable performances that occur under specific conditions and that meet specific criteria (Resnick, Wang, & Kaplan, 1973). There is an assumption of what typical achievement is for severely disabled people, resulting in an emphasis on self-help skills without consideration of numerical skills, sight vocabulary, handwriting, or other forms of communication necessary for community living (Resnick et al., 1973). Their typical peers, who regularly engage in these complicated behaviors, have previously mastered a complex foundation of prerequisites and components as well as a plethora of related skills. If the instructional objectives are sequenced so that foundational skills at each level facilitate acquisition of skills at the next higher level, the result would be a hierarchical arrangement of the curriculum (Resnick et al., 1973).

Using task analysis, there is an ability to use these component skills as long range outcomes, at least at the basic skill level normally acquired in early elementary education. A longitudinal approach would decrease the likelihood of fragmented or splintered skill profiles, and would prevent deficits from accumulating because the necessary component skills would be taught prior to instruction in the skills that depend on those component skills (Resnick et al., 1973).

Barrett (1979) concluded that the measurement of human behavior is best way to communicate. It is a universal language, especially for those who are non-verbal. Community behavior norms guide training of people with disabilities to the extent that we implicitly or explicitly compare individual accuracies. This comparison may be too restricted due to the fact that percentage correct is highly restrictive, which yields little information from an individual.

Carl Binder, along with Beatrice Barrett discovered the importance of establishing basic component motor skills before the training of more complex composite skills, while doing work with developmentally disabled adults. This theory was also previously observed by Eric and Elizabeth Haughton (Johnson & Layng, 1994). These basic component motor skills are now referred to as the Big 6 + 6. The component skills consist of the following: point, touch, reach, grasp, place, release, push, pull, twist, squeeze, tap and shake.

By combining the component and composite analyses, cumulative instruction, and increasing the frequency of the component behaviors, an instructional method transpires. This method, which addresses performance acquisition, retention, and application (adduction), provides the child with an array of fluent skills that are applied to new contexts and situations without the need for instruction. This method of instruction demonstrates the meaning of generative instruction (Johnson & Layng, 1994).

Precision Teaching and Curriculum Based Assessments

Educational interventions are intended to improve student academic and social development. Within special education, the resources are allocated to design instructional interventions or programmatic modifications to increase individual success (Deno, 1986). The interventions for individual students must provide data to document the effectiveness of those modifications. School psychologists and special educators formulate program modification decisions deliberately. A major characteristic of a school psychologist is a data based decision maker and problem solver (Deno, 1986). Public Law 94-142, which refers to all individuals right to education, states that the right rests on the assumption that we can provide each disabled individual an appropriate education within the Least Restrictive Environment (LRE). In developing Individual Education Plans (IEP), the discussion focuses on where to place child in continuum of services as opposed to what kind of educational treatment is most appropriate (Deno, 1986). The appropriateness is defined as consensus or agreement among IEP planners, rather than as a substantive improvement in a student's program (Deno, 1986). The lack of focus on evidence for improvement may be related to the fact that existing assessment methodologies may decrease our chance of defining appropriate educational programs (Deno, 1986). IEPs explicitly or implicitly rest on a differential diagnostic treatment model that never has been proven to be empirically defensible (Arter & Jenkins, 1977). Ysseldyke and Salvia (1974) identified an alternative to the traditional diagnostic-prescriptive model, which they referred to as task analysis. The task analysis model directs practitioners to teach basic skill components rather than abilities that do not necessarily transfer to basic skill development, which is comparable to The Morningside Model of Generative Instruction theory (Ysseldyke & Salvia, 1974). The difference is not the initial diagnosis, more accurately the types of skills diagnosed as deficits. One approach involves the identification of theory-based processing skills, while the following focuses on the identification of task components prerequisite to reading, writing, mathematics and spelling (Ysseldyke & Salvia, 1974). Time series designs have been widely used and applied to single subjects by behavior analysts (Sulzer-Azaroff & Mayer, 1977). A time series graphic record of individual student performance, which is considered a reliable, valid and practical database, must be produced through repeated measurement. Without reliable and valid data on student achievement, which can be used to evaluate the effects of proposed developments in education, an experimental approach is not viable (Sulzer-Azaroff & Mayer, 1977).

Curriculum Based Measurements (CBM)

The Morningside Model of Generative Instruction employs a useful tool in tracking progress on important learning outcomes for individual learners. This approach is known as Curriculum Based Measurement (CBM) (Deno, 1986). Curriculum Based Measurement (CBM) uses a generated time series design for individual students. CBM refers to procedures for quantifying student performance on curriculum tasks, which usually involves the direct observation of student performance (Deno, 1986).

CBM can also be defined as a set of procedures based on standardized frequency-based measurements used to evaluate student performance in fundamental academic skills (Deno, 1986). Initially, CBM was developed as a tool for teachers to evaluate student performance in an academic area with reliability and validity, thus providing a basis on which to make data-based decisions throughout the school year (Johnson & Street, 2004). The conceptual foundations of CBM are embedded in the work of applied behavior analysts and the use of single subject data methodology and frequency being the key unit of measurement (Johnson & Street, 2004).

CBM emphasizes fundamental academic skills monitoring using short-duration, parallel and alternate forms (Johnson & Street, 2004). The assessments are brief, and are approximately three to five minutes in length. The CBM assessments have specific directions, and time criterions that remain constant throughout the administrations. The performance of the individual(s) is scored based on those criterions (Johnson & Street, 2004). These assessments have been proven to be valid and reliable measurements of general academic achievement (Shinn, 1989). The key focus of CBM is on long term or annual goal measurement. This can be measured by researching the baseline performance, normative performance, and accepted individual skill performances (Johnson & Street, 2004). The assessment materials and procedures are curriculum-referenced; meaning the material is drawn from the school curriculum already in place (Johnson & Street, 2004). These assessments can be norm-referenced when comparing local school districts and creating local norms (Johnson & Street, 2004). CBM is individually referenced because each individual student performance can be compared throughout the year to monitor growth and development (Johnson & Street, 2004). For example, as the preliminary entry into The Morningside Academy, a CBM measurement is administered which will provide the teachers with a baseline of performance measures on which to create annual goals and objectives. The CBM weekly results are charted throughout the year, and feedback is provided to the parents, as well as the student (Johnson & Street, 2004). CBM measurements are used as instructional guides to help monitor the student's progress to assist in achieving the set annual goals, as well as monitor the usefulness of the present intervention procedures, and if necessary determine the need for instructional change (Johnson & Street, 2004). A variation of CBM has been used in a number of instructional intervention models initially created for use in special education programs within Precision Teaching (Lindsley, 1972). Each of the models is distinctive; however, all share the same assumption that the student performance in the school curriculum provides the most relevant data for making instructional decisions (Johnson & Street, 2004).

Precision Teaching (PT)

One of the most critical tools in the monitoring of instructional program effectiveness is identified to be the use of Precision Teaching timing and the Standard

Celeration Charting (Lindsley, 1972). Precision Teaching is an essential tool in The Morningside Model of Generative Instruction. Precision Teaching has the primary emphasis on the speed and accuracy of responding, and mastery criteria, which are stated in terms of the rate of correct responses and incorrect responses on curriculum tasks. Precision Teaching, during the 1960s and 1970s, evolved with a number of other mastery learning approaches. However, the term mastery was commonly defined differently and in terms of performance accuracy or percent correct, whereas Precision Teaching defined mastery in terms of rate of responding (Lindsley, 1972).

Precision Teaching began with Ogden Lindsley in 1964 when he originally applied principals of functional behavior analysis and count per minute measures to the direct measurement of 'retarded' behavior (Binder, 2005). Lindsley was highly influenced by Skinner, believing rates of responding were the primary data to study change in human behavior (Johnson & Street, 2004).

Ogden Lindsley was an exception, first using humans in laboratory research that lead to coining the term 'behavior therapy' in 1954, and in the development of Precision Teaching (Lindsley, 1972). Lindsley insisted on using rate or frequency measures (counts per minute) as the basic data for analysis. Lindsley formulated methods of Precision Teaching based on the daily measures of student response rates established from classroom activities (Binder, 1993).

The Skinnerian view of response rate implies that it is a variable that may be moved up or down using contingencies of reinforcement. Lindsley recognized that traditional measurement systems that focus on percent correct are place artificial ceilings on performance, leading to a false sense in the student's true ability level (Johnson &

Street, 2004). Precision Teachers found that student performance ‘ceilings’ were imposed by non-fluent prerequisites or component skills, and that reinforcement procedures do not enable the students to break through those ceilings. Those ‘ceilings’ were lifted, allowing fluency, after practice of the component skills, as well as attainment of higher performance rates (Binder, 1993). Only additional practice of components and attainment of higher performance rates allowed students to lift imposed ceilings and achieve fluency on more advanced or composite performances (Binder, 1993).

Response rate or frequency, is not just a measure of behavior, it is a dimension or property of behavior with qualitative implications (Lindsley, 1991). Lindsley established a new paradigm beyond the traditional behavior analyst’s use of response rate as a sensitive measure of behavioral probability. Through these early discoveries, Precision Teaching derived the instructional principal that in order to acquire and smoothly attain competence on a given composite skill or educational performance task, one must achieve both accuracy and speed on its lower level component parts (Binder, 1988, 1993).By adding the time component to the definition of mastery, Precision Teaching formulated a technical definition of fluency as accuracy plus speed or quality plus pace (Binder, 1988, 1993).

Dr. Eric Haughton (1972) one of the earliest contributors to Precision Teaching, as well as a student of Lindsley, developed a one minute timing to follow performance frequencies during practice sessions (Johnson & Street, 2004; Lindsley, 1972). Haughton and Lindsley encouraged practice schedules that quickly produced high-frequency accuracy rates and low-frequency error rates on curriculum slices (Johnson & Street, 2004). He encouraged teachers to use these brief daily samples of correct and incorrect academic response rates to make decisions about student progress. Haughton would set performance frequency rates or aims to those who which would be considered an expert in performing the desired task, and the learners would practice until the rates of the learner and the expert were of equal performances (Johnson & Street, 2004). The daily sample rates, which were usually one-minute durations, were then graphed on a Standard Behavior Chart developed by Lindsley. By using the Standard Behavior Chart, teachers were able to analyze performance and learning for each critical objective in their instructional programs (Johnson & Street, 2004). The teachers discovered that students must achieve certain minimum rates of correct responding on prerequisite skills or knowledge tasks in order to progress smoothly through curriculum (Binder, 1993).

Haughton (1972) discovered that competent adults can write correct answers to single-digit arithmetic problems at rates between 80 per minute and 110 per minute, with 1-2 errors. Elementary Students could perform this skill at a minimum of 50 to 60 per minute correct to move through subsequent steps in the California math curriculum. However, the students could not attain this performance criterion unless they could accurately write digits and read random digits at a minimum rate of 100 per minute.

Precision Based teaching is a method whose key components include Ogden Lindsley's count per minute performance, Eric Haughton's mastery criteria, and Carl Binder's behavioral fluency, which is defined as speed plus accuracy (Johnson & Layng, 1994). Data collected has shown that non-fluent performances, or a lack of automaticity of a skill, has increased effects on error rates, as well as increased negative emotional and behavioral issues towards those activities (Binder, Haughton, & Van Eyk, 1990). The key components of Precision Teaching can be defined as setting time-based mastery criteria for each curriculum step, providing daily opportunities for practice (Johnson & Street, 2004). Each timed measurement used to chart performance is placed on a graph called the Standard Behavior Chart. By utilizing this chart, the teacher is able to analyze the data and change procedures when the chart shows those procedures are not effective (Pennypacker, Koening, & Lindsley, 1972).

Precision Teaching findings report that students must achieve fluency in basic skills in order to progress smoothly to higher level material (Johnson & Street, 2004). A common reason for math failure is due to non-fluent basic component skills in mathematics, for example number writing, and digit reading. The average student is able to produce 50-70 problems per minute (Binder, 1988; Haughton, 1972). Kunzelman and colleagues worked to establish the count per minute fluency standards for a wide range of academic skills (Binder, 1988; Haughton, 1972). Kunzelman also reported that school workbooks and computer-based lessons prevent students from achieving fluency due to lack of examples and time between problems (Binder, 1988; Haughton, 1972). Precision Teachers develop materials that foster growth and free students to respond as rapidly as possible.

Olander, Collins, McArthur, Watts, and McDade (1986) examined whether precision-taught nursing students would learn and retain more information than those taught traditionally. There were nine students in each class, and the same instructor taught both classes with same text material. The traditional class consisted of 2 ½ hour lectures per week and the students were examined every 2 chapters and comprehensively. The precision teaching students were self paced with oral tests based on 10 flash cards, after every 2 chapters. There were no lectures. In order to proceed to the next unit, the students were required to answerer 8/10 questions correctly per minute. The students charted their performance on The Standard Celeration chart recording the number of correct and incorrect responses per minute. The average precision teaching student attained a 3.0 out of a possible 3.0. The traditional average grade was a 1.78 out of a 3.0. When a retention check was conducted 8 months later, Precision Teaching students were 1.8 times more fluent and 1.8 times more accurate than the rational students were.

PT and CBM: Similarities and Differences

Precision Teaching and CBM both use frequent and usually brief (1-5 minute) timed measures of student performance on specific curriculum pinpoints to make decisions about individual student's programming and placement. The time-based performance separates these measurements from mainstream educational practice, and allows practitioners of each approach to make sensitive distinctions between multiple levels of student achievement, which is not possible with conventional untimed measurement procedures (Barrett, 1979). Both CBM and precision teaching use the term fluency to describe the mastery learning at each step in the curriculum sequence. Each method appreciates the meaningful statements about performance, and those performance objectives which must include the time dimension in order to distinguish between the beginning levels of performance and mastery (Binder, 1988).

The type of data graphically displayed and used to evaluate program success, however is very different. Precision Teaching uses semi-logarithmic graph paper to display changes in rate of responding across time and CBM uses Cartesian graph paper to display changes in the rate of mastery of successive curriculum tasks (Deno, 1986).

Whether one approach can be used more effectively by teachers has not been empirically resolved (Deno, 1986).

CBM uses equal interval or ‘add/subtract’ graphs, which are not always standardized with a count per minute scale (Binder, 2005). Precision Teaching is founded on the Standard Celeration Chart or the Standard Behavior Chart, which is a 6-cycle semi-logarithmic or ‘multiply-divide’ count per minute graph, which is a powerful tool due to the standardization. The graph gives tremendous analytic power in contrast to CBM ‘add/subtract’ scale. The ‘multiply/divide’ scale turns learning curves into learning lines or ‘celerations’ (Binder, 2005). The expression of learning as a multiplicative factor per week provides the first simple predicative power of the chart (Binder, 2005). This is demonstrated with the straight-line projections that can reliably predict future course of behavior, and the chart also maintains homogeneity and symmetry of variance, important for scientific analysis and classroom decision-making (Binder, 2005).

The establishment of performance criteria is also different between Precision Teaching and CBM. CBM uses class averages, however if class performs below the mastery level, then a class norm is not a fair judgment of mastery criterion. Precision Teaching assumes there is a level of performance for any given skill that will support retention and maintenance, endurance or attention span, and application or transfer of training (Binder, 1988).

Precision Teaching uses a particular set of measurement tasks that is not specified routinely, rather directions are given regarding how to obtain a measure of response rate from any curriculum task deemed important by the teacher (Binder, 2005). A greater flexibility exists in Precision Teaching, where different curriculum tasks can be introduced as long as the response rate on the task is obtainable.

The Standard Celeration Chart

Precision Teaching (PT) is a method of instruction that uses the Standard Celeration Chart and timed measurements of performances to provide supporting evidence on when to make a curriculum based decision (Binder, Haughton, & Van Eyk, 1990). The recorded accelerations for each individual learner are collected on Ogden Lindsley's Standard Celeration Chart (Johnson & Layng, 1994). Lindsley wanted to add measurement procedures that were designed to make educational decisions on student performance (Binder, 1988). The Standard Celeration Chart provides the basis for setting fluency targets, as well as making decisions and changes in the curriculum based on the student's acceleration (Johnson & Layng, 1994).

Important discoveries about the use of count per minute fluency standards or 'aims' (Haughton, 1972) and how to progress individuals through the curriculum sequences on fluency-based standards at each identified phase (Starlin, 1972) were revealed through the use of the standard celebration chart. Performance 'aims' inform the student and the teacher how many responses of a certain skill they should complete in the specified timing period. There are set rates that are arbitrarily chosen based on competent adults. Additionally, these set rates have appeared to be associated with the characteristics of fluency (Johnson & Street, 2004).

Celeration is the measure of a change in rate over time. A celeration 'aim' is the line of progress drawn on the Standard Celeration Chart to denote a certain angle from the student's baseline performance frequency to the current frequency aim. This line predicts how many days it will take the student to reach the performance aim (Johnson & Street, 2004). A celeration 'aim' of X2 is the slope of the celeration line from the student's baseline frequency to the frequency aim suggesting a doubling in frequency per week (Johnson & Street, 2004). As such, learners who meet their indicated performance aim during one-minute intervals move into the endurance phase. The endurance phase makes certain that the student can maintain speed, as well as accuracy over a longer period of time (Johnson & Street, 2004). Powerful fluency-based insights emerged. Beck (1979) demonstrated that 20-30 minutes per day in the classroom boosted achievement test scores as much as 20-40 percentile points in a school in Great Falls, Montana. The ramification of this difference is that interventions in the systems that emphasize speed as well as accuracy are designed to improve fluency in student responding to a greater degree than systems emphasizing accuracy alone.

The Standard Celeration Chart provides a clear picture of the individual learner's performance rates, error rates, and growth rates in a standardized design, allowing teachers to make decisions regarding student educational performance (Johnson & Street, 2004). The expression of learning as a multiplicative factor per week provides the first simple predicative power of the chart (Johnson & Street, 2004). This is confirmed through the use of straight-line projections, which reliably predict the future course of behavior. The chart also maintains homogeneity and equilibrium of variance important for scientific investigation and classroom based decision-making (Binder, 2005).

This precision measurement tool provides a data-based window into student learning and growth, allowing the teacher to make decisions based on the sensitivity of the tool to fine increments of progress (Johnson & Street, 2004). The teacher is able to probe performance on future sections into the curriculum to discern if the student can move ahead or will benefit from brief, intentional instruction (Johnson & Street, 2004).

Defining Fluency-based Instruction

Fluent performance, a specific vernacular for Precision Teachers, is thought to occur once a performance of an individual demonstrates retention, endurance, and application (Johnson & Street, 2004). Fluent performance is thought to be flowing, effortless, automatic, practiced, accurate and in a sense second nature (Johnson & Layng, 1996). A fluent performance is a performance of probable activity that is naturally reinforced (Johnson & Street, 2004).

Dr. Carl Binder devised the term fluency building, which refers to practice sessions that are designed to achieve the goals of automatic, effortless, and errorless responding (Johnson & Street, 2004). Fluency-based instruction uses the acceleration of successful performances to guide and develop a permanent successful student. A true definition of mastery is fluency, a combination of accuracy (quality) plus speed. This will ensure that the child will be able to perform easily in the presence of distraction, will be able to retain newly-learned skills and knowledge, and will be able to apply what they've learned to acquire new skills or to real-life situations. It is also thought of as 'second-nature' knowledge, or automatic performance without hesitation in the midst of distraction (Binder, 1988). The difference between the beginner, who may forget what they might have recently learned or have difficulty applying the information, and a true expert, is not accuracy, but it is the speed or rate of responding. Standard percentage scores do not differentiate beginner and expert levels of achievement (Johnson & Street, 2004).

Fluency oriented educators, or precision teachers, claim that attention span or endurance is a by-product of behavioral fluency. Precision Teaching is a technical offshoot of behavior analysis (Potts, Eshleman, & Cooper, 1993). It is not a way of teaching but a general approach that involves repeated practice, error-correction procedures, timed drills to meet predetermined fluency aims and the use of the standard Celeration chart (Pennypacker et al., 1972). It is reported that when students reach fluency, they can work steadily for extended periods of time and maintain high levels of correct responding (Binder et al., 1995).

McDowell and Keenan (2001) conducted a fluency-based study on a 9-year-old child with ADHD. At baseline, the child had low rates of responding (3-6 per minute) and incorrect responding occurred at 5-7 per minute. The baseline sessions increased, however incorrect responses continued to occur at a higher rate than correct responses, indicating the speed as opposed to the accuracy was increasing. It was recorded that only 50% of each 10-minute session were on-task. After the intervention, the child remained on-task 100% of the sessions, while at baseline spent 50-60% of each session on task. Fluency goals were reached at the 24th session (64 correct responses per minute), however teaching and practice counted for 19 additional sessions to ensure maintenance especially after incorrect responses increased after a 2 week vacation. The results showed a reversal to baseline when fluency goals were not met, which resulted in a decrease in the rate of correct responding, and not being on-task for the entire 10-minute session. The child's performance remained fluent and endurance improved during the third reversal to baseline.

Bucklin et al. (2000) conducted a study that included 10 males and 20 females recruited from junior and senior level classes at a midwestern university. The mean age was 22.3 years old. The individuals were included if, after practice, could print 160 letters correctly per minute, copy 160 numbers correctly per minute, and answer 80 addition problems correctly per minute. Precision teaching practitioners recommended this fluency-based criterion. The results indicated that fluency trainees averaged 17.27 correct responses per minute, while accuracy trainees average 8.97, which is statistically significant at ($p < 00001$). When examining percent correct scores, the fluency trainees averages 92.52% correct and accuracy trainees averaged 86.20%, which was not statistically significant at ($p= .098$). Thus, fluency trainees completed many more items correctly per minute than accuracy trainees did with similar accuracy supporting the claim that fluent component skills lead to more fluent composite skills. These results also suggest that fluent component skills ease the acquisition of higher level skills (Bucklin et al., 2000).

Fluency-based Instruction: Instructional Design

The Morningside Model of Generative Instruction follows the system of Tiemann and Markle, as described earlier, as a system of instructional design (Johnson & Street, 2004). Typically, based on the content analyses, as well as the task analyses, instructional materials are developed or used from commercially available materials (Johnson & Street, 2004). Instructional protocols are overlapped to the materials to ensure those materials meet the standards that have been adopted. Conversation between the student and the teacher during instruction is minimized in order to optimize learner responding (Johnson & Street, 2004). This is done to strive for faultless communication; verifying only one message was conveyed. The designers favor programs that move quickly from instructional programs to practice routines. The teacher must provide praise for each correct response, and direct corrective feedback for incorrect responding (Johnson & Street, 2004). All instructional programs are designed to fit the learner without assumptions based on age or grade level (Johnson & Street, 2004).

Instruction, Practice, and Application

The tasks are taught within three primary activities: instruction, practice and application (Johnson & Street, 2004). Instruction refers to the acquiring of a new performance that was previously unable to be performed. Instructional programs are meant to teach associations, sequences, concepts, and applications that will promote strategy learning, referred to as contingency adduction. This instruction can take place with a single learner, a small group, or a classroom (Johnson & Street, 2004).

A goal during instruction is the students learn not only when to respond, but how to respond. A teacher will make sure that the learner can respond correctly to the set of questions or tasks ahead, known as verifying (Johnson & Street, 2004). The teacher will provide 'think time' before each prompt to assure correct responding (Johnson & Street, 2004). After verifying, the teacher moves to randomization. The teacher will randomize each item to make certain that the student performance is answering the task, not the order of presentation (Johnson & Street, 2004). Thus, after randomization, the pace of instruction is increased. Pacing reduces the amount of 'think time' for the learner, which prepares them for fluency building.

After a successful instructional lesson, practice of the newly acquired skill is completed. The practice is timed, highly structured, goal oriented, and monitored

(Johnson & Street, 2004). These practice sessions apply the PT method of design. During the practice piece, the students are timed for one-minute intervals, and their performance is charted on the Standard Celeration Charts. When the prerequisites of a skill are fluent, subsequent skill attainment is successful (Johnson & Street, 2004). The performance aims, as well as the celeration aims are set individually. Each practice activity is designed to comprise more items than the learner could attain to avoid placing ceilings on the individual's performance frequency.

The mastery piece of this instruction assumes that when the practice sessions combine timing, charting, and frequency-building characteristics of PT and mastery learning, the goals assure that students permanently retain the skills they are taught; can perform those skills for an extended period of time; can perform those skills in a distracting situation; and can easily apply them to both new learning constraints and real world situations (Johnson & Street, 2004). Again, contingency adduction is the keystone of student learning and skill acquisition in attaining higher level tasks without direct instruction (Johnson & Street, 2004). Skill acquisition is detected during instructional probes. Those newly acquired skills may need to practice to achieve fluent levels of performance; however the direct instruction of the component skills needed to master that skill is unnecessary (Johnson & Street, 2004).

As part of the skill acquisition process, students are building fluent component skills, which are standardized and have the ability to stand alone during practice or instruction. More importantly, the ultimate goal is for application of those fluent skills in a real world setting (Johnson & Street, 2004). The students, after successful instruction and practice regimens, are to apply those newly acquired skills to novel activities and situations (Johnson & Street, 2004). The activities are comprised of composite skills used to stimulate creative novel problem solving and learning (Johnson & Street, 2004). This is also referenced as project-based learning, which assumes that the students are able to perform all of the component skills necessary, and the compound tasks will produce the appropriate contingency adduction (Johnson & Street, 2004). This usually happens within one to two different ways: the student is either required to engage in a previously learned performance in a new context or situation; or, there is a design of new combinations of previously learned elements (Johnson & Street, 2004). For example, advanced sports are re-combinations of motor skill elements that can be individually taught, and can come together to form a compound skill of advanced sports (Johnson & Street, 2004).

Implications in the Schools

This study provides an intervention that is not simply just chained or sequenced events introduced to solve one particular problem, but a foundation where any student can learn. An intervention that is simply trying to produce a desired result for the problem at hand is not addressing the real issues of the problem (Johnson & Layng, 1992). Rather, the true problem is the fact that the underlying component parts of the skill are not intact or fluent (Johnson & Layng, 1992).

It is important to recognize that the tenets of the Morningside Model, combined with the fluency-based instructional method do not have to be isolated in the academic world. These methods of instruction can be used with any skill an individual has to perform, such as but not limited to self-care skills, vocational skills, fine and gross motor skills (Binder, 2003). In all of these complex skills, building the component skills to a criterion level of accuracy and speed (fluency) and produce a true mastery of fluency development is necessary (Binder, 2003).

With the prevalence of autism and other developmental disabilities on the rise, it is imperative that we, as educators, provide schools with efficacious interventions that will support the learning and success of all students. Adverse behaviors have been seen to manifest partly due to frustration caused by aphasia, or other language or developmental disabilities. With the introduction of an effective way to increase skill acquisition, such as the use of a fluency-based approach to academic curriculum, there could be a decline in such maladaptive behaviors (Pearl et al., 2001). By bringing fluency-based instruction into the public school systems, we are providing our regular and special education teachers, parents and children an intervention for increasing skill acquisition, and fostering growth and independence for our students.

Role of the School Psychologist

The role of School Psychologist is to help evaluate and monitor student progress. CBM and formative evaluation creates an opportunity for school psychologists to get involved in formulating and documenting the effectiveness of instructional interventions in a direct and useful way (Deno, 1986). In response to the Gaskin's settlement, it is imperative that we provide our student's with a researched-based approach in skill acquisition that will increase their success in the regular education environment with supplementary aids and accommodations. As a school psychologist, we are responsible in providing our multidisciplinary teams with the knowledge necessary to develop goals that will meet the needs of the individual student in all environments. We are also to provide our teams with scientifically based research, as indicated in the Individuals with

Disabilities Education Improvement Act (IDEIA; 2004) as aligned with the No Child Left Behind standards (NCLB). As reported in IDEIA, teams are to use scientifically based research that involves the application of rigorous, systematic, and objective procedures to obtain reliable and valid knowledge relevant to education activities and programs and includes research that: (1) Employs systematic, empirical methods that draw on observation or experiment; (2) Involves rigorous data analyses that are adequate to test the stated hypotheses and justify the general conclusions drawn; (3) Relies on measurements or observational methods that provide reliable and valid data across evaluators and observers, across multiple measurements and observations, and across studies by the same or different investigators; (4) Is evaluated using experimental or quasi-experimental designs in which individuals, entities, programs, or activities are assigned to different conditions and with appropriate controls to evaluate the effects of the condition of interest, with a preference for random-assignment experiments, or other designs to the extent that those designs contain within-condition or across-condition controls; (5) Ensures that experimental studies are presented in sufficient detail and clarity to allow for replication or, at a minimum, offer the opportunity to build systematically on their findings; and (6) Has been accepted by a peer-reviewed journal or approved by a panel of independent experts through a comparably rigorous, objective, and scientific review (U.S. Department of Education, n.d.).

Fluency-based instruction in the classroom not only provides progress monitoring of student success, but is a research based intervention that can provide valid and reliable data that can be generalized to all environments, which will foster growth for all students.

Links between LKS, MST, and Fluency

The relationship between MST Surgery and the fluency-based approach may be important in the proper skill acquisition of a child with Landau Kleffner Syndrome. Early identification and intervention may increase skill acquisition rates in children with LKS, which will enhance all aspects of their social, emotional, and academic development.

Future Research

The current research is limited in all aspects of Landau Kleffner Syndrome, including empirical interventions used to treat LKS, the response children have to the variety of treatments in LKS, and psychoanalytic data for pre- and post-surgery.

Goals

This study is going to focus on the areas of skill acquisition in LKS, and interventions used to enhance skill development, specifically fluency-based instruction for skill acquisition, specifically Big 6 skill acquisition in the areas of: point, reach, pinch, squeeze, turn, and shake coupled with the Big 6+6 skills combination skill reach, grasp, place, and release (RGPR).

CHAPTER III

METHODOLOGY

The purpose of this study was to introduce a fluency-based approach in skill acquisition to two children with LKS. This study will also discuss the role, as well as the benefits, of a fluency-based approach within the school setting.

A single subject AB unidirectional changing-criterion design was used to test the hypotheses (Kazdin, 1982). The independent variable in this study was fluency-based intervention and the dependent variable was motor skill acquisition. The purpose of this design was to demonstrate the effects of a fluency-based intervention on two children diagnosed with Landau Kleffner Syndrome, both of whom underwent MST surgery.

Participants and Setting

Both participants had a current diagnosis of Landau Kleffner Syndrome and had undergone MST surgery. A sample size of two children diagnosed with Landau Kleffner Syndrome in Pennsylvania were chosen for this single subject design study (N = 2). The children were male adolescents, and the data collected occurred within their home setting. The data collected for this study was part of an existing data set collected through a local service provider within Pennsylvania.

Both Participant 1 and Participant 2 were Caucasian adolescents from Pennsylvania. Participant 1 was a 16 year-old male, and diagnosed with Landau Kleffner Syndrome at 4 years of age. Participant 2 was a 15 year-old male diagnosed with Landau Kleffner Syndrome at 4.5 years of age.

Participant 1 demonstrated limited verbal abilities with the following diagnostic impressions: Axis I Autistic Disorder; Axis II Mental Retardation; and Axis III Landau

Kleffner Syndrome. Participant 1 used verbal language to communicate, as well as the Picture Exchange Communication System (PECS) to help with clarification; however, due to his limited ability to verbally communicate his wants and needs, Participant 1 engaged in some self-injurious behaviors such as chin hitting, and shirt biting. Participant 1 previously participated in the Lovaas Discrete Trial program. Participant 1 underwent Multiple Subpial Transection surgery (MST) in October, 2005 in Omaha, Nebraska. The leading neurosurgeon reported complications during each portion of the surgery, the first being right vocal cord paralysis; the second being fluid on the brain after surgery. To note, no further surgery was required.

Participant 2 was a non-verbal child with the following diagnostic impressions: Axis I diagnosis of Autism: Secondary to a Medical Condition; Axis II Mental Retardation; and Axis III Landau Kleffner Syndrome. Participant 2 utilized augmentative communication devices and the Picture Communication System (PECS) to communicate basic wants and needs; however, due to his limited ability to communicate, Participant 2 engaged in self-injurious behaviors which included fist to face hits, head banging, finger biting, and fist pounding. Participant 2 previously participated in a Lovaas Discrete Trial program. Participant 2 underwent Multiple Subpial Transection Surgery (MST) in April, 2004 in Omaha, Nebraska. The leading neurosurgeon did not report complications during surgery.

Materials

Materials used for this study included a standard digital timer that has the ability to measure seconds, a pencil, the Standard Celeration chart, reinforcements individualized for each child, and 3 x 5 notecards to develop individualized materials per component skill.

Dependent Measures

The dependent variable in this study was motor skill acquisition. The independent variable in this study was fluency-based instruction. Each component skill and/or compound skill was charted on the Standard Celeration Chart, developed by Dr. Ogden Lindsley in 1965. The rates of responding for each component skill were charted based on the recorded floor. The Standard Celeration Chart is based on behaviors over a 24-hour period. Therefore, the chart can be broken down into rate of responses per minute. All recordings were based on the rate of responding per minute. The ‘floor’ refers to the amount of time the child is being timed for. There are specific timings done based on the complexity of the skill. For the purposes of this study, the timings consisted of 10 second, 15 second, 20 second, and 45 second intervals. The number of correct responses in 1-minute intervals were recorded and graphed on the Standard Celeration Chart.

Recruitment of Participants

Participants were selected from a local agency with written parent permission based on current diagnoses, MST surgery participation, and involvement in a fluency-based instruction intervention. The participants previously participated in fluency-based instruction, thus the participants were chosen through an existing data set.

Research Design

This study is a single subject AB unidirectional changing criterion design. Generalizability to the group (LKS) poses as a possible threat to external validity. The aim of this study was to increase skill acquisition in individuals with LKS. Possible threats to internal validity included the measurement of fluency-based instructional performance data being measured consistently between raters. Observer reliability was taken into account, as well as interobserver reliability. All sessions were standardized, using the same timer and counting method to ensure accurate data collection by each observer. The location of each session was the same, providing consistency for the observer and the child.

Changing-criterion design demonstrates the effects of the intervention by showing that a behavior gradually changes over the course of the intervention (Kazdin, 1982). The behavior was anticipated to progress in increments to match a criterion for performance that was specified as part of the intervention. A functional relationship exists between the behavior and the changing criterion design. As the behavior changes over time, so does the set criterion for the behavior or set of behaviors (Kazdin, 1982). In changing-criterion designs, the necessary levels of performance are changed over the course of the intervention to increase performance over time. The effects of the intervention are displayed when performance repeatedly changes to meet the criterion (Kazdin, 1982). Changing-criterion designs display characteristics similar to ABAB experimental designs and multiple baseline designs; however have important, distinguishing characteristics (Kazdin, 1982). Changing-criterion designs do not withdraw or temporarily suspend the intervention in order to demonstrate a functional relationship between the intervention and the behavior; nor is the intervention only applied to one behavior, and then to others (Kazdin, 1982).

Changing-criterion design begins with a baseline phase (Kazdin, 1982). The baseline phase provides an opportunity for the observation of a single behavior for one or more persons. This phase is labeled (A). After the baseline phase (A), the intervention phase (B) begins. Changing-criterion designs employ the use of several subphases within the intervention phase (Kazdin, 1982). A criterion is set for performance within the intervention phase. As within each subphase, a different criterion of performance is specified. As the performance stabilizes and consistently meets criterion, the criterion is made more rigorous, and criterion changes are made continuously over the program of the design (Kazdin, 1982). The changing-criterion design baseline is similar to the ABAB and multiple-baseline designs baseline phase. The baseline phase serves to describe current performance, and to predict future performance of the behavior (Kazdin, 1982). The subphases were designed to make and test those predictions. During each subphase, a criterion or performance standard was set; thus, if the intervention were accountable for change, then the performance would be expected to follow the shifts in the criterion (Kazdin, 1982). The changing criteria resemble what the performance of the behavior would be if the intervention put forth control over the behavior. If the performance correlates closely to the changes in the criterion, then the intervention can be considered to be accountable for the change in performance (Kazdin, 1982).

Intervention Procedures

The fluency-based instruction sessions consisted of one-to-one instruction with the first author, as well as trained Therapeutic Staff Supports (TSS) within the child's home setting. The TSSs were supervised by the first author on a weekly basis to ensure consistency between therapists. The sessions lasted 20-30 minutes, approximately 3 times per week after school and on the weekends. The 'floor' on the chart was dropped according to specific aims of the component skill. The aim lines were developed based on specific research collected from the Great Falls Project. When the performer would reach the aim in 3 consecutive sessions, the floor was dropped to the next step. This procedure continued throughout the timings previously listed. After 3 consecutive sessions within aim at 20 seconds, the performer was then timed for 45 seconds, which was referred to as an Endurance Check. If the performer's rate of responding was comparable to the aim, then the skill is stopped for 4 weeks. At the 4-week mark, the skill is then tested again at 45 seconds, which is referred to as a Retention Check. If the performer did not reach the aim rate of responding, the participants continued the skill at 20 seconds until the aim was reached. The observer/charter was responsible for running the timer, counting the targeted responses, charting the best score for the day on the Standard Celeration Chart, and reinforcing the performer immediately after an activity. The reinforcement for each activity was determined by the individual. Therefore, the reinforcement was apt to change based on the individual performer's preference. When reinforcement was changed, or an approach to teaching the skill was changed, a phase line is drawn on the graph to indicate a change in delivery. This procedure was the same procedure for all component skills introduced in this study. Participants were introduced to the Big 6 (+6) skills, of which included reach, point, pinch, shake, turn, squeeze and the combination skill reach, grasp, place, release. The Big 6 (+6) skills were measured on both the left and right hand.

Baseline

The first week of fluency-based instruction beginning at the component skills within the Big 6 (+6) for the participants was considered the baseline. The data was collected in the child's natural home setting.

Interobserver Reliability and Integrity

Interobserver reliability and integrity were assessed with an observation by the first author one time per week with each staff implementing the intervention. This was done to ensure reliable and consistent recording of behavior.

Data Analysis

Data was analyzed throughout this study using visual analysis and the percentage of nonoverlapping data (Kazdin, 1982). Changing criterion design employs the use of a gradual approximation of the final level of desired performance (Kazdin, 1982). Throughout the study, increased demands were placed on the participant only after the child has shown mastery of performance at the previous level (Kazdin, 1982).

Visual Analysis of Graphed Data

Visual discrimination of the graphed data. The five criteria utilized by this examiner were the following: (a) changes in mean levels of performance across criterion, (b) changes in level of the performance from the end of one phase to the beginning of the next phase, (c) changes in trend or slope from one criterion to the next, (d) latency of the change, and (e) stability of behavior change within criterion changes (Kazdin, 1982).

Percentage of Nonoverlapping Data

Nonoverlapping data percentage. To ascertain careful visual analysis, the percentage of nonoverlapping data points will be employed. This percentage will identify the values of the data points during the baseline phase do not approach any of the values of the data points achieved during the intervention phase, thus the more effective and reliable the intervention (Scruggs, Mastropieri, & Casto, 1987).

Effect Size Calculation

An effect size was attempted to be calculated to determine the degree in which there was an effect of fluency-based instruction on skill acquisition. The effect size was attempted using Cohen's *d* (Allison & Gorman, 1993). The use of effect size in single-subject research designs has been debated: applied clinical importance has in many circles been viewed as more important than statistical relevance in this research (Kazdin, 1982). Effect size has, however, been calculated to provide a statistical measure of the magnitude of treatment impact (Allison & Gorman, 1993). Statistical results have been particularly useful when baseline has not been stable or when results have not been clearly interpretable through visual analysis (Kazdin, 1982). Use of an effect size calculation has been recommended in the *Publication Manual of the American Psychological Association* (APA; American Psychological Association, 2009).

Research Questions and Hypotheses

Research Question 1

When implementing fluency-based instruction, will the posed intervention increase the acquisition of the Big 6 (+ 6) skills?

Hypothesis 1

It is hypothesized that fluency-based instruction will increase the acquisition of all Big 6 (+ 6) skills.

(1A): When implementing fluency-based instruction, will the skill of pointing increase in acquisition of skills?

Hypothesis (1A): It is hypothesized that the skill of pointing will increase when fluency-based instruction is implemented.

(1B): When implementing fluency-based instruction, will the skill of pinching increase in acquisition of skills?

Hypothesis (1B): It is hypothesized that the skill of pinching will increase when fluency-based instruction is implemented.

(1C): When implementing fluency-based instruction, will the skill of reaching increase in acquisition of skills?

Hypothesis (1C): It is hypothesized that the skill of reaching will increase when fluency-based instruction is implemented.

(1D): When implementing fluency-based instruction, will the skill of turning increase in the acquisition of skills?

Hypothesis (1D): It is hypothesized that the skill of reaching will increase when fluency-based instruction is implemented.

(1E): When implementing fluency-based instruction, will the skill of shaking increase in the acquisition of skills?

Hypothesis (1E): It is hypothesized that the skill of shaking will increase when fluency-based instruction is implemented.

(1F): When implementing fluency-based instruction, will the skill of squeezing increase in the acquisition of skills?

Hypothesis (1F): It is hypothesized that the skill of squeezing will increase when fluency-based instruction is implemented.

Research Question 2

When implementing fluency-based instruction, will the participant maintain the acquisition of the Big 6 (+ 6) skills?

Hypothesis 2

It is hypothesized that the participant will maintain the skill acquisition of the Big 6 (+ 6) skills.

(2A): When implementing fluency-based instruction, will the participant maintain the skill of pointing?

Hypothesis (2A): It is hypothesized that the participant will maintain the skill of pointing.

(2B): When implementing fluency-based instruction, will the participant maintain the skill of pinching?

Hypothesis (2B): It is hypothesized that the participant will maintain the skill of pinching.

(2C): When implementing fluency-based instruction, will the participant maintain the skill of reaching?

Hypothesis (2C): It is hypothesized that the participant will maintain the skill of reaching.

(2D): When implementing fluency-based instruction, will the participant maintain the skill of turning?

Hypothesis (2D): It is hypothesized that the participant will maintain the skill of turning.

(2E): When implementing fluency-based instruction, will the participant maintain the skill of shaking?

Hypothesis (2E): It is hypothesized that the participant will maintain the skill of shaking.

(2F): When implementing fluency-based instruction, will the participant maintain the skill of squeezing?

Hypothesis (2F): It is hypothesized that the participant will maintain the skill of squeezing.

Research Question 3

When implementing fluency-based instruction, will the participant demonstrate generalization of the acquisition of all Big 6 (+ 6) as demonstrated in the task reach, grasp, place, release?

Hypothesis 3

The participant will demonstrate generalization of the Big 6 (+ 6) skills as demonstrated in the task reach, grasp, place, release.

CHAPTER IV

RESULTS

Single Subject Analysis of the Research Questions

The Big 6 skills data was collected from each participant during baseline and treatment. The Big 6 skills included reach, point, pinch, shake, turn, and squeeze on both the left and right hand. Both of the participants were prescribed medications over the course of the baseline and intervention phases. Data were analyzed using visual analysis (Kazdin, 1982), percentage of nonoverlapping data points (Scruggs, Mastropieri, & Casto, 1987), and effect size (Allison & Gorman, 1993).

Research Question 1

When implementing fluency-based instruction, will the posed intervention increase the acquisition of the Big 6 (+ 6) skills?

Hypothesis 1

It is hypothesized that fluency-based instruction will increase the acquisition of all Big 6 (+ 6) skills.

(1A): When implementing fluency-based instruction, will the skill of pointing increase in acquisition of skills?

Hypothesis (1A): It is hypothesized that the skill of pointing will increase when fluency-based instruction is implemented.

(1B): When implementing fluency-based instruction, will the skill of pinching increase in acquisition of skills?

Hypothesis (1B): It is hypothesized that the skill of pinching will increase when fluency-based instruction is implemented.

(1C): When implementing fluency-based instruction, will the skill of reaching increase in acquisition of skills?

Hypothesis (1C): It is hypothesized that the skill of reaching will increase when fluency-based instruction is implemented.

(1D): When implementing fluency-based instruction, will the skill of turning increase in the acquisition of skills?

Hypothesis (1D): It is hypothesized that the skill of reaching will increase when fluency-based instruction is implemented.

(1E): When implementing fluency-based instruction, will the skill of shaking increase in the acquisition of skills?

Hypothesis (1E): It is hypothesized that the skill of shaking will increase when fluency-based instruction is implemented.

(1F): When implementing fluency-based instruction, will the skill of squeezing increase in the acquisition of skills?

Hypothesis (1F): It is hypothesized that the skill of squeezing will increase when fluency-based instruction is implemented.

Visual Analysis of the Graphed Data

Four criteria were utilized by the experimenter to analyze the collected data (Kazdin, 1982): (a) changes in the mean level of performance across phases, (b) changes in the level of performance from the end of one phase to the beginning of the next phase, (c) changes in trend or slope from one phase to the next, and (d) the latency of behavior change across phases. To address this research question, results from the Big 6 (+ 6) skills from baseline through the end of the treatment were analyzed for each participant.

Changes in means. Changes in mean scores of the Big 6 (+ 6) skills were present for each participant over the course of treatment. Participant 1 was not able to complete the skill independently upon introduction; thus the mean Baseline score for Point (right) was zero. During intervention the criterion was first set at 10-seconds, the mean score was 17 seconds, then 35.5 seconds for the 15-second criterion and 35 for the 20-second criterion, with an overall mean score of 29.17 during treatment phases. Similarly for Point (left), Participant 1 was unable to complete the skill independently upon introduction, thus the mean Baseline score for Point (left) was zero. During intervention the criterion was first set at 10-seconds, the mean score was 17.8 seconds, then 23.2 seconds for the 15-second criterion and 37.5 for the 20-second criterion, with an overall mean score of 26.7 during treatment phases. Participant 1 was not able to complete Pinch Right independently upon introduction; thus the mean Baseline score for Pinch (right) for Participant 1 was zero seconds. For the 10-second criterion of treatment, the mean score was 12.3 seconds, then 26.6 seconds for the 15-second criterion and 34.8 seconds for the 20-second criterion, with an overall mean score of 24.57 seconds during treatment phases. Participant 1's Pinch (left) Baseline score was zero seconds. For the 10-second criterion of treatment, the mean score was 17 seconds, then 27.4 seconds for the 15-second criterion and 32.7 seconds for the 20-second criterion, with an overall mean score of 25.7 seconds.

Participant 2's Baseline Point (right) baseline score of zero increased to a mean of 24.5 seconds over the course of the 10-second criterion. The mean score increased to 45 seconds for the 15-second criterion and 57.5 seconds for the 20-second criterion, with an overall mean score of 42.33 seconds. Participant 2's Baseline Point (left) baseline score of zero seconds increased to 39.3 seconds over the course of the 10-second criterion. The mean score increased to 52 seconds for the 15-second criterion and 157 seconds for the 20-second criterion, with an overall mean score of 82.77 seconds.

Participant 2's Baseline Pinch (right) mean score of zero seconds increased to 24.6 seconds over the course of the 10-second criterion. The mean score increased to 33.5 seconds for the 15-second criterion and 13 for the 20-second criterion, with an overall mean score of 23.7 seconds. Participant 2's Baseline Pinch (left) mean Baseline score of zero seconds increased to 19.75 seconds over the course of the 10-second criterion. The mean score increased to 29.4 seconds for the 15-second criterion and 42.6 seconds for the 20-second criterion, with an overall mean score of 30.58 seconds.

Participant 1's Reach (right) Baseline score of zero seconds increased to 8 seconds over the course of the 10-second criterion. The mean score increased to 12 seconds for the 15-second criterion and 25.3 seconds for the 20-second criterion, with an overall mean score of 15.1 seconds. Participant 1's Reach (left) Baseline score zero increased to 6 seconds over the course of the 10-second criterion. The mean score increased to 12.8 seconds for the 15-second criterion and to 24.1 seconds for the 20-second criterion, with an overall mean score of 14.3 seconds.

Participant 2's Reach (right) Baseline score of zero seconds increased to 17.6 seconds over the course of the 10-second criterion. The mean score increased to 25.5 seconds for the 15-second criterion and 39.5 seconds for the 20-second criterion, with an overall mean score of 27.53 seconds. Participant 2's Reach (left) Baseline score of zero seconds increased to 14.4 seconds over the course of the 10-second criterion. The mean score increased to 22.7 seconds for the 15-second criterion and 35 seconds for the 20-second criterion, with an overall mean score of 24.03 seconds.

Participant 1’s Turn (right) Baseline score zero seconds increased to 11.8 seconds over the course of the 10-second criterion. The mean score increased to 20.7 seconds for the 15-second criterion and 32.9 seconds for the 20-second criterion, with an overall mean score of 21.8 seconds. Participant 1’s Turn (left) Baseline score of zero seconds increased to 11.1 seconds over the course of the 10-second criterion. The mean score increased to 21.8 seconds for the 15-second criterion and 32.3 seconds for the 20-second criterion, with an overall mean score of 21.73 seconds.

Participant 2’s Turn (right) Baseline score of zero seconds increased to 15.3 seconds over the course of the 10-second criterion. The mean score decreased to 14.25 seconds for the 15-second criterion and increased to 38 seconds for the 20-second criterion, with an overall mean score of 22.52 seconds. Participant 2’s Turn (left) Baseline score of zero seconds increased to 14.6 seconds over the course of the 10-second criterion. The mean score increased to 17 seconds for the 15-second criterion and 38.6 seconds for the 20-second criterion, with an overall mean score of 33.93 seconds.

Participant 1’s Shake (right) Baseline score of zero seconds increased to 24.3 seconds over the course of the 10-second criterion. The mean score increased to 39.2 seconds for the 15-second criterion and 50.6 seconds for the 20-second criterion, with an overall mean score of 30.03 seconds. Participant 1’s Shake (left) Baseline score of zero seconds increased to 22.6 seconds over the course of the 10-second criterion. The mean score increased to 40.6 seconds for the 15-second criterion and 50 seconds for the 20-second criterion, with an overall mean score of 37.73 seconds.

Participant 2's Shake (right) Baseline score of zero seconds increased to 33.5 seconds over the course of the 10-second criterion. The mean score increased to 52 seconds for the 15-second criterion and 57.6 seconds for the 20-second criterion, with an overall mean score of 47.7 seconds. Participant 2's Shake (left) Baseline score of zero seconds increased to 35 seconds over the course of the 10-second criterion. The mean score increased to 38 seconds for the 15-second criterion and 46 seconds for the 20-second criterion, with an overall mean score of 39.67 seconds.

Participant 1's Squeeze (right) Baseline score of zero seconds increased to 7 seconds over the course of the 10-second criterion. The mean score increased to 18.6 seconds during the 15-second criterion and 36.7 seconds for the 20-second criterion, with an overall mean score of 17.43 seconds. Participant 1's Squeeze (left) Baseline score of zero seconds increased to 12.6 seconds over the course of the 10-second criterion. The mean score increased to 19 seconds during the 15-second criterion and 28.5 seconds for the 20-second criterion, with an overall mean score of 20.03 seconds.

Participant 2's Squeeze (right) Baseline score of zero seconds increased to 22 seconds over the course of the 10-second criterion. The mean score increased to 30 seconds during the 15-second criterion and 41 seconds for the 20-second criterion, with an overall mean score of 31 seconds. Participant 2's Squeeze (left) Baseline score of zero seconds increased to 18 seconds over the course of the 10-second criterion. The mean score increased to 28 seconds during the 15-second criterion and 46.8 seconds for the 20-second criterion, with an overall mean score of 30.93 seconds.

Changes in level. Participant 1 during Point (right) skill demonstrated an increase from a baseline of zero to 12 at the first criterion, and then increased to 6 after the second criterion, with a decrease of 16 after the third set criterion. Point (left) demonstrated an increase from a baseline of zero to 15 at the first set criterion, with a decrease of 5 at the second set criterion, and at the third set criterion a decrease of 7. Participant 2's scores for Point (right) increased from a baseline of zero to 42 at the first set criterion then decreased 42 at the second set criterion, with an additional decrease of 10 at the third set criterion. Point (left) demonstrated an increase from a baseline of zero to 18 at the first set criterion, then a decrease of 18 at the second set criterion with a gain of 105 at the third set criterion.

Participant 1 Pinch (right) skill demonstrated an increase from a baseline of zero to 14 at the first set criterion, with an additional increase of 12 at the second criterion and an increase of 3 at the third set criterion. Pinch (left) demonstrated an increase from a baseline of zero to 20 at the first set criterion, an additional increase of 10 at the second set criterion and a final addition of 7 at the third set criterion.

Participant 2 Pinch (right) skills demonstrated an increase from a baseline of zero to 3 at the first set criterion, with a decrease of 8 at the second set criterion with an additional decrease of 44 at the third set criterion. Pinch (left) skills demonstrated an increase from a baseline of zero to 33 at the first set criterion, with an additional increase of 32 at the second set criterion, as well as an increase of 5 and 40 at the third and fourth set criterions respectively.

Participant 1 Reach (right) skills demonstrated an increase from a baseline of zero to 8 at the first set criterion. No changes occurred at the second set criterion. An increase of 7 was demonstrated at the third set criterion. Reach (left) skills demonstrated an increase from zero at baseline to 5 at the first set criterion. No changes occurred during the second and third set criterions.

Participant 2 Reach (right) skills demonstrated an increase from a baseline of zero to 15 at the first set criterion, with an additional increase of 10 at the second set criterion and an increase of 20 at the third set criterion. Reach (left) demonstrated an increase from a baseline of zero to 13 at the first set criterion, with an increase of 10 at the second set criterion and an increase of 20 at the third set criterion.

Participant 1 Turn (right) demonstrated an increase from a baseline of zero to 15 at the first set criterion, with an additional increase of 7 at the second set criterion and an increase of 5 at the third set criterion. Turn (left) demonstrated an increase from a baseline of zero to 12 at the first set criterion, with an increase of 2 at the second set criterion, and a decrease of 1 at the third set criterion.

Participant 2 Turn (right) demonstrated an increase from a baseline of zero to 18 at the first set criterion, with a decrease of 5 at the second set criterion and an increase of 6 at the third set criterion. Turn (left) demonstrated an increase from a baseline of zero to 18 at the first set criterion, a decrease of 3 at the second set criterion and a decrease of 6 at the third set criterion.

Participant 1 Shake (right) demonstrated an increase from a baseline of zero to 30 at the first set criterion, an increase of 27 at the second set criterion and an increase of 3 at the third set criterion. Shake (left) demonstrated an increase from a baseline of zero to 30 at the first set criterion, an increase of 27 at the second set criterion, and an increase of 10 at the third set criterion.

Participant 2 Shake (right) demonstrated an increase from a baseline of zero to 30 at the first set criterion, an increase of 2 at the second set criterion, and an increase of 8 at the third set criterion. Shake (left) demonstrated an increase from a baseline of zero to 35 at the first set criterion, an increase of 2 at the second set criterion, and an increase of 9 at the third set criterion.

Participant 1 Squeeze (right) demonstrated an increase from a baseline of zero to 6 at the first set criterion, with an increase of 9 at the second set criterion and an increase of 7 at the third set criterion. Squeeze (left) demonstrated an increase from a baseline of zero to 12, with an increase of 2 at the second set criterion and an increase of 7 at the third set criterion.

Participant 2 Squeeze (right) demonstrated an increase from a baseline of zero to 18, with an increase of 12 at the second set criterion and an increase of 3 at the third set criterion. Squeeze (left) demonstrated an increase from a baseline of zero to 18 at the first set criterion, with an additional increase of 9 at the second set criterion, as well as an increase of 9 at the third set criterion.

Changes in trend. Examination of regression linear trend line for each participant indicated a steady increase of scores over the course of each Phase of treatment. Examination of the linear regression trend lines for participant in each Big 6 skill indicated an increasing trend and an improvement in skill acquisition over the course of each Phase treatment.

Latency of change. Visual inspection of data indicated that change in results occurred immediately after the beginning of each criterion phase intervention for each of the participants Big 6 skills. Progress was noted as generally consistent with trends increasing.

Specifically, Participant 1 during Point (right) skill matched each set criterion across phase intervention. Point (left) matched the first set criterion, however did not meet the set criterions in either the second or third phase intervention. Participant 2's scores for Point (right) matched the first set criterion; however did not match the second or third set criterion with a demonstrated decrease in skill. Additionally, Point (left) matched the first set criterion; however did not match the second set criterion with a significant increase in skill at the third set criterion demonstrating a match of criterion at the third phase intervention.

Participant 1 Pinch (right) skill demonstrated match of all three set criterions across phase interventions. Similarly, Pinch (left) demonstrated a match of set criterion across three set criterion phase interventions.

Participant 2 Pinch (right) skills demonstrated a match of criterion at the first set criterion; however did not match the set criterion at neither the second or third set criterion. Conversely, Pinch (left) skills demonstrated a match of each set criterion across the three set criterion phase interventions.

Participant 1 Reach (right) skills demonstrated a match at the first set criterion; however no changes occurred at the second set criterion, thus did not meet the set criterion. A match of the set criterion was reached at the third phase intervention. Reach (left) skills demonstrated a match at the first set criterion; however did not meet the set criterion at the second or third set criterion phase interventions.

Participant 2 Reach (right) skills demonstrated a match to the set criterion across all three set criterion phase interventions. Similarly, Reach (left) demonstrated a match to the set criterion across all three set criterion phase interventions.

Participant 1 Turn (right) demonstrated a match to the set criterion across all three set criterion phase interventions. Turn (left) demonstrated a match increase of each set criterion across all three set criterion phase interventions.

Participant 2 Turn (right) demonstrated a match at the first set criterion; however did not meet the set criterion at the second set criterion. A match of the third set criterion was achieved at the third phase intervention. Turn (left) demonstrated a match at the first set criterion; however did not demonstrate a match of the set criterion at neither the second or third set criterion phase interventions.

Participant 1 Shake (right) demonstrated a match across all three set criterion phase interventions. Similarly, Shake (left) demonstrated a match of each set criterion across the three set criterion phase interventions.

Participant 2 Shake (right) demonstrated match of each set criterion across the three set criterion phase interventions. Additionally, Shake (left) also demonstrated a match of each set criterion across the three set criterion phase interventions.

Participant 1 Squeeze (right) demonstrated a match of each set criterion across the three set criterion phase interventions. Similarly, Squeeze (left) also demonstrated a match to each set criterion across the three set criterion phase interventions.

Participant 2 Squeeze (right) demonstrated a match of each set criterion across the three set criterion phase interventions. Additionally, Squeeze (left) demonstrated a match of each set criterion across the three set criterion phase interventions (see Figures 1.1

through 6.4). In all figures, endurance and maintenance occur at a 45-second timing interval.

Percentage of Nonoverlapping Data

Percentage of nonoverlapping data points was employed to further insure careful visual analysis. The less overlap found between data points, the more effective and reliable the intervention (Scruggs et al., 1987). Due to each participant's baseline of zero, the percentage of nonoverlapping data points cannot be calculated.

Effect Size

Along with visual analysis, effect size was to be calculated to provide a measure of the magnitude of treatment impact, and compared Baseline to overall Intervention. The effect size cannot be calculated due to the baseline scores of zero for each participant, for each skill. As per Daly, Chafouleas, and Skinner (2005) an effect size cannot be calculated when a standard deviation is equal to zero.

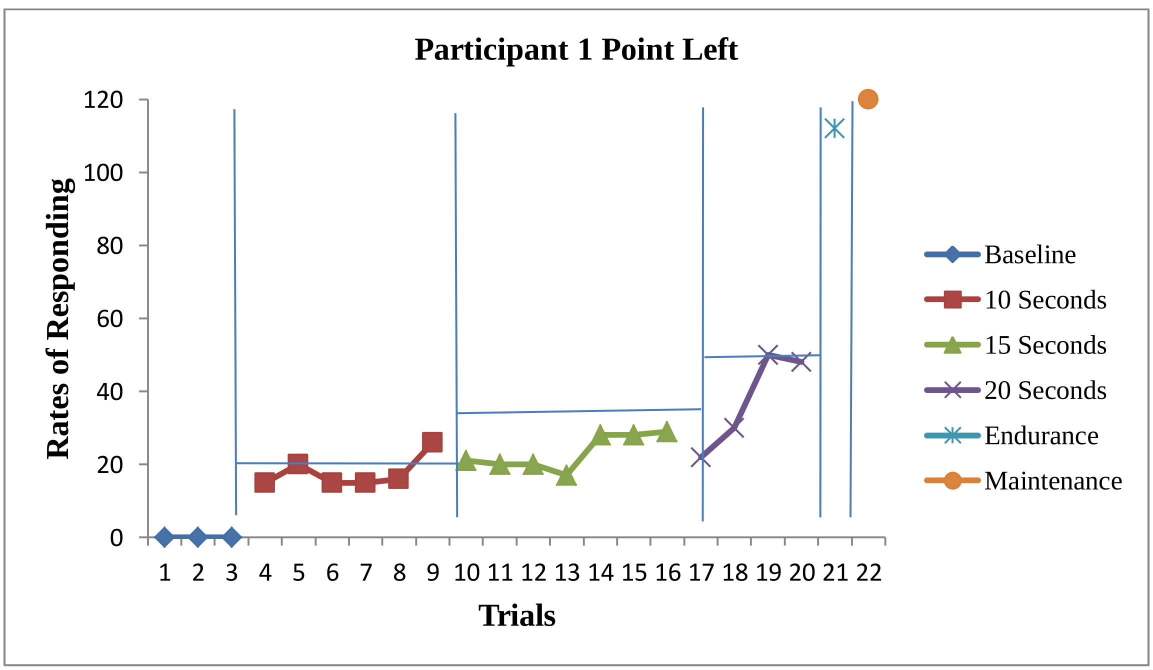

Figure 1.1. Participant 1 point left skill acquisition.

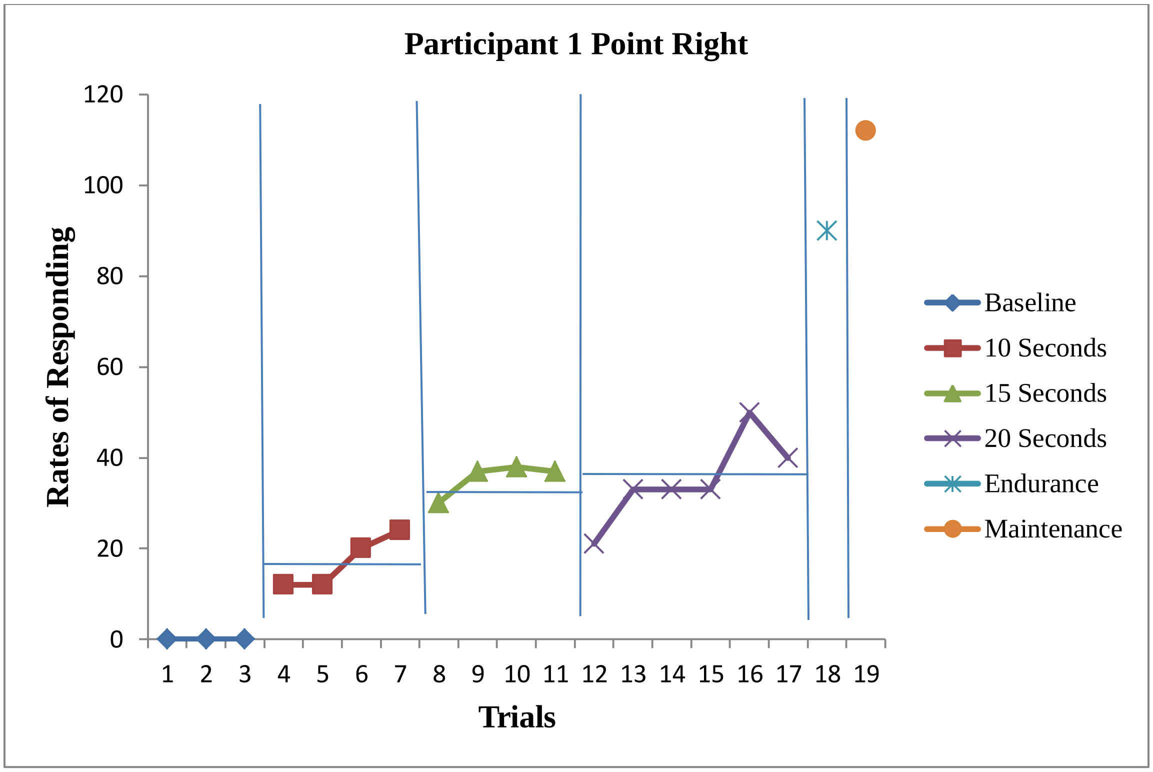

Figure 1.2. Participant 1 point right skill acquisition.

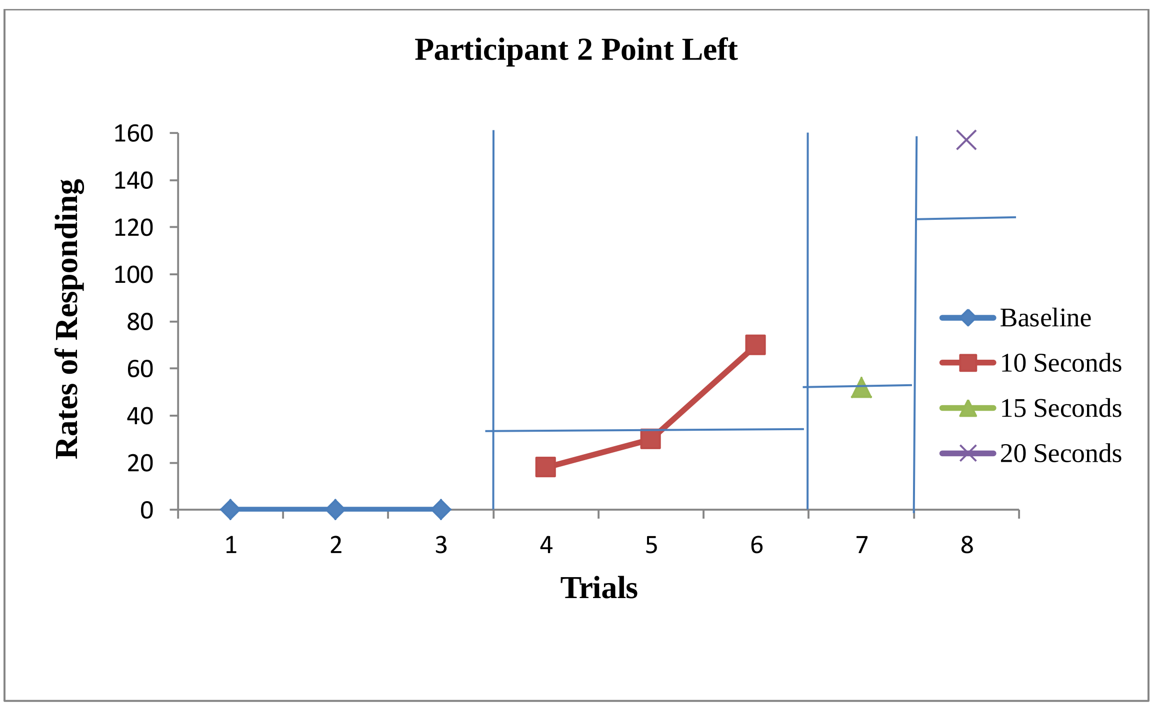

Figure 1.3. Participant 2 point left skill acquisition.

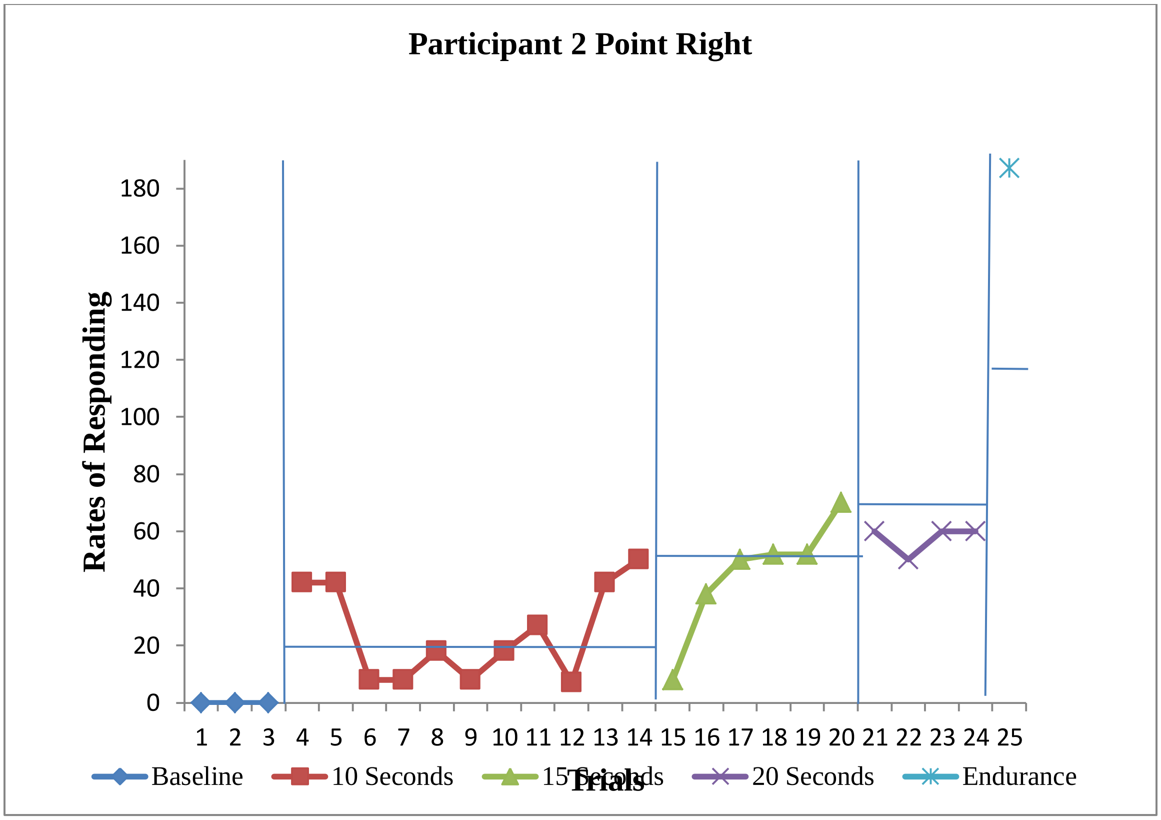

Figure 1.4. Participant 2 point right skill acquisition.

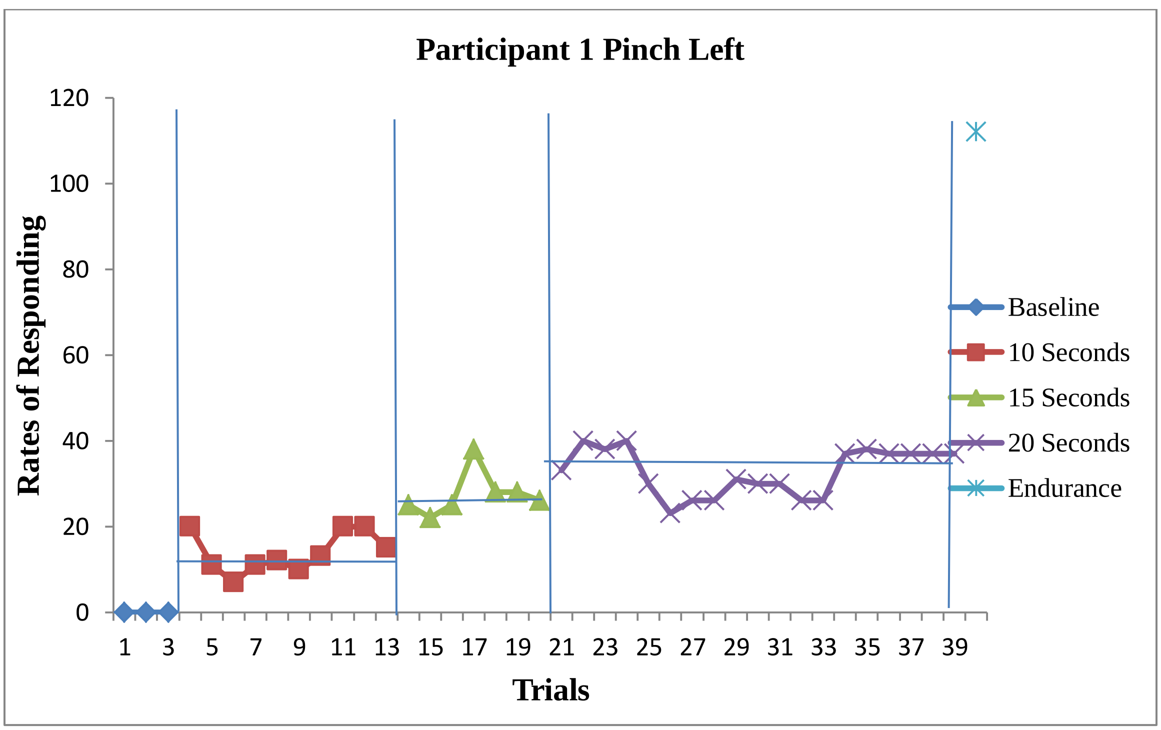

Figure 2.1. Participant 1 pinch left skill acquisition.

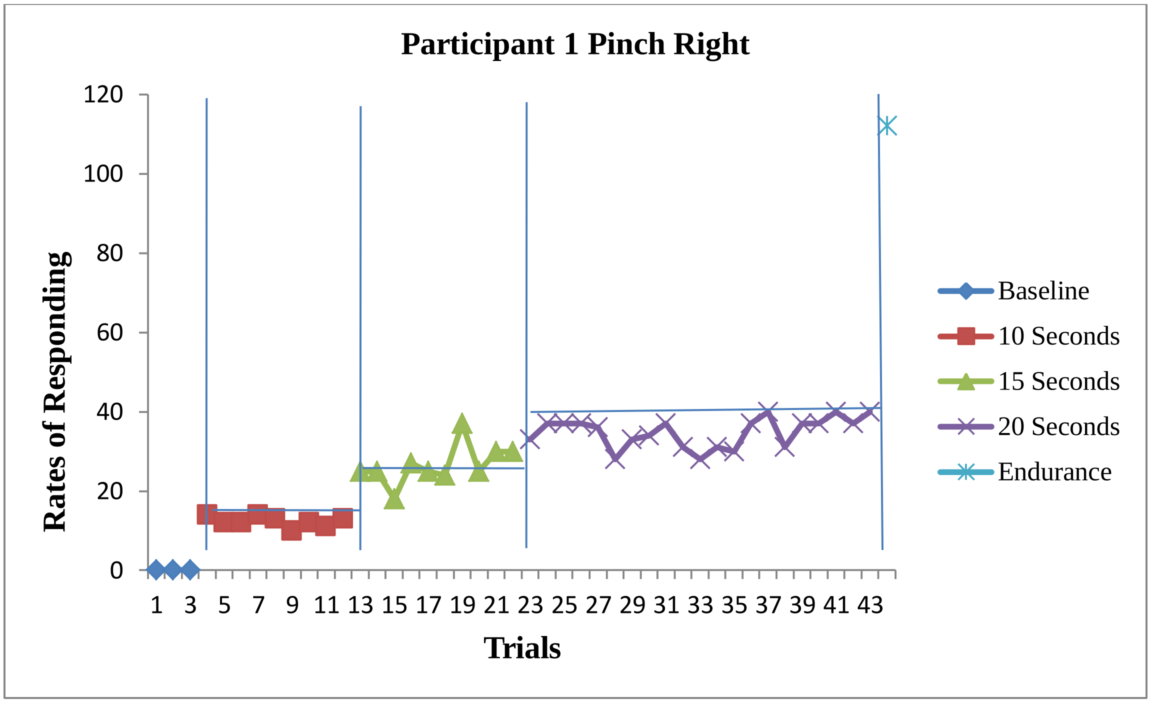

Figure 2.2. Participant 1 pinch right skill acquisition.

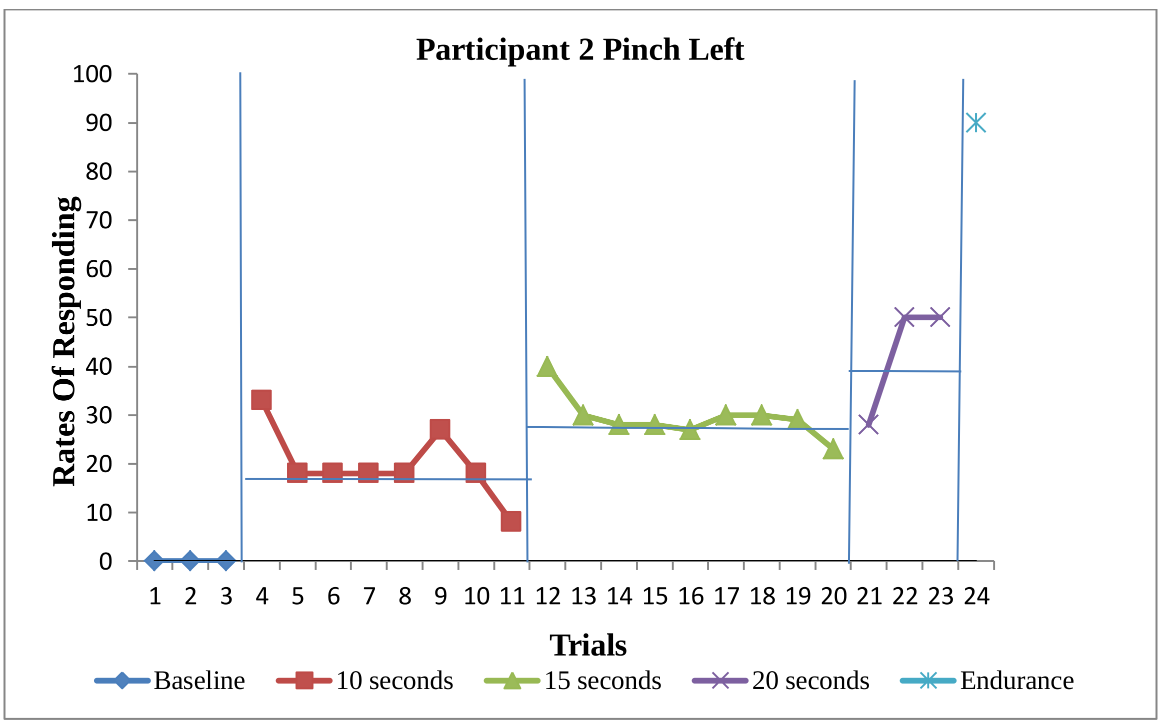

Figure 2.3. Participant 2 pinch left skill acquisition.

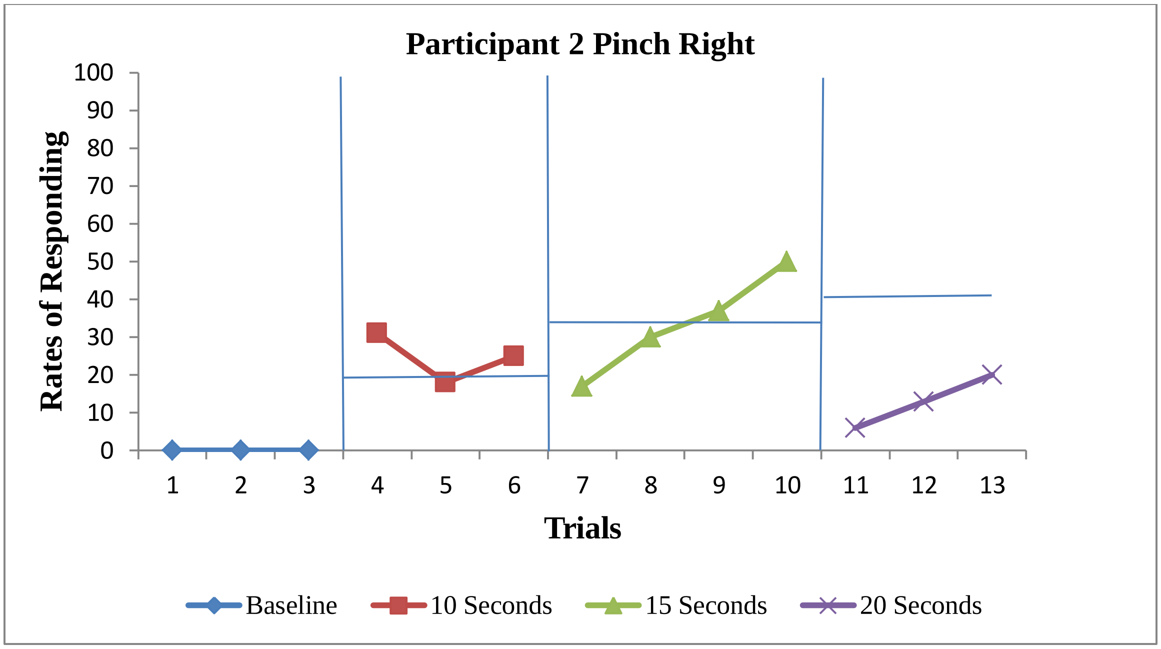

Figure 2.4. Participant 2 pinch right skill acquisition.

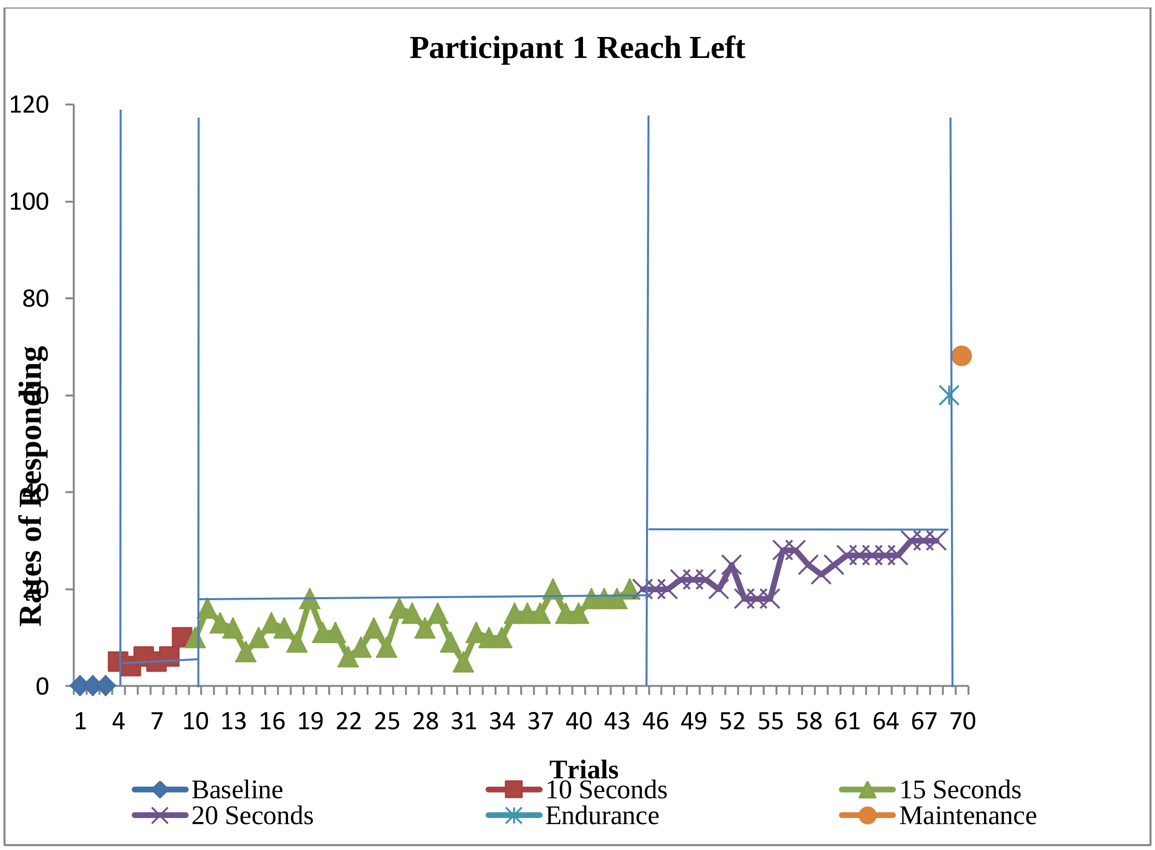

Figure 3.1. Participant 1 reach left skill acquisition.

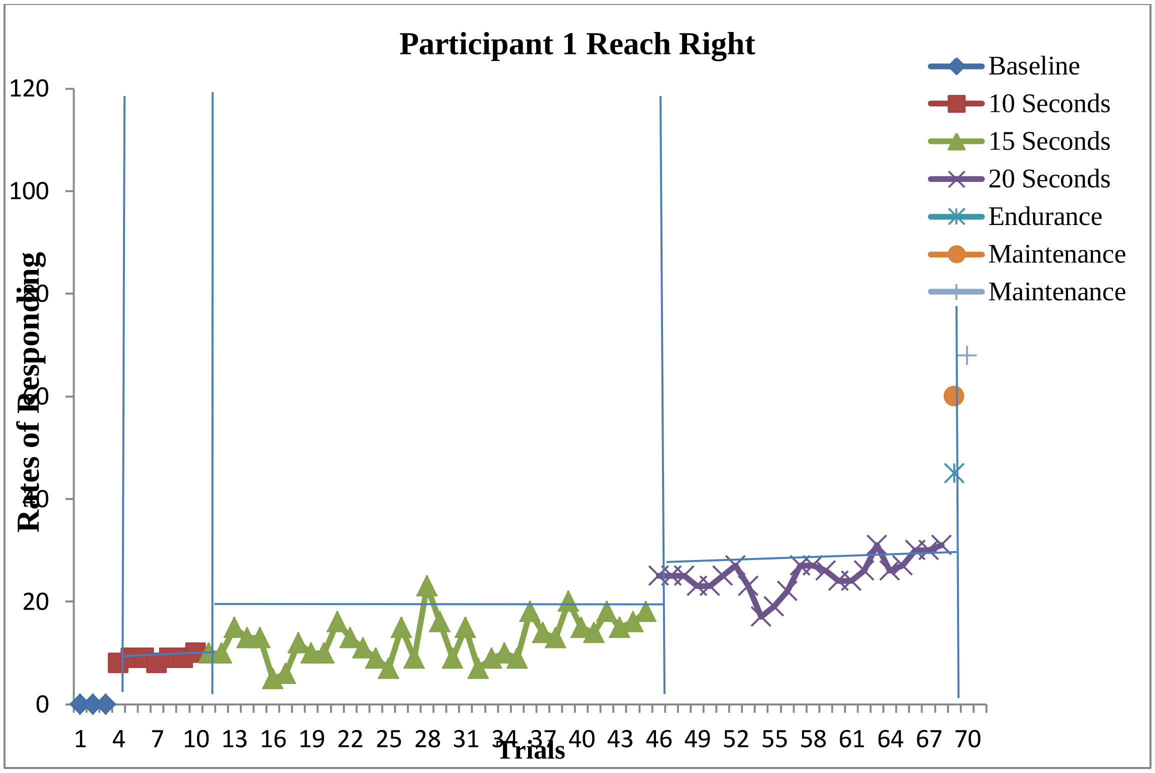

Figure 3.2. Participant 1 reach right skill acquisition.

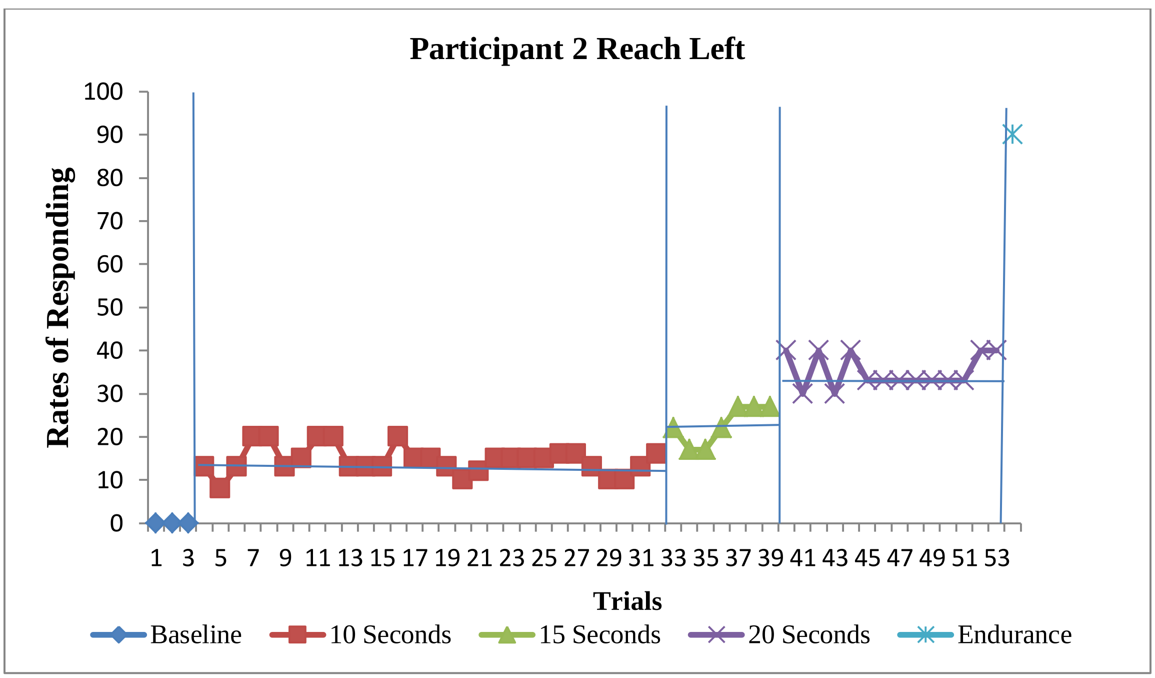

Figure 3.3. Participant 2 reach left skill acquisition.

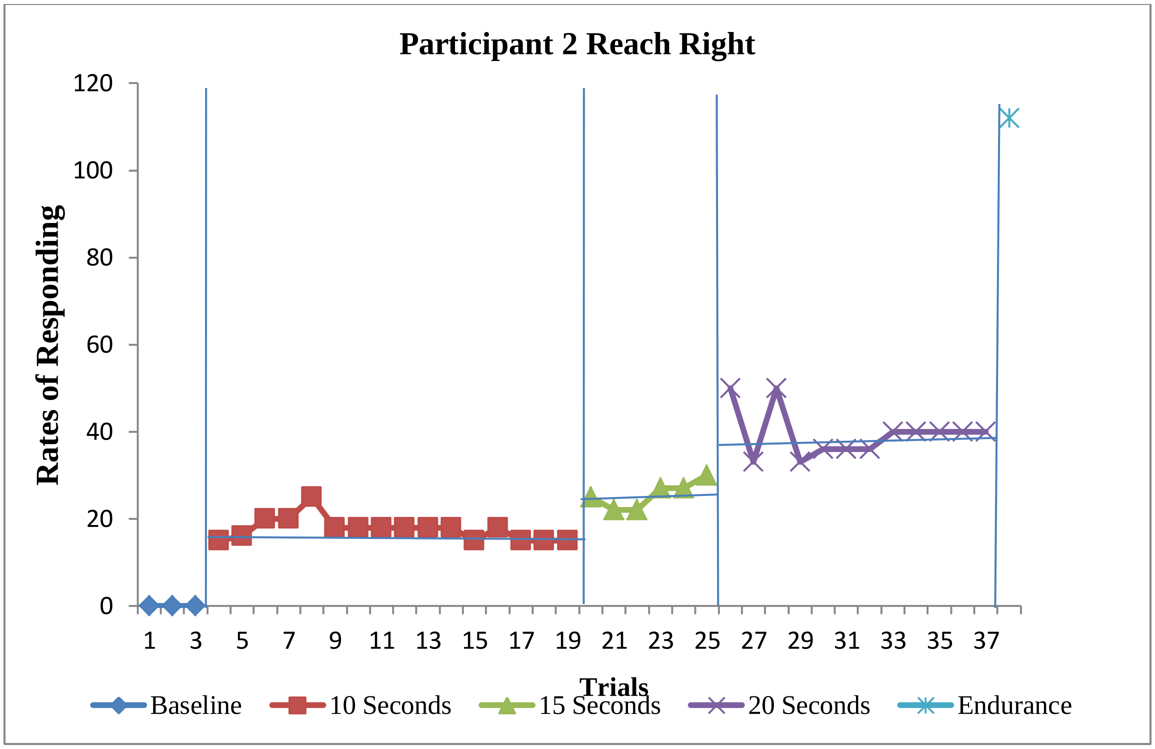

Figure 3.4. Participant 2 reach right skill acquisition.

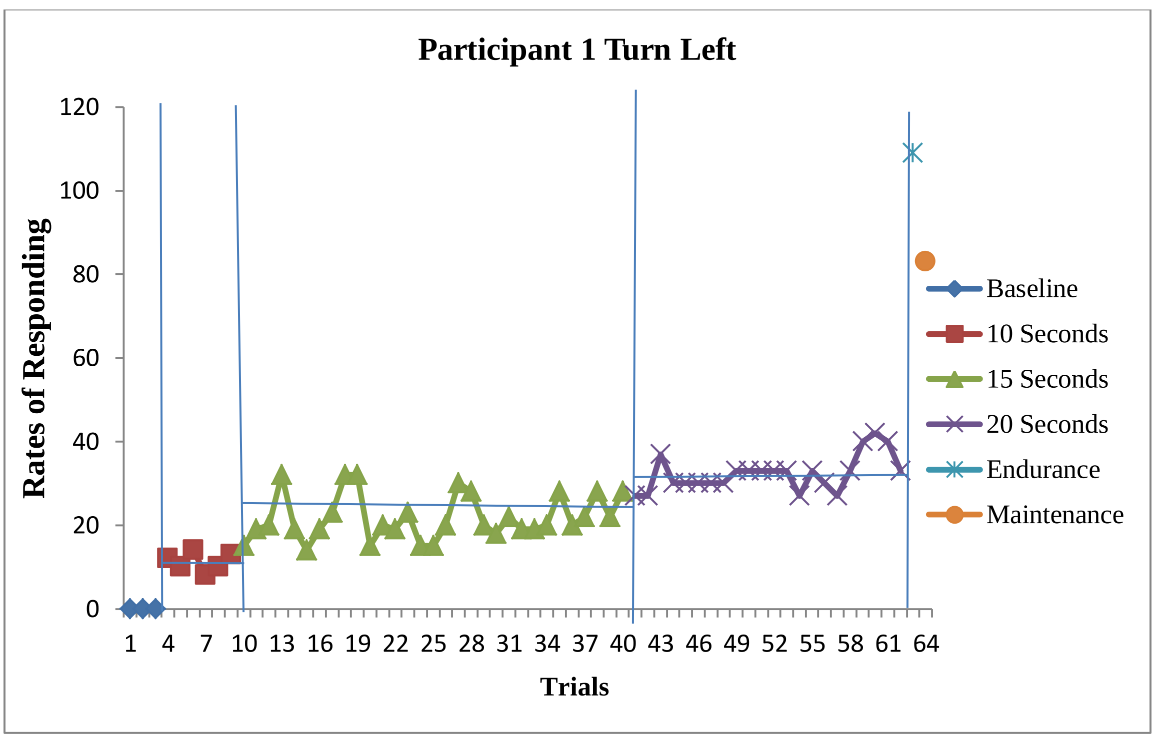

Figure 4.1. Participant 1 turn left skill acquisition.

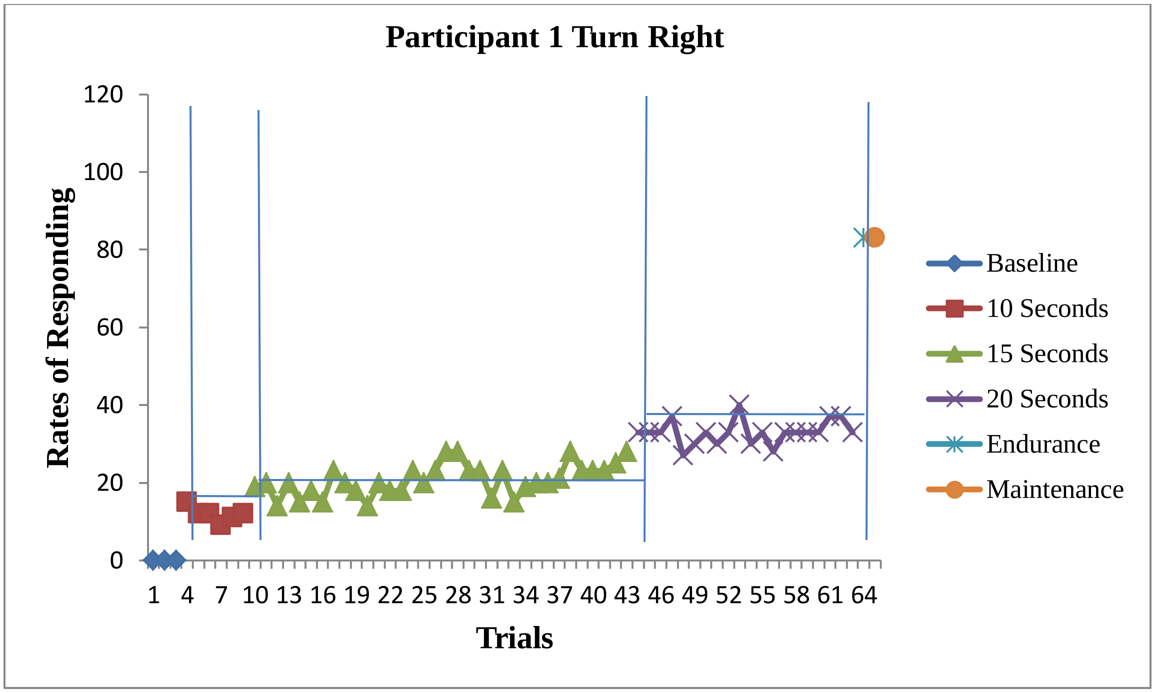

Figure 4.2. Participant 1 turn right skill acquisition.

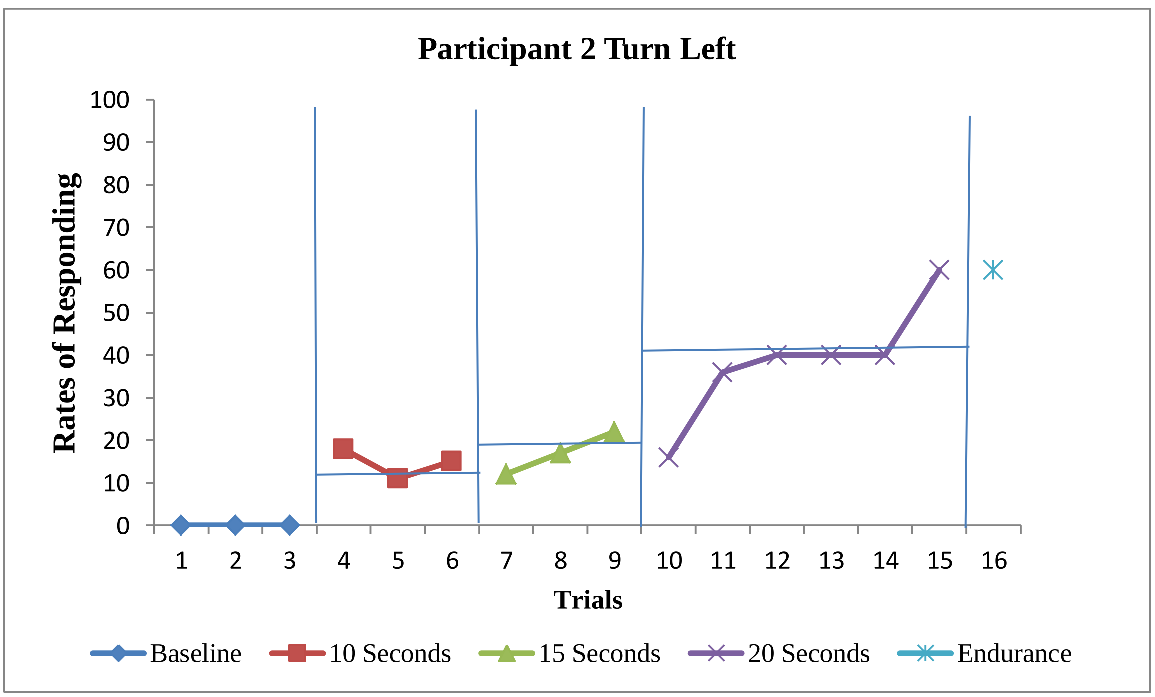

Figure 4.3. Participant 2 turn left skill acquisition.

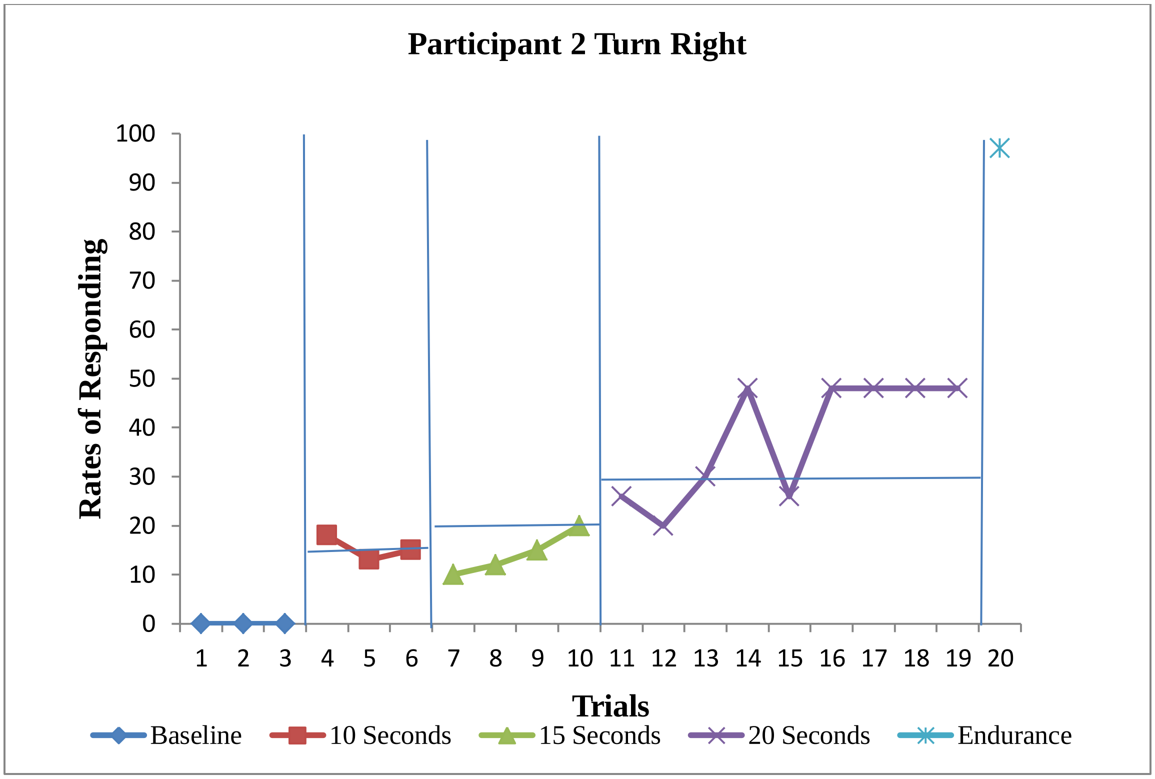

Figure 4.4. Participant 2 turn right skill acquisition.

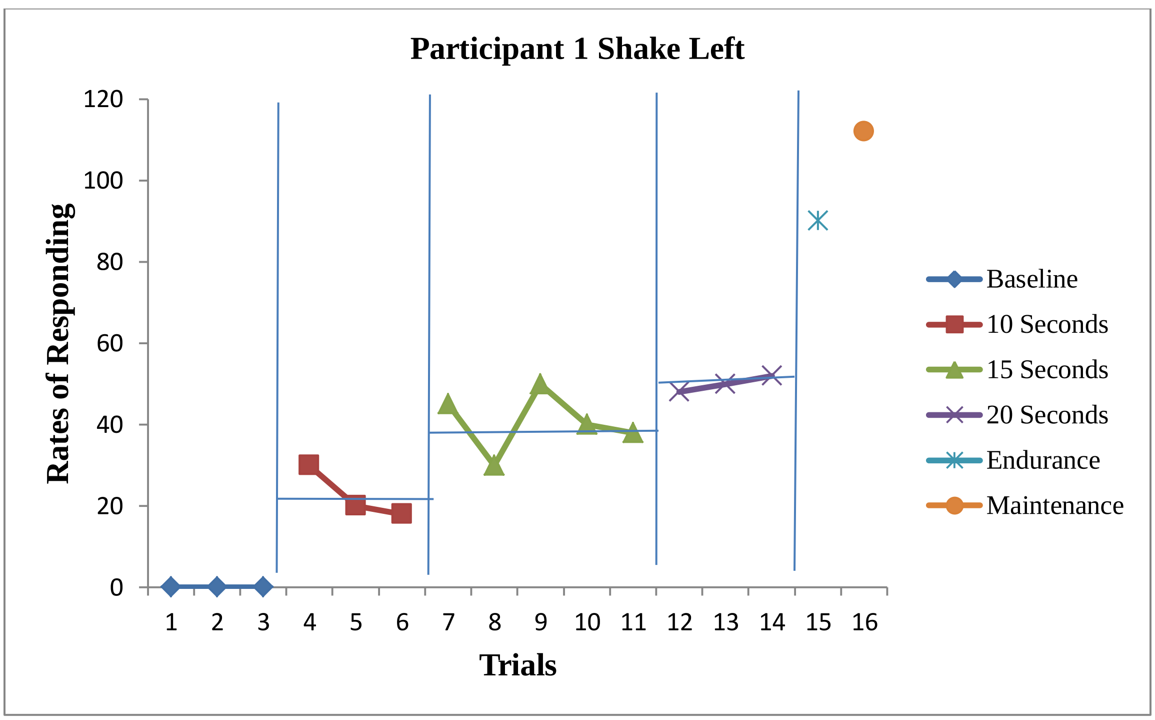

Figure 5.1. Participant 1 shake left skill acquisition.

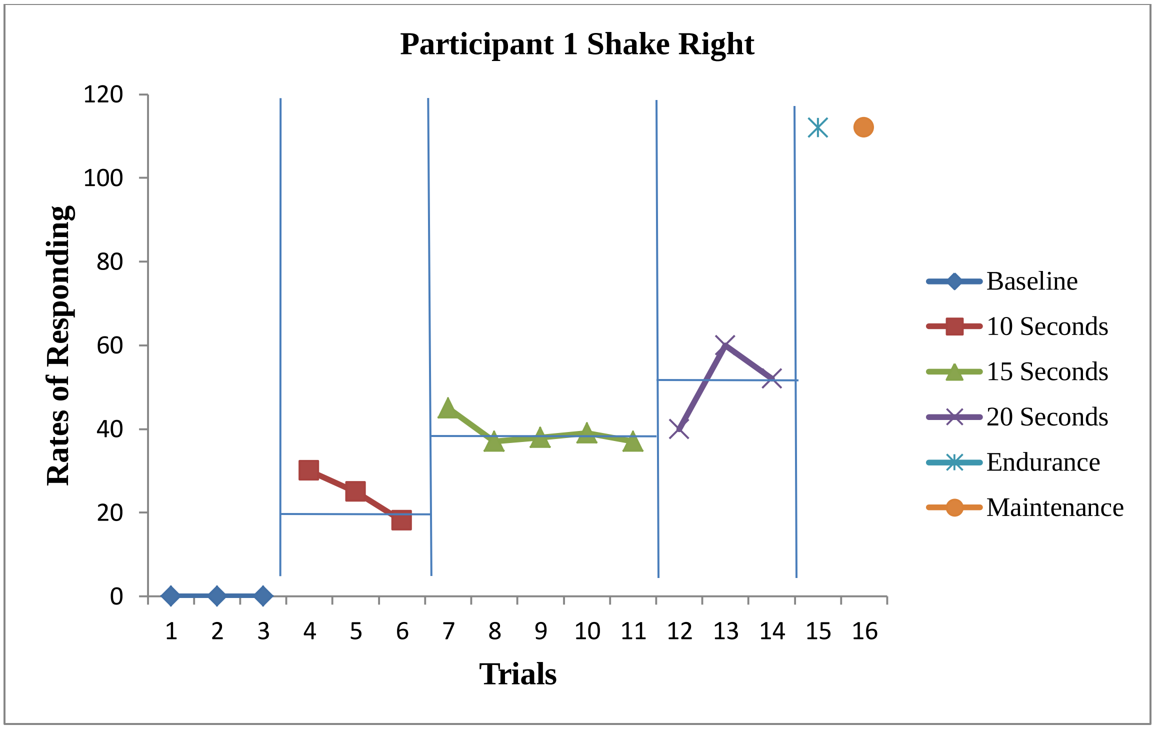

Figure 5.2. Participant 1 shake right skill acquisition.

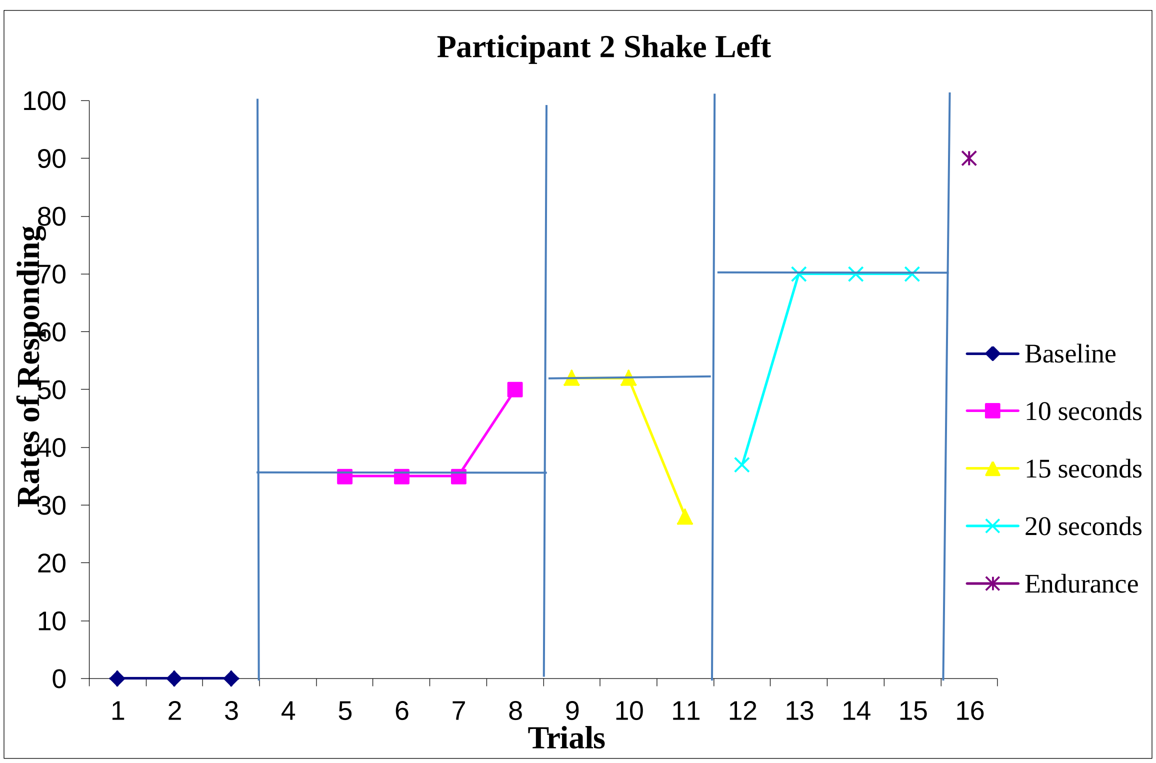

Figure 5.3. Participant 2 shake left skill acquisition.

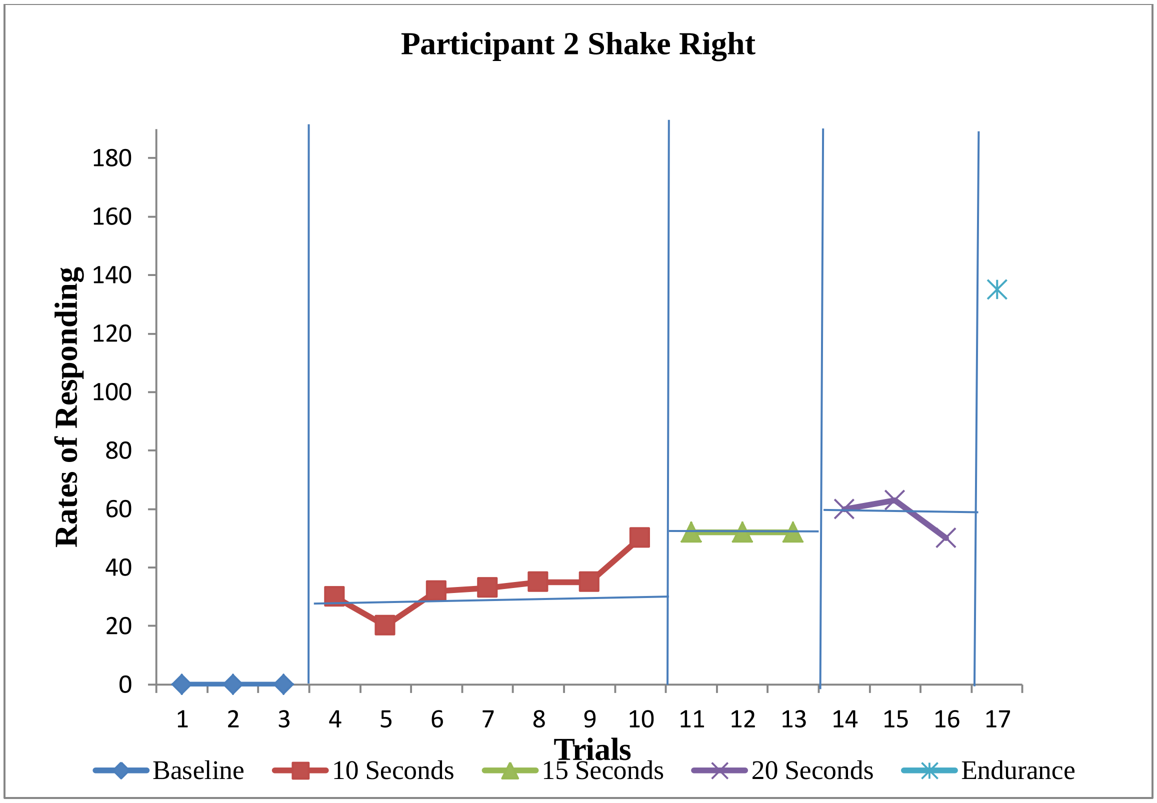

Figure 5.4. Participant 2 shake right skill acquisition.

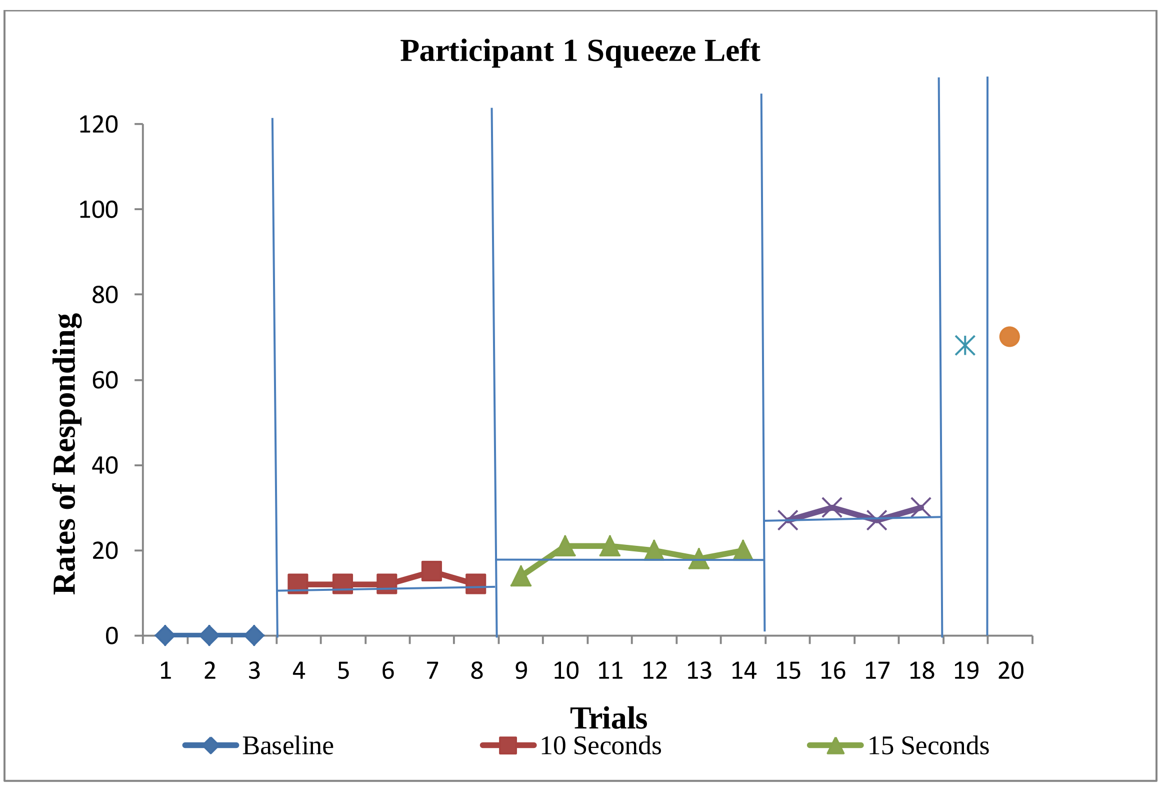

Figure 6.1. Participant 1 squeeze left skill acquisition.

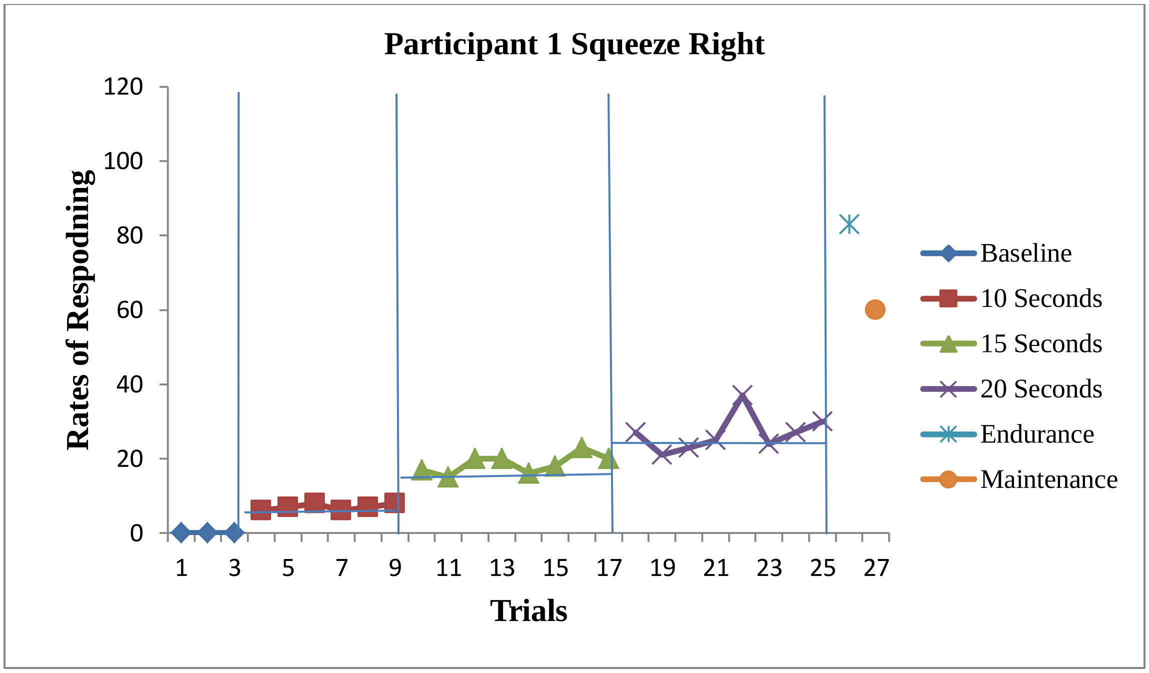

Figure 6.2. Participant 1 squeeze right skill acquisition.

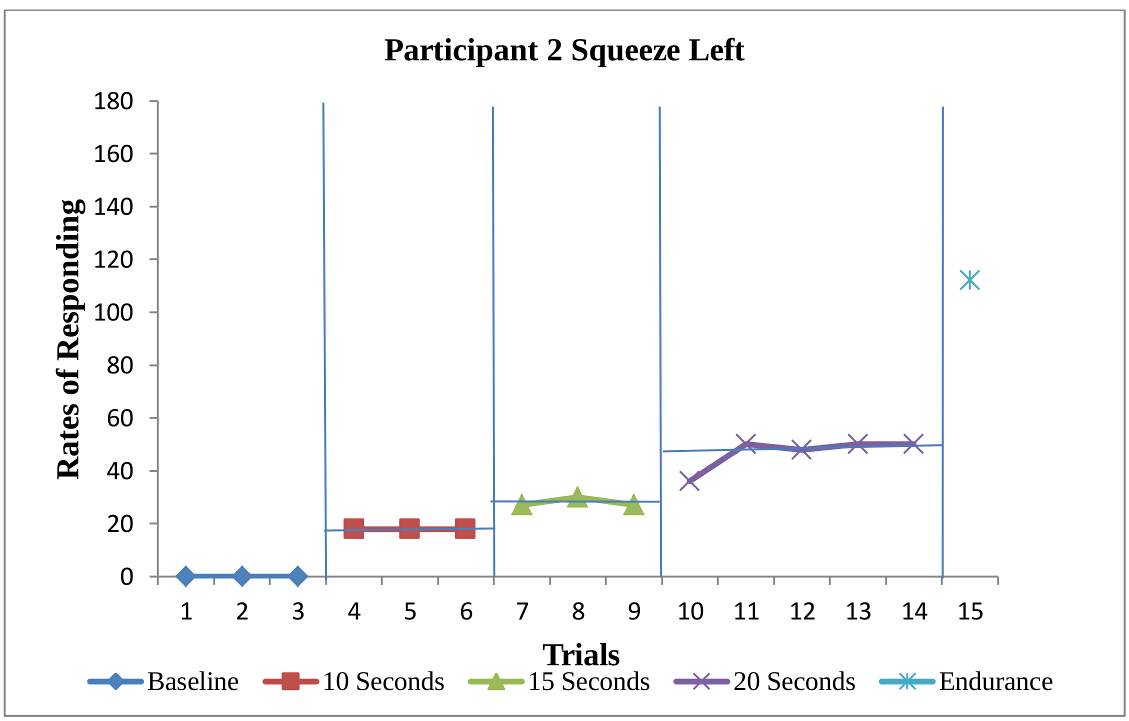

Figure 6.3. Participant 2 squeeze left skill acquisition.

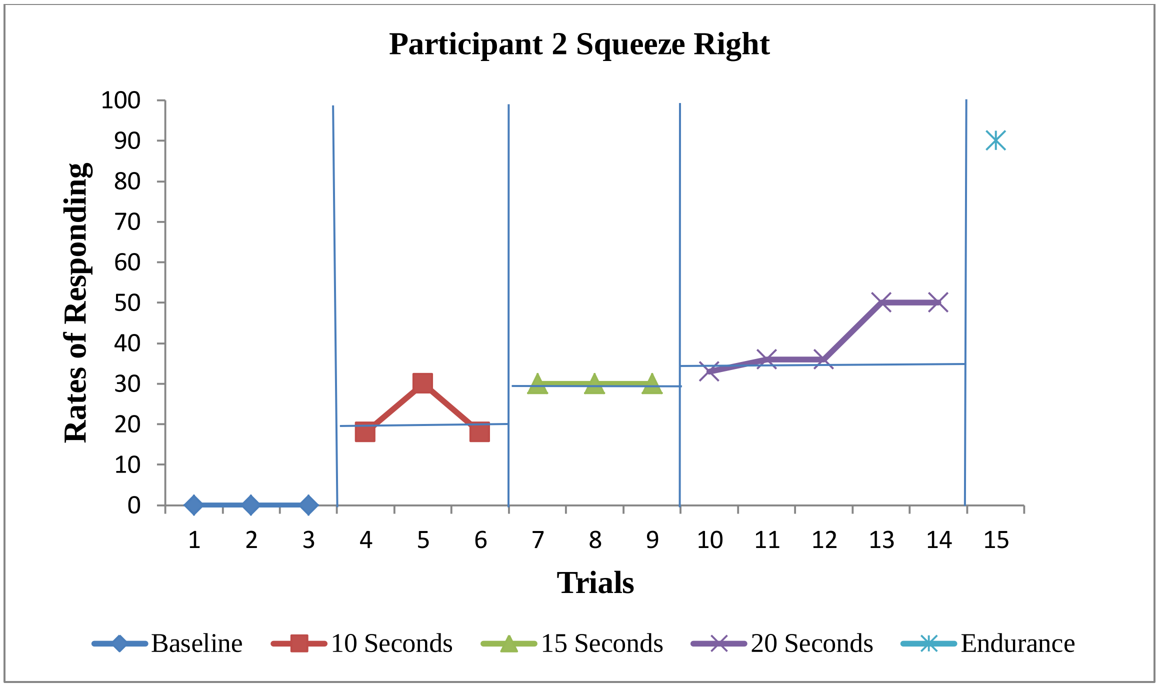

Figure 6.4. Participant 2 squeeze right skill acquisition.

Research Question 2

When implementing fluency-based instruction, will the participant maintain the acquisition of the Big 6 + 6 skills?

Hypothesis 2

It is hypothesized that the participant will maintain the skill acquisition of the Big 6 + 6 skills.

(2A): When implementing fluency-based instruction, will the participant maintain the skill of pointing?

Hypothesis (2A): It is hypothesized that the participant will maintain the skill of pointing.

(2B): When implementing fluency-based instruction, will the participant maintain the skill of pinching?

Hypothesis (2B): It is hypothesized that the participant will maintain the skill of pinching.

(2C): When implementing fluency-based instruction, will the participant maintain the skill of reaching?

Hypothesis (2C): It is hypothesized that the participant will maintain the skill of reaching.

(2D): When implementing fluency-based instruction, will the participant maintain the skill of turning?

Hypothesis (2D): It is hypothesized that the participant will maintain the skill of turning.

(2E): When implementing fluency-based instruction, will the participant maintain the skill of shaking?

Hypothesis (2E): It is hypothesized that the participant will maintain the skill of shaking.

(2F): When implementing fluency-based instruction, will the participant maintain the skill of squeezing?

Hypothesis (2F): It is hypothesized that the participant will maintain the skill of squeezing.

Visual Analysis of the Graphed Data

Visual analysis (Kazdin, 1982) was used to analyze data collected from the endurance phase of the criterion from the Big 6 + 6 skills.

Changes in means. There were no changes in mean scores present for the Big 6 + 6 skills for the endurance criterion phase as there is only one score present for each Big 6 + 6 skill.

Changes in level. Participant 1 during Point (right) skill demonstrated an increase from zero to 90 from the end of Baseline to the endurance criterion. Participant 2's scores for Point (right) increased from zero to 187 from the end of Baseline to the endurance criterion. Participant 1 during Point (left) skill demonstrated an increase from zero to 112 from the end of Baseline to the endurance criterion. Participant 2 did not complete the Point (left) endurance phase.

Participant 1 during Pinch (right) demonstrated an increase from zero to 112 from the end of the Baseline to the endurance criterion. Participant 2 did not complete the endurance phase for Pinch (right). Participant 1 during Pinch (left) demonstrated an increase from zero to 112 from the end of the Baseline to the endurance criterion. Participant 2 did not complete the endurance phase for Pinch (left).

Participant 1 during Reach (right) demonstrated an increase from zero to 45 from the end of Baseline to the endurance criterion. Participant 2 during Reach (right) demonstrated an increase from zero to 112 from the end of the Baseline to the endurance criterion. Participant 1 during Reach (left) demonstrated an increase from zero to 60 from the end of Baseline to the endurance criterion. Participant 2 during Reach (left) demonstrated an increase from zero to 90 from the end of Baseline to the endurance criterion.

Participant 1 during Turn (right) demonstrated an increase from zero to 83 from the end of Baseline to the endurance criterion. Participant 2 during Turn (right) demonstrated an increase from zero to 97 from the end of Baseline to the endurance criterion. Participant 1 during Turn (left) demonstrated an increase from zero to 109 from the end of Baseline to the endurance criterion. Participant 2 during Turn (left) demonstrated an increase from zero to 60 from the end of Baseline to the endurance criterion.

Participant 1 during Shake (right) demonstrated an increase from zero to 112 from the end of Baseline to the endurance criterion. Participant 2 during Shake (right) demonstrated an increase from zero to 135 from the end of Baseline to the endurance criterion. Participant 1 during Shake (left) demonstrated an increase from zero to 90 from the end of Baseline to the endurance criterion. Participant 2 during Shake (left) demonstrated an increase from zero to 90 from the end of Baseline to the endurance criterion.

Participant 1 during Squeeze (right) demonstrated an increase from zero to 83 from the end of Baseline to the endurance criterion. Participant 2 during Squeeze (right) demonstrated an increase from zero to 90 from the end of Baseline to the endurance criterion. Participant 1 during Squeeze (left) demonstrated an increase from zero to 68 from the end of Baseline to the endurance criterion. Participant 2 during Squeeze (left) demonstrated an increase from zero to 112 from the end of Baseline to the endurance criterion.

Changes in trend. Examination of regression linear trend line for each participant indicated a steady increase of scores over the course of each criterion of treatment through the endurance phase of treatment. Examination of the linear regression trend lines for participant in each Big 6 skill indicated an increasing trend and skill maintenance over the course of each phase treatment.

Latency of change. Visual inspection of data indicated that change in results occurred immediately after the presentation of the endurance criterion with an increase of timed practice anticipating the maintenance of the skill performance coupled with an increase in time performance (See above Figures 1.1 through 6.4).

Percentage of Nonoverlapping Data

Percentage of nonoverlapping data points was employed to further insure careful visual analysis. The less overlap found between data points, the more effective and reliable the intervention (Scruggs et al., 1987). Due to each participant's baseline of zero, the percentage of nonoverlapping data points cannot be calculated.

Effect Size

Along with visual analysis, effect size was to be calculated to provide a measure of the magnitude of treatment impact, and compared Baseline to overall Intervention. Effect size was calculated using Cohen's *d* (Allison & Gorman, 1993). The effect size cannot be calculated due to the baseline scores of zero for each participant, for each skill.

Research Question 3

When implementing fluency-based instruction, will the participant demonstrate generalization of the acquisition of all Big 6 (+ 6) as demonstrated in the task reach, grasp, place, release?

Hypothesis 3

The participant will demonstrate generalization of the Big 6 (+6) skills as demonstrated in the task reach, grasp, place, release.

Visual Analysis of the Graphed Data

Visual analysis (Kazdin, 1982) was used to analyze data collected from the task reach, grasp, place, release to demonstrate generalization of skill acquisition.

Changes in means. Changes in mean scores of the Big 6 (+6) reach, grasp, place, release were present for each participant over the course of treatment. Participant 1 was not able to complete the combination skill independently upon introduction; thus the mean Baseline score for Reach, Grasp, Place, Release (RGPR; right) was zero. During intervention the criterion was first set at 10-seconds, his mean score was 8.4, then 13.4 for the 15-second criterion and 18 for the 20-second criterion, with an overall mean score of 13.27 during treatment phases. Participant 2's RGPR (right) Baseline score was zero as he was not able to complete the combination skill independently upon introduction. For the 10-second criterion of treatment, his mean score was 19, then 22 for the 15-second criterion and 39.4 for the 20-second criterion, with an overall mean score of 26.8.

Participant 1 was not able to complete RGPR (left) independently upon introduction; thus the mean Baseline score for RGPR (left) for Participant 1 was zero seconds. For the 10-second criterion of treatment, his mean score was 8.5, then 15.3 for the 15-second criterion and 18 for the 20-second criterion, with an overall mean score of 13.93 during criterion phases. Participant 2's RGPR (left) Baseline score was zero, as he was unable to complete the combination skill independently upon introduction. For the 10-second criterion of treatment, his mean score was 8.5, then 15 for the 15-second criterion and 20 for the 20-second criterion, with an overall mean score of 14.5.

Changes in level. Participant 1 during RGPR (right) skill demonstrated an increase from a baseline of zero to 8 at the first criterion, and then increased to 8 after the second criterion, with an additional increase 3 at the third set criterion. RGPR (left) demonstrated an increase from a baseline of zero to 5 at the first set criterion, with an increase of 10 at the second set criterion, and at the third set criterion an increase of 3. Participant 2's scores for RGPR (right) increased from a baseline of zero to 10 at the first set criterion, with no changes occurring at the second set criterion, with an increase of 9 at the third set criterion. RGPR (left) demonstrated an increase from a baseline of zero to 7 at the first set criterion, with an increase of 4 at the second set criterion and an additional increase of 5 at the third set criterion.

Latency of change. Visual inspection of data indicated that a change in results occurred immediately after the presentation of the RGPR criterion with an increase of timed practice anticipating the generalization of the skill performance.

Participant 1 RGPR (right) demonstrated a match of each set criterion across all three set criterions phase interventions. RGPR (left) demonstrated a match of all three set criterions across phase interventions. Participant 2 RGPR (right) demonstrated a match of the first and third set criterion; however did not demonstrate a match of the set criterion in the second set criterion phase intervention. RGPR (left) demonstrated a match of each set criterion across the three set criterion phase interventions (See Figures 7.1 through 7.4). Endurance and maintenance again occur at a 45-second timing interval in all figures.

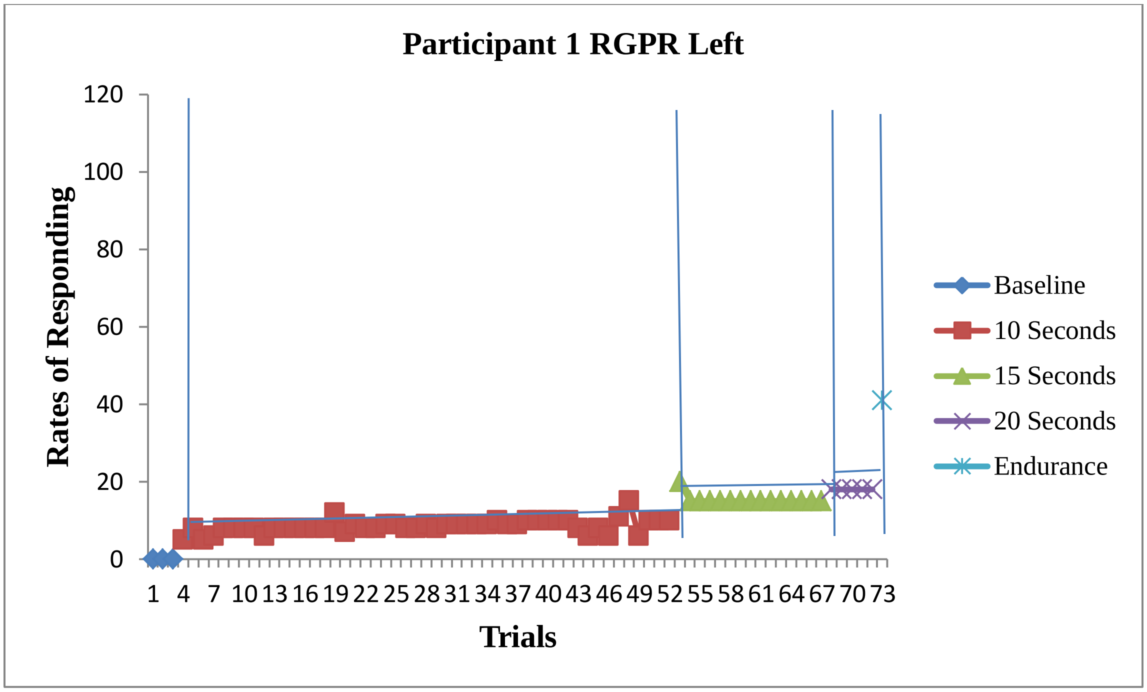

Figure 7.1. Participant 1 RGPR left combination skill acquisition.

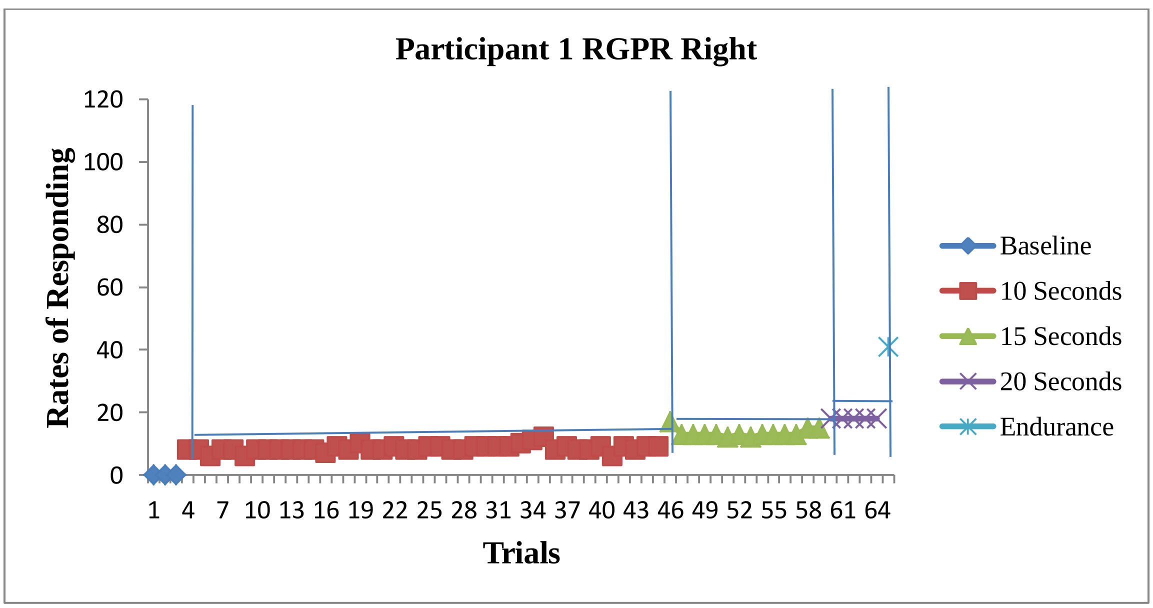

Figure 7.2. Participant 1 RGPR right combination skill acquisition.

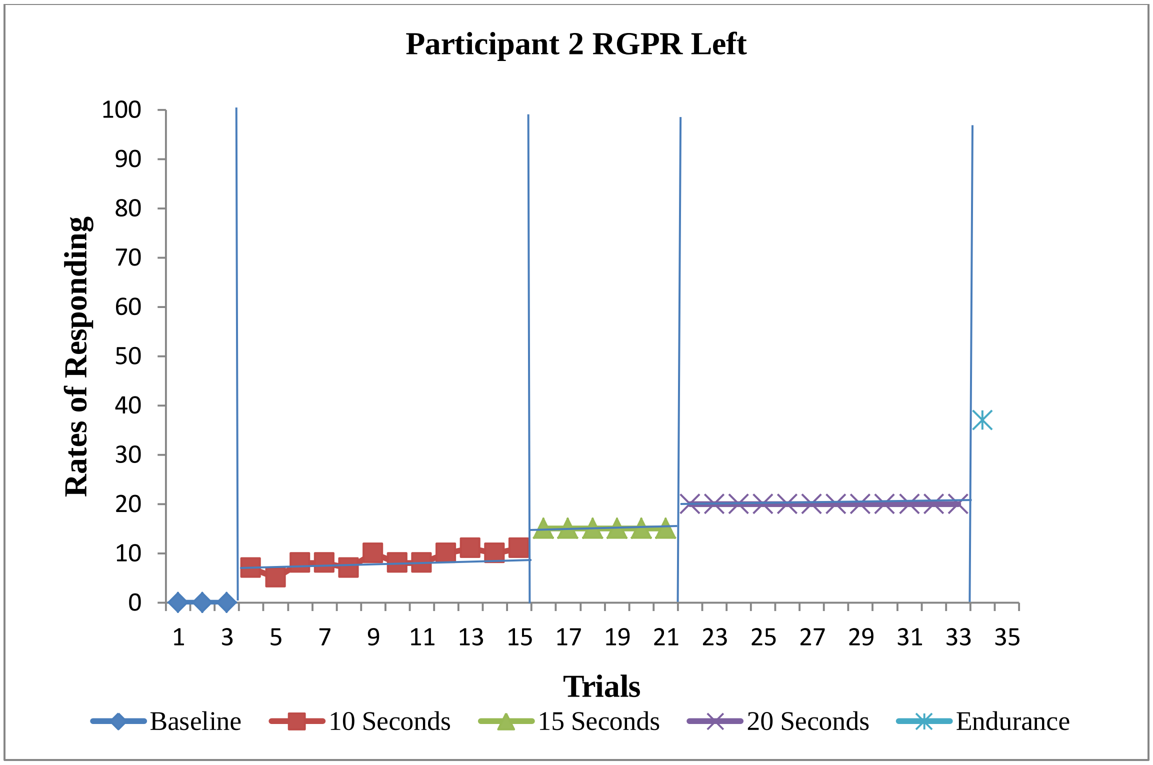

Figure 7.3. Participant 2 RGPR left combination skill acquisition.

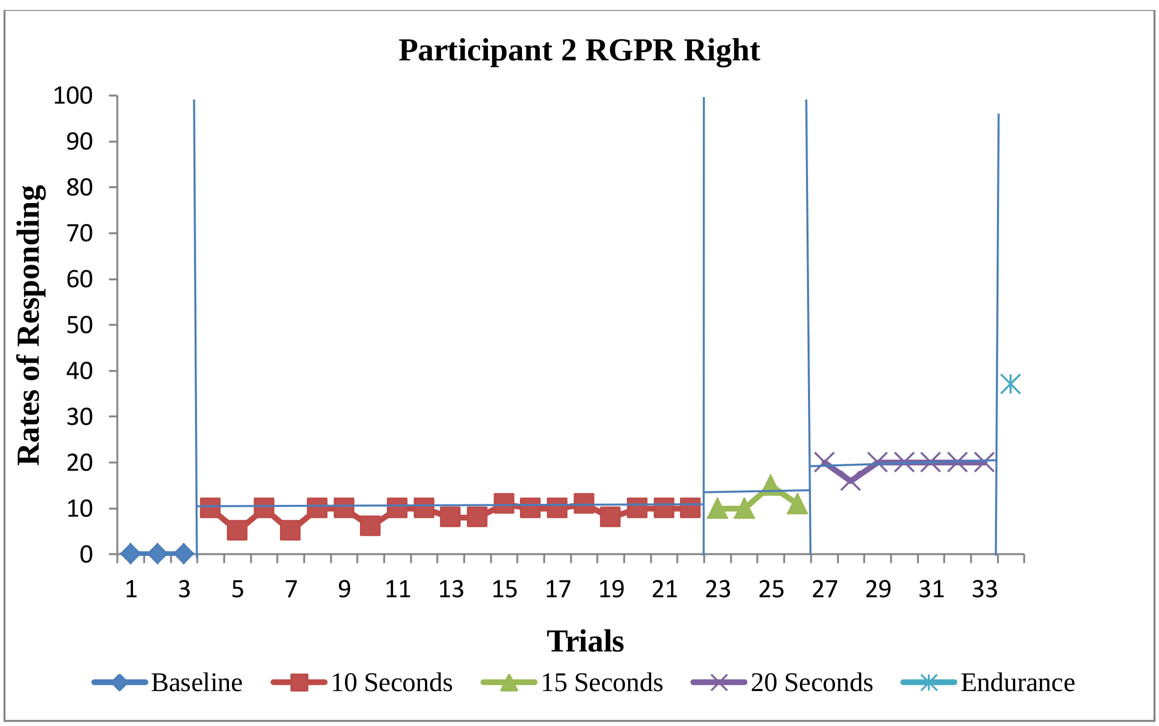

Figure 7.4. Participant 2 RGPR right combination skill acquisition.

Percentage of Nonoverlapping Data

Percentage of nonoverlapping data points was employed to further insure careful visual analysis. The less overlap found between data points, the more effective and reliable the intervention (Scruggs et al., 1987). Due to each participant's baseline of zero, the percentage of nonoverlapping data points cannot be calculated.

Effect Size

Along with visual analysis, effect size was to be calculated to provide a measure of the magnitude of treatment impact, and compared Baseline to overall Intervention. Effect size was calculated using Cohen's *d* (Allison & Gorman, 1993). The effect size cannot be calculated due to the baseline scores of zero for each participant, for each skill.

CHAPTER V

DISCUSSION

Summary of Research Questions

The first research question examined the impact on the acquisition of the Big 6 skills with the introduction of fluency-based instruction. The question hypothesized that the fluency-based instruction will increase the acquisition of the Big 6 skills. The Big 6 skills include Point, Reach, Turn, Squeeze, Shake, and Pinch.

Analysis of the research questions through visual analysis showed that both participants demonstrated increases in the acquisition of the Big 6 skills. Effect size, recommended in the most recent *Publication Manual of the APA* (American Psychological Association, 2009) is used to provide further evidence of the treatment's success beyond the use of visual analysis including nonoverlapping data points; however, could not be calculated due to baseline scores of zero across both participants and across all skills. That is, neither student evidenced any of these skills at the start of the intervention.

Analysis of the data indicated that the introduction of the fluency-based instruction effectively increased skill acquisition for both participants over the course of treatment. During natural observation of each participant, both demonstrated increase in the fluency of skill upon verbal instruction compared to baseline.

More specifically, when examining Pinch Left for Participant 1, skill acquisition increased at each criterion, with a significant increase of skill at the endurance check. Similarly, Pinch Right also demonstrated an increase of skill acquisition at each criterion as well as a significant increase of skill acquisition at the endurance check. Participant 2 demonstrated commensurate results when examining skill acquisition for Pinch Left and Right. Participant 2 demonstrated skill acquisition in Pinch Left; however when the treatment sessions would occur repetitively, Participant 2 often demonstrated a decrease of skill acquisition and an immediate increase of skill acquisition when the criterion was changed. Endurance checks were not completed with Participant 2 due to interfering behaviors surrounding this skill when presented in sessions. Participant 2 demonstrated skill acquisitions in Pinch Right with a slight drop in skill at the change of the criterion however would immediately increase demonstrating skill acquisition.

When examining Participant 1's Turn Left skill demonstration, Participant 1 demonstrated a slight increase in skill acquisition from baseline, with a significant increase of skill acquisition at the endurance check. Participant 1 demonstrated small, albeit inconsistent, skill acquisition at each set criterion. Notably, Participant 1 underwent MST surgery with complications at the presentation of skills, thus this may be a limitation in the treatment success for Participant 1. It should be noted that these complications did not require any further surgery. Similarly, upon visual analysis, Turn Right also demonstrated skill acquisition at each criterion, with a significant increase of skill at the endurance check. A clear criterion was difficult to establish due to the inconsistency in skill presentation.

Participant 2, when examining Turn Left demonstrated steady skill acquisition after baseline intervention was delivered. Similarly, Turn Right also demonstrated steady skill acquisition at each set criterion.

Participant 1's Point Left demonstrated steady increase in skill acquisition at each set criterion. Point Right also demonstrated steady increase in skill acquisition based on visual analysis, however when comparing Point Left with Point Right, Participant 1 demonstrated stronger skill presentation. Notably, Participant 1 is right handed.

When examining Participant 2's skill demonstration of Point Left, the criterion after baseline was met; however was unable to complete the skill of Point Left due to increasing self-injurious behaviors during this response request. Similarly, Point Right, based on visual analysis, demonstrates inconsistent, however an increase in skill acquisition at each set criterion.

Participant 1's Squeeze Left and Squeeze Right both demonstrated a steady increase of skill acquisition at each set criterion. Similarly, Participant 2 also demonstrated steady skill acquisition at each set criterion for the skills of Squeeze Left and Squeeze Right.

When examining Reach Left and Reach Right for Participant 1, a steady increase of skill acquisition is demonstrated; however most notably due to inconsistencies in skill presentation across treatment sessions, each set criterion occurred across several weeks of treatment before the skill was considered stable for the next stage of treatment.

Upon visual analysis, Participant 2's Reach Left and Reach Right skills demonstrated a steady increase of skill at each set criterion; however when stability of the skill demonstration lasted for a several weeks, a slight decrease of skill was observed before the next criterion was introduced. At the introduction of the next phase of treatment, an increase of skill acquisition was demonstrated.

Visual analysis of Participant 1's Shake Left and Shake Right at phase one of treatment after baseline, a decrease of skill acquisition was demonstrated; however when the next phase of treatment was introduced, a steady increase of skill acquisition was observed.

Similarly, visual analysis of Participant 2's Shake Left demonstrated an immediate increase of skill acquisition after baseline; however did not meet the set criterion of phase two of treatment. When phase three was introduced, an immediate and steady increase of skill acquisition occurred. Shake Right demonstrated a steady increasing of skill acquisition at each set criterion across all phases of treatment.

The second research question examined the maintenance of the acquisition of the Big 6 skills upon introduction of the fluency-based instruction. The question hypothesized that each participant will maintain the acquisition of skills across treatment. To investigate this question, visual analysis was analyzed and described.

Analysis of this research question indicated a steady increase and maintenance of skill across the endurance criterion from each participant. Visual analysis indicated generally stable results in terms of maintenance of skill across treatment. Analysis of the data indicated that the maintenance of the Big 6 skills based on fluency-based instruction remained steady after the course of intervention for each of the participants.

More specifically, Participant 1 for both Pinch Left and Pinch Right demonstrated a stable maintenance of skill at the endurance check. Participant 2 demonstrated a stable maintenance of skill at the endurance check for Pinch Left; however due to significant self-injurious behaviors, Pinch Right endurance check was unable to be completed.

When examining the maintenance of skill acquisition for Participant 1 in relation to Turn Left and Turn Right, stable skill maintenance is observed based on visual analysis. Similarly, Participant 2 also demonstrated skill maintenance in relation to the endurance check for Turn Left and Turn Right.

In terms of skill maintenance for Point Left and Point Right as demonstrated by Participant 1, a stable maintenance of skill was demonstrated based on visual analysis of the endurance check. Participant 2 did not complete the endurance check to demonstrate maintenance of skill acquisition due to increasing self-injurious behaviors, thus impacting treatment success in terms of analyzing set criterion success.

When determining maintenance of skill acquisition for Squeeze Left and Squeeze Right in regards to Participant 1, a stable maintenance of skill acquisition was demonstrated when visually analyzing the endurance check. Notably, Participant 2 was unable to participate in the endurance check for Squeeze Left; however did complete the endurance check for Squeeze Right demonstrating steady maintenance of skill acquisition.

Participant 1 demonstrated stable maintenance of skill acquisition in relation to the skills Reach Left and Reach Right based on visual analysis. Participant 2 however only participated in the endurance check for the skill of Reach Left, demonstrating stable maintenance of skill acquisition. Participant 2 did not complete the endurance check of Reach Right, thus no conclusions in terms of maintenance of skill acquisition can be inferred.

Upon visual analysis of the skills Shake Left and Shake Right in relation to Participant 1, stable maintenance of skill acquisition was demonstrated based on visual analysis of the endurance check for such skill. Similarly, Participant 2 also demonstrated stable maintenance of skill acquisition for Shake Left when analyzing the endurance check. Participant 2 did not complete the endurance check for Shake Right, thus no conclusions can be made in terms of maintenance of skills.

The third research question examined the generalization of skill over time, and hypothesized that skills would be generalized based on the combination skill Reach, Grasp, Place, Release (RGPR).

Participant 1 demonstrated an increase of skill across the course of treatment for RGPR from baseline; however because Participant 1 was unable to complete the RGPR skill independently at baseline, intervention to complete the skill was necessary. Thus, albeit RGPR for Participant 1 did increase across the course of treatment, generalization did not occur indicating the hypothesis was not supported.

At follow-up, Participant 2 also demonstrated an immediate increase of skill at the first set criterion, as well as an increase at the third set criterion; however similar to Participant 1, Participant 2 also required intervention at baseline and was unable to perform the skill without said intervention, thus generalization did not occur and the original hypothesis was not supported.

It should be noted that when examining the endurance and maintenance skill performance, a significant increase occurred from phase three to endurance. This increase is due to increased opportunity in terms of rates of responding as the endurance phase was a 45-second timed phase which provided the participant with an increased amount of time to demonstrate skill performance.

Conclusions

Relevant Literature

Findings from this study found that fluency-based instruction was indeed an efficacious treatment for increasing basic psychomotor skills; both participants from this study experienced an increase of skill over the course of treatment, as well as maintenance and of skill over time. Results were convergent with findings from previous research (Bucklin, Dickinson, & Brethower, 2000; Johnson & Layng, 1992; Olander, Collins, McArthur, Watts, & McDade, 1986) where individuals in both school and university settings showed progress. Results from this study further validate the importance of the acquisition and maintenance to assist in connecting basic to more complex skills. In other words, the implications of this study indicate that acquiring and demonstrating basic component skill sets to fluent levels and performing at those fluent levels over time contribute to the successful combination of more complex psychomotor skill sets. Indeed, when instructional objectives are arranged so that lower level skills facilitate the acquisition of skills at the next higher level, the result would be a hierarchical arrangement of the curriculum (Resnick, Wang, & Kaplan, 1973) that would be more consistent with skills learned by typical peers. Thus, the strength of fluency-based instruction is in the emphasis in basic skill development that can result in effective communication and understanding of the environment. Fluency generated instruction begins with psychomotor skills that are the component parts of the skill that is not yet intact (Johnson & Layng, 1992). In this systematic way, fluency instruction can address an individual's behavioral frustration that is the result of an individuals' limited ability to influence goal directed behaviors in the environment.

Relevant Theory

Johnson and Street (2004) noted that The Morningside Model of Generative Instruction can be described as a model of instruction, which centers on a belief that complex behavioral repertoires emerge without explicit instruction only when well-selected component skills are appropriately sequenced and carefully instructed. Thus, the Morningside Model of Generative Instruction is consistent with the type of intervention likely to be effective for children with LKS who have undergone MST surgery and are in need of intensive interventions that break down skills into component parts necessary for successful skill acquisition. Results of this study support the use of a fluency-based instruction, such as the Morningside Model for Big 6 skills. Further, there is support for the maintenance and generalization of combination skills across treatment, such as engaging in activities that required a combination skill of Reach, Grasp, Place, Release which includes engaging in TEACCH activities. The participants in this study were previously unable to successfully complete goal directed behaviors such as using a pincer grasp for pencil holding, turning a door knob without assistance and utilizing their pointer finger to indicate a choice. After fluency-based instruction they were able to utilize a pencil grip and use a writing tool to begin to make pencil to paper marks. It should also be noted that these psychomotor skills were also a part of a combination skill of writing, thus as the basic psychomotor skills become more fluent an impact on alternative combination skills is present. Therefore, fluency-based instruction (i.e., Morningside Model) is likely to be highly advantageous for practitioners in a public school setting who are attempting to find research-based alternatives to treat children with significant developmental disabilities. Similarly, when making programming choices for students with disabilities, considerations regarding basic psychomotor skill development should be taken into consideration prior to embarking on programs that rely on such skills to have already been mastered. Specifically, when examining an approach similar to Lovaas Discrete Trial Training, basic and combination psychomotor skill acquisition fluency should be considered as these skills are at the foundation of making and discriminating among choices and communicating with individuals. In addition, based on the literature surrounding fluency-based instruction, if basic component skills are not built to a fluent level, combination skill mastery will not be attained, thus negatively impacting future programming involving combination skills. Further, it is hypothesized that when basic psychomotor skills are not built to a level that is fluent, non-verbal communication skills such as micro-gesturing and sign language would be negatively impacted.

Limitations

While this study was implemented according to the methodological design, some limitations did exist. Integrity checks were used, treatment provisions were consistent, and the researcher participated in trainings related to fluency-based designed, and direct supervision from a professional trained in fluency-based design was provided on an as-needed basis. While treatment was provided on a consistent basis, an increase in staff absences, participant absences and staff turnovers could have potentially guided treatment more effectively. It should also be noted that an increasing number of participants may have also guided treatment more effectively and provided a clearer effect of treatment success. Additionally, the lack of consistent behavioral output with participant 2, specifically increasing amounts of self-injurious behaviors described as fist-to-face and fist-to-head hits as well as the aggressive behaviors toward staff, was a significant limitation in the study. Although self-injurious behaviors were considered a limitation to this study, it should be noted that these types of behaviors are often observed in students with significant developmental disabilities.

As noted in Chapter 3, instrumentation remained potential threats to internal validity. It should also be noted that history and maturation are also considered threats to internal validity. Instrumentation factors could have impacted results, although observer reliability was taken into account, as well as interobserver reliability. All sessions were standardized, using the same timer and counting method to ensure accurate data collection by each observer. The location of each session was the same, providing consistency for the observer and the child. As mentioned above, the impact of measurement between staff was controlled by observer reliability, but remained a potential limitation.

RGPR combination skill mean results from both of the participants required intervention to complete the targeted combined skill. Due to both participants' lack of skill production upon introduction of the skills resulting in baseline scores of zero, higher level measures of effect (e.g., effect size and nonoverlapping data points) could not be calculated – as such the reliability and magnitude of treatment success was not directly measured. More specifically, as mentioned above, the baseline of each skill for both participants were noted as zero, thus effect size could not be calculated due to the zero baseline impact on the standard deviation across the treatment phases.

Recommendations for Future Research

Although the findings from this study provide further empirical support for fluency-based instruction as an efficacious treatment option for children with significant developmental disabilities, further research of this treatment remains a need. Future studies should incorporate parent and teacher input. Parent and teacher interview could provide an observational perspective and insight into the impact of the child's skill development across settings (e.g., home and school). Future research could evaluate how and when the movement from component skills to combination skills may be better understood. Further, how these component skills are related to academic functioning (e.g., reading, writing and math skills) would be important to the literature.

Results of this study provided evidence of fluency-based instruction as an efficacious treatment for children with significant developmental disabilities. The participants demonstrated steady increase of skill acquisition, as well as the maintenance and generalization of combined skills over time. These results should inform school psychologists and other personnel working with children who evidence severe developmental disabilities. Based on the legal requirements of the Individuals with Disabilities Education Improvement Act (IDEIA; 2004) these results support fluency-based instruction as meeting Response to Instruction and Intervention (RTII) criteria defined as an effective, time-limited, and research-based option to treat children with significant developmental disabilities within the school setting. Also evident, high expectations in terms of rates of responding allowed for the use of clinical judgment on the part of the interventionists, which allowed for 'real world' changes during the course of the intervention phases. This flexibility in terms of making changes based on the learner and their rates of responding are applicable within the academic setting. Additionally, consistent with changing criterion design, fluency-based instruction and applied clinical judgment allowed a 'double back' approach when the data of the learner indicated non-fluent performance. This is in contrast to clinical case studies where changes in phase levels cannot occur without meeting the specified criteria.

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