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The effects of sensory stimulation on students with traumatic brain injury as compared to students with developmental disabilities

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THE EFFECTS OF SENSORY STIMULATION ON STUDENTS WITH TRAUMATIC BRAIN INJURY AS COMPARED TO STUDENTS WITH DEVELOPMENTAL DISABILITIES

by
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ABSTRACT

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The Effects of Sensory Stimulation on Students with Traumatic Brian Injury as Compared to Students with Developmental Disabilities

2001

Dr. Jay Kuder

Research and Seminar in Special Education

The purpose of this research was to determine if Sensory Stimulation had an effect on the motor development and communication skills of the students with Traumatic Brain Injury as compared to the students with Developmental Disabilities. Four students participated in this study: two were Traumatic Brain Injured and the other two were Developmentally Disabled.

To establish change over time the students' communication and motor skills were observed individually three times a week for four weeks. Eight domains were covered; responses could be verbal or non-verbal.

The results indicated that Sensory Stimulation proved to be beneficial because all four students showed some type of improvement. However, the Traumatic Brain Injured students responded significantly higher than the Developmentally Disabled students.

MINI-ABSTRACT

Eileen M. Bertolino-Russell

The Effects of Sensory Stimulation on Students with Traumatic Brain Injury as Compared to Students with Developmental Disabilities

2001

Dr. Jay Kuder

Research and Seminar in Special Education

A study was done to determine if Sensory Stimulation had an effect on the motor development and communication skills of two Traumatic Brain Injured students as compared to two Developmentally Disabled students. Improvement was noted in all four students. However, the Traumatic Brain Injured student responded significantly higher than the Developmentally Disabled student.

ACKNOWLEDGEMENTS

Thank you Mom, Dad and Joe for all your love and support. You have seen me through my own Traumatic Brain Injury with the belief in me that I could do anything that I put my mind to.

To my loving husband, Walter, for sticking by me, believing in me, and encouraging me to keep going.

To my family and friends especially my Grandmother, Lillian, and Jackie. You have been my saving grace. Thank you for the many prayers.

Most importantly, thank you God! I would not have made it where I am today without you!

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CHAPTER I

INTRODUCTION

Sensory stimulation can affect the communication skills and motor development of individuals with Traumatic Brain Injury (TBI) and persons with developmental disabilities. The individuals with developmental disabilities can have an inadequate ability to communicate at a normal age-appropriate level. These individuals may have neurological and motor delays based on their underlying medical diagnosis.

The student with Traumatic Brain Injury often experiences an absence of verbal communication. The reason for this is that most likely these students suffer from paralysis and atrophy of muscles. Therefore, some have limited communication leaving them to communicate through eye blinks, facial expressions, and/or body movements that are all age appropriate. However, not all Brain Injuries are as severe. Every Brain Injury is different because there is no one brain that is alike.

Sensory stimulation may be beneficial when working with these groups of individuals because it helps to arouse all the senses. Both the TBI students and the individuals with developmental disabilities may benefit from sensory input to increase blood flow, circulation, and balance. I know first hand that repetitive stimulation was instrumental in my own recovery from a Traumatic Brain Injury.

This topic relates to school success because the more study and research on the effects of sensory stimulation on the students with TBI as compared to the individuals

with developmental disabilities, the better equipped schools will be to help students achieve their highest functioning potential for future growth and development as adults.

Problem Statement

Does sensory stimulation have an effect on communication skills and motor development in the students with Traumatic Brain Injury as compared to the individuals with Developmental Disabilities?

Hypothesis

It is hypothesized that sensory stimulation has an effect on the communication skills and the motor development on the students with TBI as compared to the individuals with developmental disabilities. Students with TBI have an advantage over the developmentally disabled student because they had gone through the normal stages of growth and development prior to their injury, which occurred during their teen-age years. Therefore, many memories, experiences, and tasks were stored in their brain cells. Some cells died thus leaving healthy brain cells isolated and the person confused and unable to communicate. Repetitive stimulation helps to develop new pathways in the brain by passing the damaged part of the brain thus re-establishing a pathway to the healthy cells thus opening lines of communication.

Individuals born with congenital disabilities never had the opportunity to proceed through a normal growth and development. With daily repetition of teaching, students with Developmental Disabilities will remain the same or have little improvement in cognition skills.

Statement of Purpose

1. I hope to show the difference that sensory stimulation has on the Traumatic Brain Injured student's versus the developmental disability student's ability to learn and relearn communication skills and motor development. With the Developmental student, I would expect to keep their communication skills functioning with minimal regression. With the TBI student, I would like to show steady progressive gains in communication responses.

2. What I hope to see change in the near future is better research and development with regards to communication techniques for TBI and individuals with developmental disabilities. Computers can be part of sensory stimulation and communication. It is a link to auditory, visual, and tactile stimulation. Along with better research and development coupled with earlier teaching interventions, this should advance the TBI and the developmental disabled student's socialization skills for future participation in the outside world.

3. What could impact the findings of this study? There are three main things that could have an effect on the outcome of the data being collected. Health issues are a big part of the student's lifestyle. At times, the student may suffer an illness that set then back. For example, a code that may lead to regression.

   Familiarity of the instructor is another. It is important that the same person needs to do the study and keep data because the student may respond differently to a non-familiar instructor.

Third, the student's mood also plays a big role in how the day will turn out. Sometimes the students can come to class in a non-working mood. They sometimes do not want to participate.

Overview

In the chapter to follow, the literature review will explain in more detail about sensory stimulation and Traumatic Brain Injury. The following chapters explain the design of study, the data analysis, the summary and conclusion.

CHAPTER II

LITERATURE REVIEW

Sensory stimulation involves techniques that arouse the tactile, gustatory, visual. olfactory, and auditory senses. Doman (1984) states that "stimulation is vital to our brain's efficiency. It is the regular and proper stimulation of our brain through our five senses that permit us to be able to function on a relatively steady, even keel most of the time as our brain relates us to what is happening around us."

Traumatic Brain Injury is an insult to the brain. Kraemer and Blacher (1997) cite Harvington (1987) as defining TBI as "closed" or "open" brain trauma. Closed head injury occurs when the brain moves rapidly causing injury at the point of impact or at the site opposite impact. Cells are damaged in different areas of the brain because of the jolting and moving causing bleeding and tearing. Kraemer and Blacher say nerve cells in the brain are short circuited thus breaking down lines of communication. Open head injury is when a foreign object penetrates the brain thus causing either focal or "diffuse" brain damage.

Jacqueline Baker (1988) quotes Plum and Posner (1982) in their definition of coma as follows "Coma is... the total absence of awareness of self and environment even when the subject is externally stimulated." Baker (1988) also cites Hunter's (1980) theory that the brain can adjust and regroup. She talks about spare parts in the brain that take over when other parts are damaged. Again she cites Hunter (1980), when she states that the redundancy theory explains how the brain can copy "neuronal Pathways" so that

if one route is gone another can be established. After a brain injury, axons that were not hurt seek out new links to reconnect because some brain cells are now dead and cannot regenerate. Baker (1988) supports the environmental effect theory that certain institutionalized children who received forms of sensory stimulation were much faster attaining skills than those who were not stimulated. With these theories in mind, this study encourages the use of Coma Arousal Therapy on all comatose patients by stimulating the five senses so that the brain-injured individuals can have a better chance to improve. Baker (1988) believes that any program that improves the life of a brain-injured person should be implemented so that he is given a chance to reach his fullest potential.

Kathryn Kater (1989) says that modern technology has kept head-injured victims alive but has left them with cognitive and behavioral deficits. She goes on to say that while the patient's physical needs are necessary, the need for sensory stimulation, which is just as important, has been disregarded. Kater (1989) explains that when the brain is stimulated early on following injury, neurons reply and begin to compensate for the loss of brain function. No one knows why this happens, but Kater (1989) talks about "Hermann Munks vicariation theory" (cited in Spear, 1979) that non-traumatized areas on the same side of the brain will take over. Kater (1989) goes on to say that the axons germinate or take root, find another path and link up to another part of the brain, Another theory is the "substitutional theory" where one system of the brain compensates for another.

In this article, Kater (1989) talks about her study that compares the effects of sensory stimulation on two groups of fifteen patients with similar head injuries. The experimental group was given "structured" sensory stimulation. Fifteen patients in the

control group received only "random" sensory stimulation. The sensory stimulation provided to the patients consisted of visual, auditory, olfactory, cutaneous, kinesthetic, and oral stimulation. Relatives and medical staff were incorporated into the program and were told to try to stimulate the patients as much as possible. However, those individuals in the experimental group whose coma was moderate were stimulated more than those individuals in a light coma. Those in a moderate coma scored higher cognitively than those who were in a light coma because they received more sensory stimulation than those individuals. Those in a light coma received less sensory stimulation because their impairment was assumed to be less severe. All senses were stimulated with anything that was familiar to the person pre-injury. These included people, animals, scents, extracts, and music. In concluding, Kater (1989) says that the study showed that those patients who were exposed to an "enriched environment" before their injury faired better then those who did not. Kater (1989) suggests that it backs up the theory that persons with diversified experiences pre-injury may have an advantage over those with less experiences because the brain has a greater regrouping ability because of "more neural extensive functional neural circuiting." Kater (1989) also says that the patients in the structured program had a higher level of recovery.

In another article written by Kathryn Kater (1989) the need for sensory stimulation in head injured patients is discussed. According to Kater (1989), stimulating the brain right after a brain injury helps the neurons around the injured site take over and also help to recoup some of the functional losses. A study was done involving two groups of fifteen brain-injured people. The study was done in one setting and lasted three months. One group received "structured" sensory stimulation by a nurse. The other group just received general nursing care without any special structured stimulation. The

cognitive function level score increased for those who received the stimuli as opposed to those who did not. When the stimulation included some pre-injury experience patients did better. How well they did also depended on where they were at the time on the Glasgow Coma Scale. Those who experienced "enriched environment" pre-injury scored higher than those who came from a non "enriched environment" pre head injury. Kater (1989) says that when nurses make sensory stimulation part of their daily routine in taking care of their patients with head injuries, the cognitive level of the patient increases.

An article written by Mitchell, Bradley, Welch, and Britton (1990) dealt with a study done to determine the effectiveness of a coma arousal procedure. Mitchell suggests that the coma arousal procedure is necessary because the brain needs input from sense receptors in order to function properly. In this study there were two groups, the experimental group and the control group. The experimental group consisted of twelve people who were seriously brain injured. They were identified as group I. Aggressive sensory stimulation was applied to the experimental group. The control group also consisted of twelve severely head injured patients. They were identified as group II. The control group received no sensory stimulation. As soon as the patient's medical condition in group I stabilized, the patient was started on the stimulation program in order to counteract the effects of sensory deprivation on the brain. Family members participated in the coma arousal procedure along with a medical team. Coma kits with instructions were supplied to relatives to use to stimulate the patients. The kits were filled with items that could be used safely by family members to stimulate all the senses. Each of the senses was stimulated sequentially and the results were recorded. The patients were assessed and reassessed until they came out of the coma. All five senses were stimulated

until the patient came out of the coma. The results were that the experimental group I came out of the coma much more quickly as opposed to control group II.

Robert Doman (1984) has strong views on sensory stimulation. He says that it is very vital that our brain be stimulated. This need is to be done through our sense of touch, taste, sight hearing and smelling. Correct stimulation generates more links between brain cells producing better routes so that the brain works more effectively. This article talks about what could happen if the brain is deprived of sensory stimulation. Sudden deprival of brain stimulation strips the brain of its ability to work effectively causing major physical and psychological problems. Some effects could be memory loss, withdrawal, lower IQ, etc. However, this all can be reversed if the brain is properly stimulated.

Robert Doman (1980) has written another article where he advocates the need for a full sensory stimulation program. According to Doman (1980), the degree of success in how a patient recovers to his fullest potential depends on the intensity of the stimulation he receives. He speaks of a child named Dawn who has been severely brain injured from birth. She progressed to almost "normal" with his program. Then she sustained another insult to the brain when she came down with encephalitis. Doman (1980) believes the more brain injured a person is, the more stimulation he should receive because the brain is in a constant state of learning and if the brain is not stimulated, one will lose whatever they have learned. Doman (1980) states that Dawn did well with this continuous sensory stimulation. Then, when the "Right to Education Law" was enacted, the state set new guidelines for sensory stimulation. Doman's (1980) criteria and the state's were different. Dawn was given less sensory stimulation. Doman (1980) left the Program. Within six

months Dawn died. Doman alluded to the fact that Dawn had died from the lack of enough sensory stimulation.

Elayne Glover and Gary Mesibov (1978) address the issues of educating the "severely and profoundly retarded" children as required by law. Because this population of retarded children were limited in their responses, a sensory stimulation training program was proposed that incorporated the stimulation of the five senses with the hope that some type of response would be evoked from the children instead of specific responses. Glover and Mesibov (1978) claim that all students are deserving of an education regardless of how severe their handicap. The public schools already had an effective program for the mildly and moderately retarded children but there was an increasing need to educate the profoundly handicapped child. Glover and Mesibov (1978) state that the schools at that time were using teaching methods and strategies based on "behavior techniques." This concept of teaching had been used to teach the "normal" child. They thought that they could use this same method of teaching with profoundly retarded children but only in a slower and more repetitive manner. Glover and Mesibov (1978) state that this method of teaching requires a "specific response" from these children who were extremely deficient in their ability to respond. This teaching method was not working effectively because of the child's limitations. Glover and Mesibov (1978) suggest that these children could use a sensory stimulation classroom interest center to improve their awareness. Centers could be developed to stimulate the five senses. The hearing or auditory stimulation center could play all types of music with variations in sound and speed, soft or loud. Various instruments could be used along with many household items and toys that can produce a sound. A visual stimulation center could incorporate variated colored moving objects, small and large and movies. A tactile

stimulating center could use all types of materials with a variety of textures, which could also include food objects and water. In the gustatory-olfactory center the child could try many types of foods to see if he/she likes or dislikes the taste/smell. This program should be age appropriate. The author states that the sensory stimulation is to act as a supplement and is not to replace behavior techniques. The advantages of the proposed program are that teachers are challenged to express their creativity. It's still in a classroom setting and it helps stimulate the child to respond instead of demanding a specific response.

Stephen Houghton et al (1998) looked at seventeen students with severe disabilities. Most research on multi-sensory environment (MSE) has been very limited and there needs to be more research on the "effectiveness on MSE's" so that severely handicapped child can get the education that they are entitled. This article questions the effectiveness of multi-sensory environment on the severely disabled child. Seventeen Handicapped children participated in a study where they were exposed to a multi-sensory-environment (MSE). The multi-sensory-environment in this study was a big room in a school setting, which contained various items that would stimulate all the senses. The room contained a waterbed, devices that could be activated by a switch, bubble tubes, fiber optics, sounds, lights, and music. Movement and/or sound could activate items. There were also cushioned areas where children could play freely and safely. The seventeen children involved in this study after a 30-40 minute session of MSE displayed previous unseen skills, appropriate eye contact, tracking a moving object in a circular motion, horizontally, vertically in 102 out of 134 separate occasions. These children also displayed behaviors of joy and happiness, which are factors in the development of new skills and learning. The children appeared to be delighted in the

experience and their skills increased. However, it was difficult to measure the effectiveness of the MSE because of the variations of the disabilities.

Robert Doman (1982) in this article speaks about how patients in a coma in a hospital setting receive very little sensory stimulation. What they do receive is nursing care. Doman (1982) believes that the only way the brain gets any information is through the senses. He tells a story of a little boy who had been hit by a truck and was unresponsive and comatose for nine weeks. Doman (1982) developed an intense program for the little boy using tactile, olfactory, auditory, visual, gustatory, vestibular and proprioceptive stimulation. He eventually emerged from the coma and progressed. Doman says that every coma patient responses differently to stimulation. In some cases, patients go back to a normal degree of living. In other cases, some patients never fully come out of the coma, but most are being helped.

Susannah Kirkman (1992) describes the quieting effect that the newly introduced "SNOEZELEN" has on severely handicapped children in the Limington House School in Basingstoke. This is a new sensory stimulation room filled with hi-tech equipment, which provides children with an avenue for total expression. This room provides not only a soft stimulating environment but also its Disney like atmosphere encourages the child to experience tons of fun and excitement. Scented odors permeate the room. Soft music, colorful, vibrant lights and equipment bombard the atmosphere. Children learn to touch and work with switches in the room, which not only helps them to control their environment, but also helps them to stimulate their senses to learn new skills thus enhancing their growth and development. An additional padded playroom provides a fun like atmosphere where children can be let loose, wheelchair free and safe to be themselves. This warm, friendly environment seems to be a calming device. It has been

successful with those individuals who have been hard to handle and out of control. The "SNOEZELEN" has also worked well with those children with severe disabilities. This device has been able to generate a response from these children when nothing else seemed to work. This secure, calming fun like atmosphere is beneficial to everyone concerned. Parents can see their children experience joy and happiness along with learning. This type of atmosphere helps the child to feel the safe and secure. This then enables the teacher to do her /his job and observe the effects that sensory stimulation has on the child. The "SNOEZELEN" helps the children experience a wide variety of stimulation and joy thus generating overwhelming responses to the stimuli. Because of the response, the "SNOEZELEN" will be used as a diagnostic tool. This article says that this unit is an ideal charitable project that not only can help the children in the school, but also help to diagnose outside children who are handicapped.

Robert Silverman (1984) writes about his own head injury experiences. He describes being aware of his surroundings and only knowing that something big had happened. He was disoriented and confused and was unable to visualize. His senses were severely impaired and he was forced to go to a nursing home. A friend came to his aid and arranged for him to see Dr. Robert Doman. Dr. Doman and his associates understood his problems and structured an intense sensory stimulation program, which sparked his recovery. Bob is now back to his acting and was nominated for the Canadian equivalent of an Oscar for Best Supporting Actor in a film made since his accident.

Unlike Robert Doman (1982), Nathan D, Zaslar (www.biausa.org), questions the validity of sensory stimulation as a tool in the recovery from head injury. He bases this on the fact that there is little scientific evidence to back up the theories of its effectiveness. However, Zasler does conclude, "absence of proof is not proof of

absence." He suggest taking a closer look at those in a vegetative state longer than a year and that sensory stimulation should be looked at as option and not standard.

Joanne Nicolls (1986) describes how to assess and reassess the effectiveness of the stimulation. She says that even though a patient has been in a coma for long time stimulation can help in the "awakening" process. Nicholls (1986) describes how a patient's physical needs are met in a comprehensive medical way post brain injury and how on her initial evaluation she assesses the damage that the body has experienced as a result of brain injury namely coma, muscle contractions, clenched fists. She works on trying to rehabilitate the body through exercises. Usually changes in the patient are eventually noticed. Nicholls (1986) says that even though all of these measures are important, they are just not enough. She describes how one can put together a sensory Stimulation Kit" to stimulate all the senses. In her program, she provides olfactory, auditory, visual, taste, tactile, pain fiber stimulation, proprioceptive, and vestibular stimulation with regular household items. She assesses and reassesses the effectiveness of the stimulation and makes a determination if it should be increased, decreased or stopped. She involves the family in the stimulating program. Sometimes the patient reaches a plateau. Other times he becomes more responsive. Nicholls (1986) states while the awaking of a long-term coma patient is rare, it does occur, and a stimulation program enhances this possibly.

Sandra DeYoung and Robin Grass (1987) discuss the International Coma Recovery Institute and their work in trying to restore a severely head injured individual to his highest possible level of functioning Most patients have been rendered hopeless by other institutions prior to their admission. However, the rehabilitation team believes that sensory stimulation will arouse the patient from the coma and parts of the brain never

used will take over. The health care professionals aggressively start multi-sensory stimulation and all brain injured patients no matter what the prognosis and the effects of the stimulation are evaluated. "The ICRI program has treated 250 people since 1977. 92% came out of the coma 35% became functionally independent. 57% improved in physical and mental abilities. 4% no change. The average patient admitted had already been in a coma for 6 months."

Michael Wells and David Smith (1983) discuss a study of four profoundly mentally retarded and multiply handicapped institutionalized individuals who where self abusive. The self-injurious behaviors included head slapping, biting themselves, banging feet together. This abusive behavior resulted in damage to their skin. Sensory integrated treatments using tactile and vestibular stimulation was preformed five days a week and results were recorded. A great decline in the self-injurious behavior was noted.

Chaney, Givens, Aoki, and Gombiner (1989) reported that a study was done on twenty-four profoundly retarded institutionalized patients to determine pupillary response to pleasant versus unpleasant stimuli. During the evoking of the visual stimuli when someone the patient knew came near them, their pupils became dilated. If someone they didn't know approached them then their pupils became constricted. When these individuals were touched in a harsh manner, their pupils would constrict. However, when they were gently touched, their pupils would dilate. When these children were exposed to auditory stimuli, the loudness made their pupils constrict and the relaxing mellow music made their pupils dilate. The results of this study not only help care takers measure the effect that sensory stimulation has on the children but can also help them to better understand the likes and dislikes of these children by their pupillary response.

Ansell (1991) addresses the issue for treating the slow to recover (STR) population. Insurance companies are hesitant to okay sensory stimulation programs because most of the treatment the patient receives is based on theory and there is not enough proof of the efficiency of sensory stimulation. However, a new test called the "Western Neuro Sensory Stimulation Profile" can assess the population to see if they are eligible for treatment. Ansell (1991) suggests that STR patients are in need of sensory stimulation because their senses are already deprived because of brain injury, and she suggests that there are theories that support this reasoning. Ansell (1991) says that stimulation programs help to counteract the loss of function of the already deprived brain. Ansell (1991) defines deprivation as any abnormal situation or atmosphere that inhibits or decreases a person's development thus causing the person to waste away. Ansell (1991) states that the nervous system can adapt and that new connections form all the time in the brain. The brain injury itself along with experiencing an "enriched environment" can stimulate the reconnection process. Therefore, a program full of rich stimulating experiences can help the deprived head injured patient because without it the patient will continue to deteriorate.

Marilyn Chase (1999) talks about a boy named Henry who began to have night terrors, which started when he was in kindergarten. He was now in the second grade, and he was having behavior problems due to his sleepless nights. His parents tried everything and even had him undergo various "neuropsychiatric assessments." However, he scored well on all of these tests. Henry's parents finally turned to occupational therapy to calm and focus his senses. This article talks about how people have problems registering and interpreting sensory information. They also can be sensory defensive. Because of this, children can become disruptive and have behavior issues. A sensory stimulation program

was suggested for Henry. This type of program was designed to calm nerves, moderate sensory input, and coordinate appropriate responses. Sessions included firm brushing of his arms and legs with soft plastic brushes. This is believed to stimulate the nerve fiber. He played games of basketball to increase his motor skills and even jumped on a trampoline to improve his balance. Listening therapy was also incorporated into his program. He had to listen to music with the base tones muted out so that he could focus on what was coming in, so he could process it into his brain. Chase (1999) states that Henry seemed to respond well to this treatment. Soon after his treatment began, his nightmares stopped, and his disruptive behaviors decreased.

In conclusion, the brain is stimulated by the five senses. An injured extremity needs physical therapy so that the muscle will become stronger and not atrophy. The brain also needs external stimulation in order for the axons to find new pathways and connect to healthy cells. Most of the literature in this chapter supports the use of sensory stimulation in all children who are brain injured. The results of the literature review confirm the benefits that sensory stimulation has on this population. However, some of the literature questions the validity and limitations of sensory stimulation on the brain injured population. They suggest there is not enough scientific proof to back up the theories of its effectiveness.

I am doing this study because there is research evidence that sensory stimulation has benefited some Brain Injured individuals. I want to research the specific effects that sensory stimulation has on this population. I hope to prove that sensory stimulation will have an effect on the communication skills and motor development on individuals with Brain Injuries.

CHAPTER III

DESIGN OF STUDY

Population

The population that was studied is four severely handicapped, medically fragile individuals. Three of the students reside in a pediatric residential facility. One resides in a nursing home. Two are male and the other two are female. Two have suffered Traumatic Brain Injury whereas, the other individuals where born with developmental disabilities. They range from 11 to 21 years of age. Three of the students receive education services in a classroom setting within the pediatric facility; however, one student is given individual tutorial sessions in his room at the facility.

Student A is an 18-year-old male who sustained a head injury after being hit by two cars when he was riding his bike. He was 16 years old at the time of the accident. He is wheelchair dependent, non-verbal but communicates with eye blinks and smiles and is totally dependent on staff for all his needs. He needs 24-hour skilled care. I began teaching student A in May 1999.

Student B is a 16-year-old female who sustained a head injury when she was involved in a motor vehicle accident at the age of 14. She is wheelchair dependent and non-verbal. She communicates via head turn toward yes/no signs on tray. She is not my student but is part of my study.

Student C is an 11-year-old male who was born with congenital hydrocephaly. He is wheelchair and feeding tube dependent. He requires 24-hour skilled nursing care. He

has lived at the facility since 1989. I began working with him in 1996 in individual tutoring sessions.

Student D is a 21-year-old female who was born with microcephaly. She is wheelchair dependent. She requires 24-hour skilled nursing care. She has been receiving education services in my classroom since 1998. Student D recently turned 21 years of age and now resides in a nursing home; however, she continues to receive school services which she is entitle to receive through her 21st year.

Procedure

Four students where chosen for this study. Parental consent was obtained from the parents. The study was designed to do four individual case studies. Each one of the four students was to be observed when they were receiving sensory stimulation, which included auditory, tactile, olfactory, and visual.

Auditory Stimulation Activity (Communication)

The teacher tells the student that she will place the headphones on the student's head. She will then explain that she is going to let them listen to the music for 5 minutes. The teacher will then look for responses such as smiles, laughter, eye blinks, grimaces, and head turns, etc.

Visual Stimulation Activity (Communication)

The teacher will provide the student with an activity with color preferences. The student will then be given a choice of two colors. The student will be given 5 opportunities with this activity 3 times a week

Responses may include eye blinks, head turns and occasional stare.

Olfactory Stimulation Activity (Communication)

The teacher will present various scents under the student's nose one at a time pausing between each scent. The teacher will then tell the student's what they are smelling. Look for a response! The scents will include garlic, rose and peanut butter.

Responses to look for might include smiles, grimaces, head turns, eye blinks, sounds, etc.

Tactile Stimulation Activity (Communication)

Teacher will present students with feathers and burlap textures to elicit a response. An up and down motion will be used on both arms. Responses to look for will include head turns, eye blinks, grimaces, sound, laughter, smiles, crying, etc.

Auditory Stimulation Activity (Motor Development)

The teacher will give the student a switch to activate a tape player to listen to auditory stimuli. The student will have 5 trials to maneuver and manipulate in order to hit the switch to allow the tape recorder to operate. Responses to look for will include muscle tightening and head turns.

Visual Stimulation Activity (Motor Development)

Teacher will present the student with the "Disco" light for 5 minutes. Each student will track the lights with their eyes or their head via head turn.

Olfactory Stimulation Activity (Motor Development)

The teacher will present the student with garlic, rose and peanut butter. Each student responds to smell in his or her own way.

Responses to look for include pulling away, turning head, mouth movements, etc.

Tactile Stimulation Activity (Motor Development)

The teacher will present the student with feathers and burlap. Each student will respond with some kind of body movement. Some responses may include pulling away and head turns.

Data Collection

Data collection will be in the form of verbal and non-verbal responses. Each individual will have their own weekly chart. Their responses will be recorded in a form of a check mark, which indicates a response and a circle, which indicates no response. This will be done 3 days a week for 4 weeks. At the end of the 4 weeks, the data collected will be evaluated.

Student ____
Week ____

Non-verbal Response: pulling away, head turn, mouth movements, muscle tightening, eye tracking, eye blinks, grimaces, and smiles.

Verbal Response: laughter, vocalizations/sounds, yes/no eye gaze response board.

Dates _____

Activity	**Non-Verbal Response**			**Verbal Response**		
Auditory Stimulation Activity (Communication)						
Visual Stimulation Activity (Communication)						
Tactile Stimulation Activity (Communication)						
Olfactory Stimulation Activity (Communication)						
Auditory Stimulation Activity (Motor Development)						
Visual Stimulation Activity (Motor Development)						
Tactile Stimulation Activity (Motor Development)						
Olfactory Stimulation Activity (Motor Development)						

CHAPTER IV

DATA ANALYSIS

The reason for this study was to determine if sensory stimulation has an effect on communication skills and motor development in students with Traumatic Brain Injury as compared to students with Developmental Disabilities. It was hypothesized that sensory stimulation has an effect on the communication skills and motor development on the students with Traumatic Brain Injury (TBI) as compared to the students with Developmental Disabilities. The following study was conducted on four students to see how sensory stimulation plays a part in the development of the students' communication and motor skills.

To establish change over time, the students' communication and motor skills were observed three times a week for four weeks. Eight domains were covered. Individual charts were used to monitor their responses. Responses could be verbal or non-verbal. A check marked a response. A circle marked no response. Students A and B have been identified as having a Traumatic Brain Injury (TBI). Students C and D have congenital Developmental Disabilities.

During the Auditory Stimulation Communication Activity, student A responded 100% of the time. He responded 84% of the time to the Visual Stimulation Communication Activity, 92% of the time to the Tactile Stimulation Communication Activity, 97% of the time to the Olfactory Stimulation Communication Activity. Student A responded 92% of the time to the Auditory Stimulation Motor Development Activity,

58% of the time to the Visual Stimulation Motor Development Activity, 75% to the Olfactory Stimulation Motor Development Activity, and 58% to the Tactile Stimulation Motor Development Activity. For the communication activities, student A responded by smiling and eye blinks. He responded to the motor activities through arm, mouth, hand, finger, and wrist movements. He also responded with eye movement and tightening of his muscles.

Student B responded to the Auditory Stimulation Communication Activity 84% of the time, the Visual Stimulation Communication Activity 75% of the time, Tactile Stimulation Communication Activity 92% of the time, the Olfactory Stimulation Communication Activity 95%. Student B responded to the Auditory Stimulation Motor Development Activity 83% of the time, the Visual Stimulation Motor Development Activity 100%, the Olfactory Stimulation Motor Development Activity 100%, of the time and the Tactile Stimulation Motor Development Activity 100%. She responded to the communication activities through her eye gaze response board to indicate a yes/no response. Student B responded to the motor activities through mouth and arm movements, facial expressions, and by lifting and turning her head.

Student C responded non-verbally to the Auditory Stimulation Communication Activity 100% of the time and simultaneously responded 17% verbally. He smiled and vocalized by laughing and making sounds during this activity. There was 0% response to the Visual Stimulation Communication Activity. Again Student C responded Non-verbally 58% of the time to Tactile Stimulation Communication Activity and 9% of the time verbally. He responded 39% of the time to the Olfactory Stimulation Communication Activity. Student C responded to the Auditory Stimulation Motor Development Activity 67% of the time, to the Visual Stimulation Motor Development

Activity 8% of the time, to the Olfactory Stimulation Motor Development Activity 39% of the time, and to the Tactile Stimulation Motor Development Activity 54% of the time. He responded to the motor activities through inconsistent arm and leg movements. Student C frequently responded to these activities by turning his head.

Student D responded 100% of the time either verbally or non-verbally to the Auditory Stimulation Communication Activity and 33% of the time to the Visual Stimulation Communication Activity. She responded 63% of the time either verbal or non-verbal to the Tactile Stimulation Communication Activity. Student D responded 42% of the time either verbally or non-verbally to the Olfactory Stimulation Communication Activity. She responded by vocalizing both pleasant and unpleasant sounds. Other responses noted were facial expressions such as smiles as well as grimaces. Student D responded to Motor Development Activities through head, mouth, and leg movements. She responded to the Auditory Stimulation Motor Development Activity 68% of the time, 25% of the time to the Visual Stimulation Motor Development Activity, 56% of the time to the Olfactory Stimulation Motor Development Activity, and 71% of the time to the Tactile Stimulation Development Activity.

Table 1

Percentage of Non-verbal and Verbal Responses for Student A from Week 1 to Week 4

	Non-Verbal Response				Verbal Response			
Student A	Week 1	Week 2	Week 3	Week 4	Week 1	Week 2	Week 3	Week 4
Auditory Stimulation Communication Activity	100%	100%	100%	100%				
Visual Stimulation Communication Activity	67%	100%	67%	100%				
Tactile Stimulation Communication Activity	67%	100%	100%	100%				
Olfactory Stimulation Communication Activity	78%	100%	100%	100%				
Auditory Stimulation Motor Development Activity	67%	100%	100%	100%				
Visual Stimulation Motor Development Activity	33%	33%	100%	67%				
Olfactory Stimulation Motor Development Activity	22%	78%	100%	100%				
Tactile Stimulation Motor Development Activity	0%	33%	100%	100%				

Student A responded to all of the communication activities through eye blinks. He responded to the Auditory Stimulation Communication Activity consistently 100% of the time from weeks 1 through 4.

On one occasion during the first week, student A was seen at the bedside because of illness. During the Visual Stimulation Communication Activity, he went from 67% the

first week to a 100% response on week 2. He made a choice of colors via eye blinks. On week 3, his response to the activity decreased to 67%. He appeared to not want to be bothered and wasn't as responsive. His response increased to 100% on week 4.

During the Tactile Stimulation Communication Activity, his response to the textures went from 67% the first week to a consistent 100% weeks 2, 3, and 4.

He responded to the Olfactory Stimulation Communication Activity, 78% of the time during the first week and then his responses to the scents increased to 100% of the time weeks 2, 3 and 4.

During the Auditory Stimulation Motor Development Activity, student A responded by moving his hands and wrists. His movements increased from 67% on week 1 to 100% on weeks 2, 3, and 4.

Student A responded to the Visual Stimulation Motor Development Activity by tracking the stimuli with his eyes. The first and second weeks he responded 33% of the time. On the third week his response increased to 100% of the time. On week 4, his response decreased to 67% because on one occasion he kept his eyes shut.

Student A responded to Olfactory Stimulation Motor Development Activity through hand and arm movements. He had a significant increase in hand and wrist movements from 22% in week 1 to 78% in week 2. He steadily progressed from 78% on week 2 to 100% on weeks 3 and 4, exhibiting both hand and arm movements.

Student A had no response to the Tactile Stimulation Motor Development Activity On week 1. On week 2 he responded 33% with figure movements and muscle tightening. On weeks 3 and 4, he responded 100% to the stimuli. He made tremendous progress through hand and arm movements.

Table 2

Percentage of Non-verbal and Verbal Responses for Student B from Week 1 to Week 4

	Non-Verbal Response				Verbal Response			
Student B	Week 1	Week 2	Week 3	Week 4	Week 1	Week 2	Week 3	Week 4
Auditory Stimulation Communication Activity					67%	67%	100%	100%
Visual Stimulation Communication Activity					100%	67%	33%	100%
Tactile Stimulation Communication Activity					67%	100%	100%	100%
Olfactory Stimulation Communication Activity					100%	89%	89%	100%
Auditory Stimulation Motor Development Activity	33%	100%	100%	100%				
Visual Stimulation Motor Development Activity	100%	100%	100%	100%				
Olfactory Stimulation Motor Development Activity	100%	100%	100%	100%				
Tactile Stimulation Motor Development Activity	83%	100%	100%	100%				

Student B responded to all communication activities via an eye gaze board. During the Auditory Stimulation Communication Activity, She responded 67% of the time on weeks 1 and 2. Her response to the music activity increased to 100% weeks 3 and 4.

During the Visual Stimulation Activity, she chose a color 100% of the time on week 1. However, on week 2, her response decreased to 67% due to fatigue during one of the sessions. On the third week, her response further decreased to 33% due to sleepiness. During the fourth week, her arousal level increased and she responded 100% of the time.

Student B responded to the Tactile Stimulation Communication Activity 67% of the time the first week and had an increase in the response to the texture 100% of the time weeks 2, 3, and 4.

During the first week of the Olfactory Stimulation Communication Activity, she responded 100% of the time. However, there was a decrease to 89% on weeks 2 and 3. She appeared to not want to be bothered one time on each week. On week 4, her responses increased to 100%.

Student B responded to the Auditory Stimulation Motor Development Activity with head movements which increased from 33% the first week to 100% on week 2, 3 and 4.

With the Tactile Stimulation Motor Development Activity, she responded with head and arm movements 83% of the time on week 1. Her responses increased to 100% of the time on weeks 2, 3, and 4.

With both Visual and Olfactory Stimulation Motor Development Activities, she responded with head movements 100% of the time on all four weeks.

Table 3

Percentage of Non-Verbal and Verbal Responses for Student C from Week 1 to Week 4

	Non-Verbal Response				Verbal Response			
Student C	Week 1	Week 2	Week 3	Week 4	Week 1	Week 2	Week 3	Week 4
Auditory Stimulation Communication Activity	100%	100%	100%	100%		17%	33%	17%
Visual Stimulation Communication Activity	0%	0%	0%	0%				
Tactile Stimulation Communication Activity	50%	33%	50%	83%			17%	17%
Olfactory Stimulation Communication Activity	0%	11%	67%	78%				
Auditory Stimulation Motor Development Activity	0%	67%	100%	100%				
Visual Stimulation Motor Development Activity	0%	17%	0%	0%				
Olfactory Stimulation Motor Development Activity	0%	22%	67%	67%				
Tactile Stimulation Motor Development Activity	17%	33%	83%	83%				

Although the researcher was just looking for any response, there were times that student C displayed both verbal and non-verbal responses simultaneously. Student C responded non-verbally 100% of the time to the Auditory Stimulation Communication Activity weeks 1 through 4 by smiling to the music. He vocalized 17% on week 2 and 33% on week 3. On week 4 his verbal response decreased to 17%.

Student C had no response to the Visual Stimulation Communication Activity. Student C is cortically blind.

During the Tactile Stimulation Communication Activity, student C responded non-verbally 50% of the time on week 1 and non-verbally 33%of the time on week 2. The researcher was unable to explain the decline in response. On week 3, he responded non-verbally 50% of the time and verbally 17% of the time. He displayed smiles and some vocalizations. His non-verbal responses increased to 83% on week 4 while his verbal responses stayed the same at 17%.

Student C had no response to the Olfactory Stimulation Communication Activity during week 1. On week 2, he responded to the smells 11% of the time by smiling. On week 3, he responded 67% of the time with smiles. By week 4, his responses increased to 78% of the time.

During the Auditory Stimulation Motor Development Activity, student C had no response on week 1. He responded 67% of the time on week 2 by turning his head. This response to the stimuli increased on weeks 3 and 4 to 100 %.

Because student C is cortically blind, he had no responses on weeks 1, 3, and 4. However, he responded by head movement on week 2 just one time. The researcher thinks that this could have been a response to a noise from the surrounding environment.

Student C had no response to the Olfactory Stimulation Motor Development Activity on week 1. On week 2, he responded with head and mouth movements 22% of the time. Weeks 3 and 4 he responded 67% of the time with head, mouth, and arm movements.

During the Tactile Stimulation Motor Development Activity, he responded 17% of the time on week 1, 33% on week 2 and he increased to 83% of the time on weeks 3 and 4. His responses included arm, mouth, head, and some leg movements.

Table 4

Percentage of Non-verbal and Verbal Responses for Student D from Week 1 to Week 4

	Non-Verbal Response				**Verbal Response**			
Student D	Week 1	Week 2	Week 3	Week 4	Week 1	Week 2	Week 3	Week 4
Auditory Stimulation Communication Activity			67%	67%	100%	100%	33%	33%
Visual Stimulation Communication Activity	0%	0%	33%	0%				
Tactile Stimulation Communication Activity	67%	17%	50%	33%	17%	0%	17%	50%
Olfactory Stimulation Communication Activity	11%	22%	56%	33%	11%	22%	11%	11%
Auditory Stimulation Motor Development Activity	100%	67%	33%	67%				
Visual Stimulation Motor Development Activity	33%	0%	67%	0%				
Olfactory Stimulation Motor Development Activity	11%	67%	78%	67%				
Tactile Stimulation Motor Development Activity	50%	67%	83%	83%				

Student D responded verbally to the Auditory Stimulation Communication Activity 100% of the time on week 1 with calm vocal sounds. On week 2 she responded verbally 100% of the time with louder vocal sounds. On the third week, she responded non- verbally 67% of the time by shaking her head and arms in agitation and 33% of the time verbally with loud agitated vocalizations. On week 4, she responded non-verbally 67% of the time with smiles and appeared to be relaxed. She also responded verbally 33% of the time with a calming quiet sound.

Student D had no response to the Visual Stimulation Communication Activity on weeks I and 2. However, on week 3 she responded 33% of the time. She showed a response by staring at her color of choice. The researcher was not sure if this was purposeful because she decreased to no response on week 4.

This student responded both verbally and non-verbally 3 out of 4 weeks to the Tactile Stimulation Communication Activity. On week 1, she responded to the textures 67% of the time by grimacing and pulling away and 17% of the time verbally with agitated sounds. On week 2, she responded 17% of the time non-verbally by smiling and had no verbal responses. On week 3, she responded 50% of the time with smiles and frowns and responded vocally 17% of the time. On week 4, her non-verbal response decreased to 33%. She was Tactile defensive. Her verbal response increased to 50%; she whined.

Student D responded to the Olfactory Stimulation Communication Activity 11% of the time both verbally and non-verbally on week 1. Her response increased on week 2 to 22% of the time both verbally and non-verbally. On week 3, she responded non-verbally 56% of the time to the smells by smiling and/or grimacing and 11% of the time

with vocalizations. On week 4, her non-verbal responses decreased to 33%. She was agitated. Her verbal response was 11% and she whined.

During the Auditory Stimulation Motor Development Activity, student D responded 100% of the time on week 1 through arm movements. On week 2, her responses decreased to 67%. She was agitated. On week 3, she responded 33% of the time. She was very irritated. However, on week 4, she responded 67% of the time and still appeared agitated with the activity.

On week 1 student D responded 33% of the time to the Visual Stimulation Motor Development Activity by moving her head from left to right to track the lights. She had no response on week 2. She appeared uninterested and irritated. On week 3, student D showed more interest in the activity and responded 67% of the time. Once again she appeared agitated on week 4 and had no response.

On week 1 student D responded 11% of the time to the Olfactory Stimulation Motor Development Activity through head movements. Her responses to the scents increased on week 2 to 67%. She responded with head, mouth, and arm movements. On week 3, her responses increased to 78%. On week 4, her responses decreased to 67%. She was agitated.

Student D responded to the Tactile Stimulation Motor Development Activity by pulling away, moving her arms, head, and kicking. On week 1, she responded 50% of the time. Her responses increased to 67% on week 2. On weeks 3 and 4, her responses increased to 83% of the time.

Figure 1

Student A – Sensory Stimulation Communication Activities

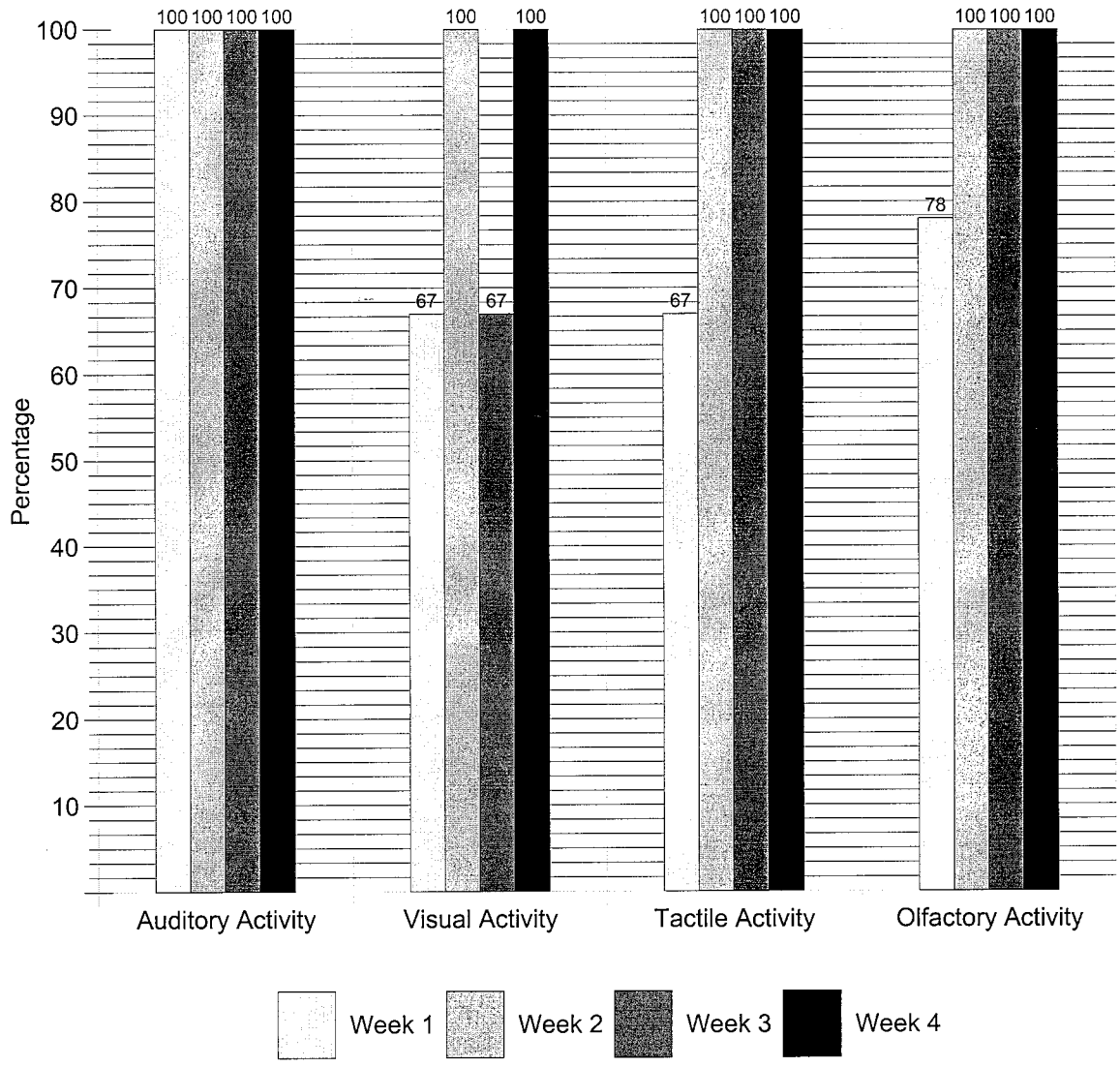


Figure 2

Student A – Sensory Stimulation Motor Development Activities

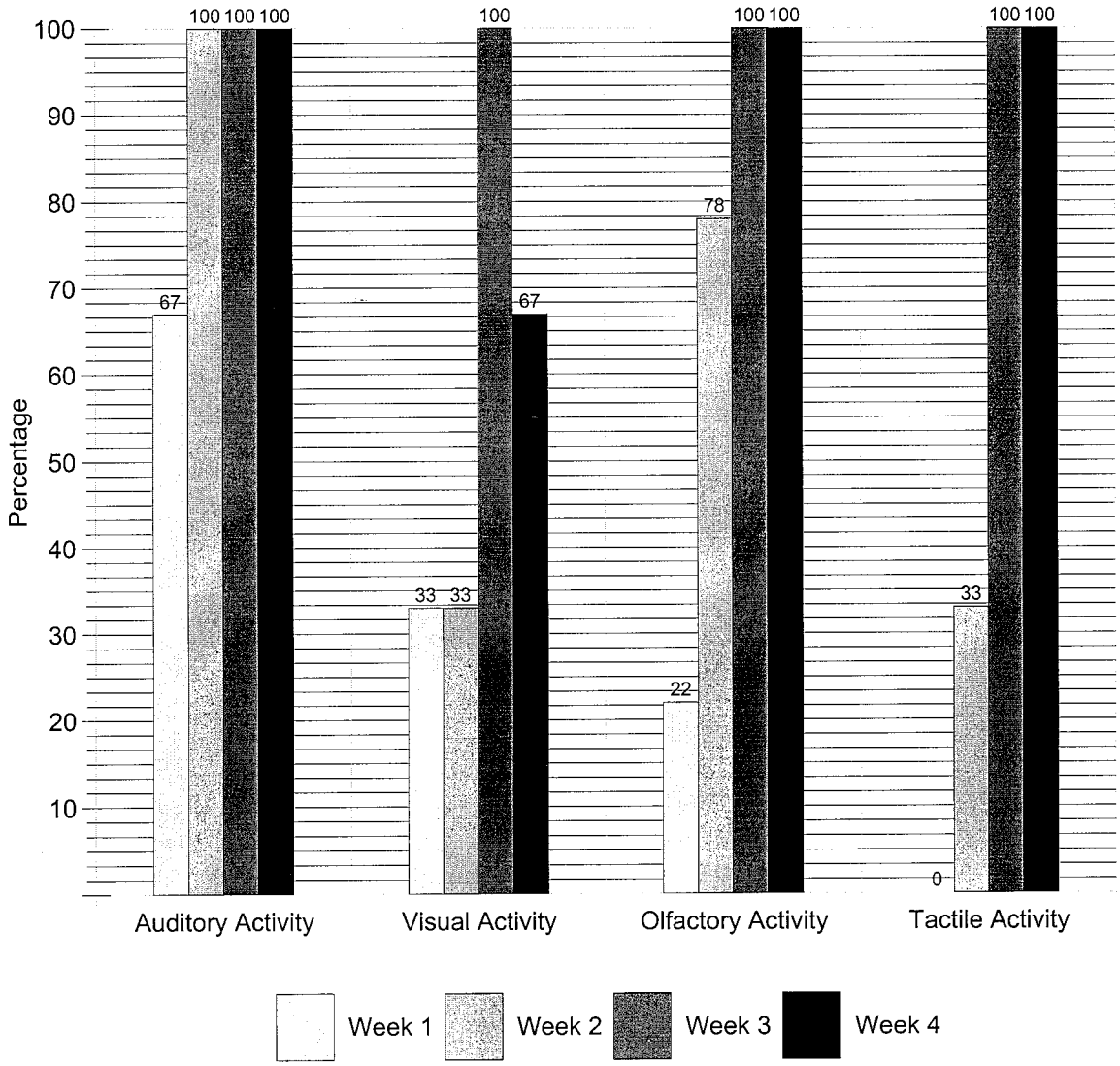


Figure 3

Student B – Sensory Stimulation Communication Activities

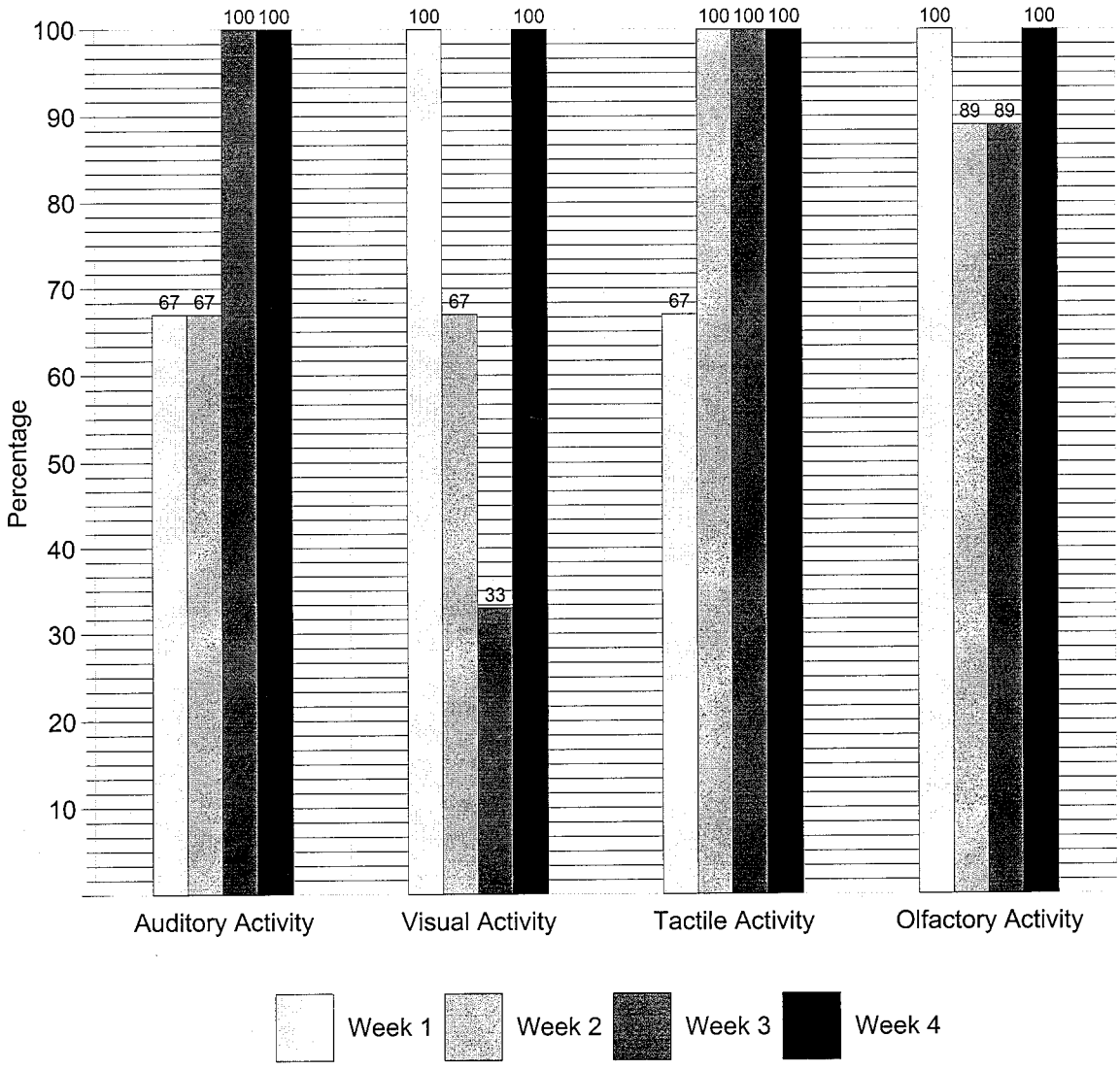


Figure 4

Student B – Sensory Stimulation Motor Development Activities

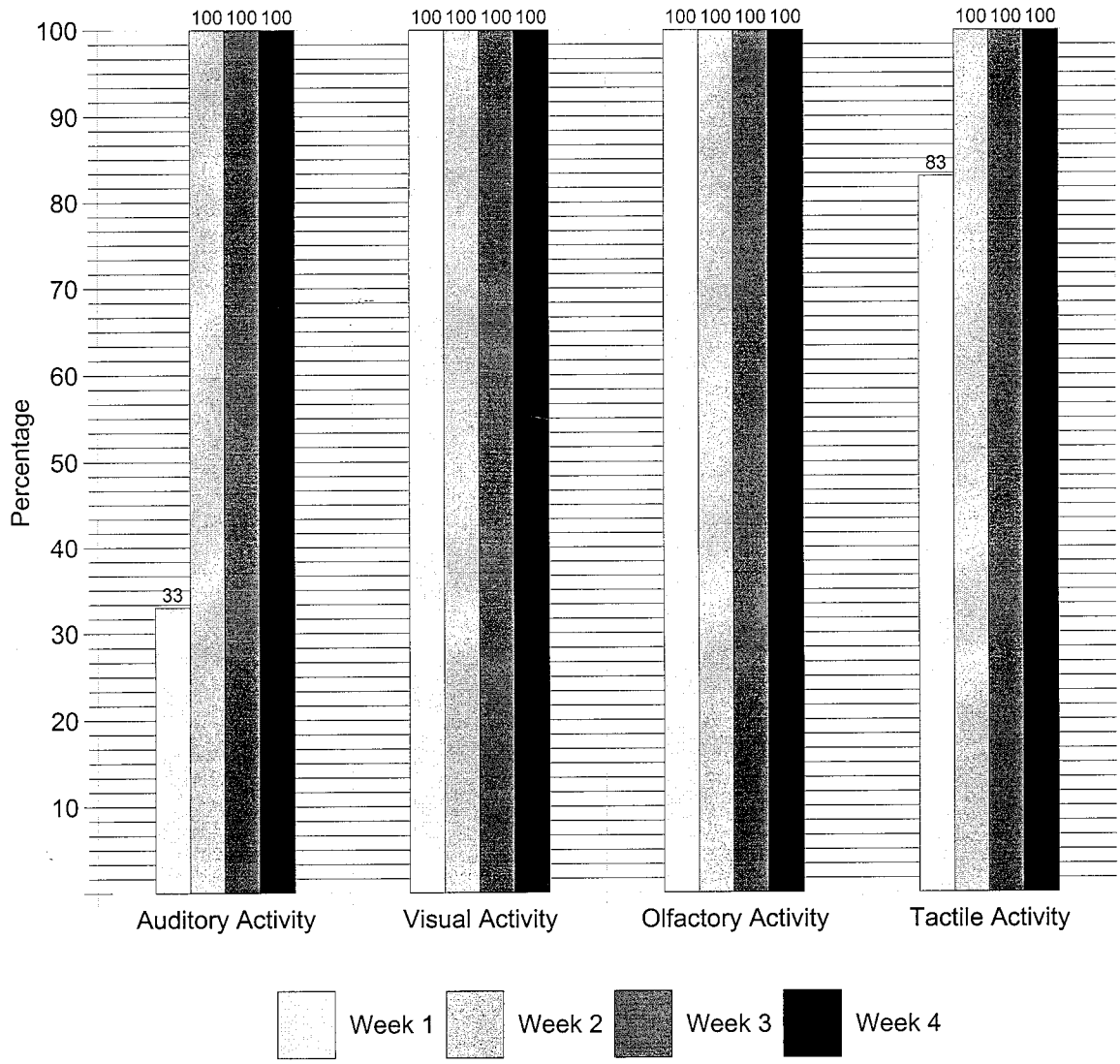


Figure 5

Student C – Sensory Stimulation Communication Activities

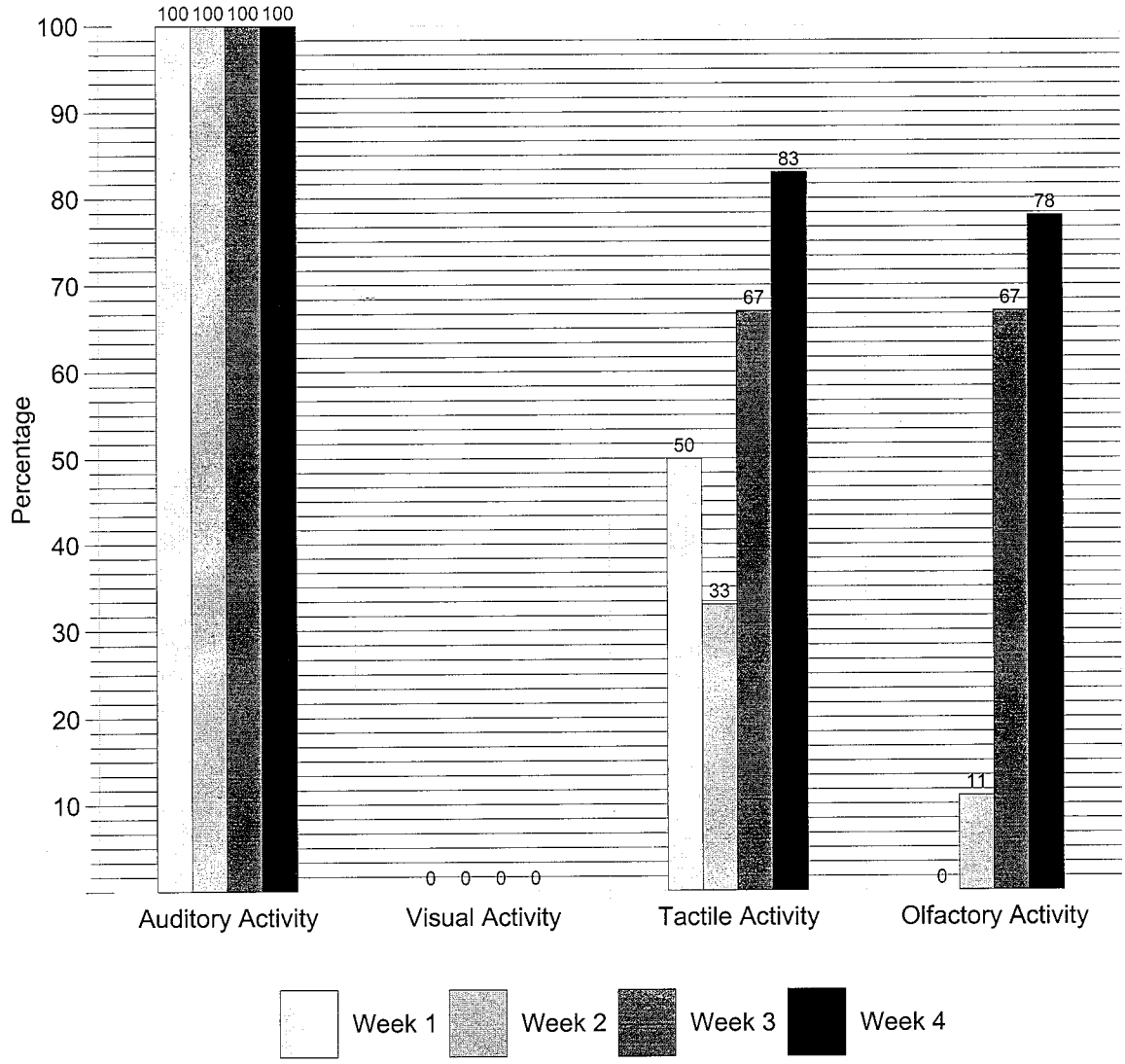


Figure 6

Student C – Sensory Stimulation Motor Development Activities

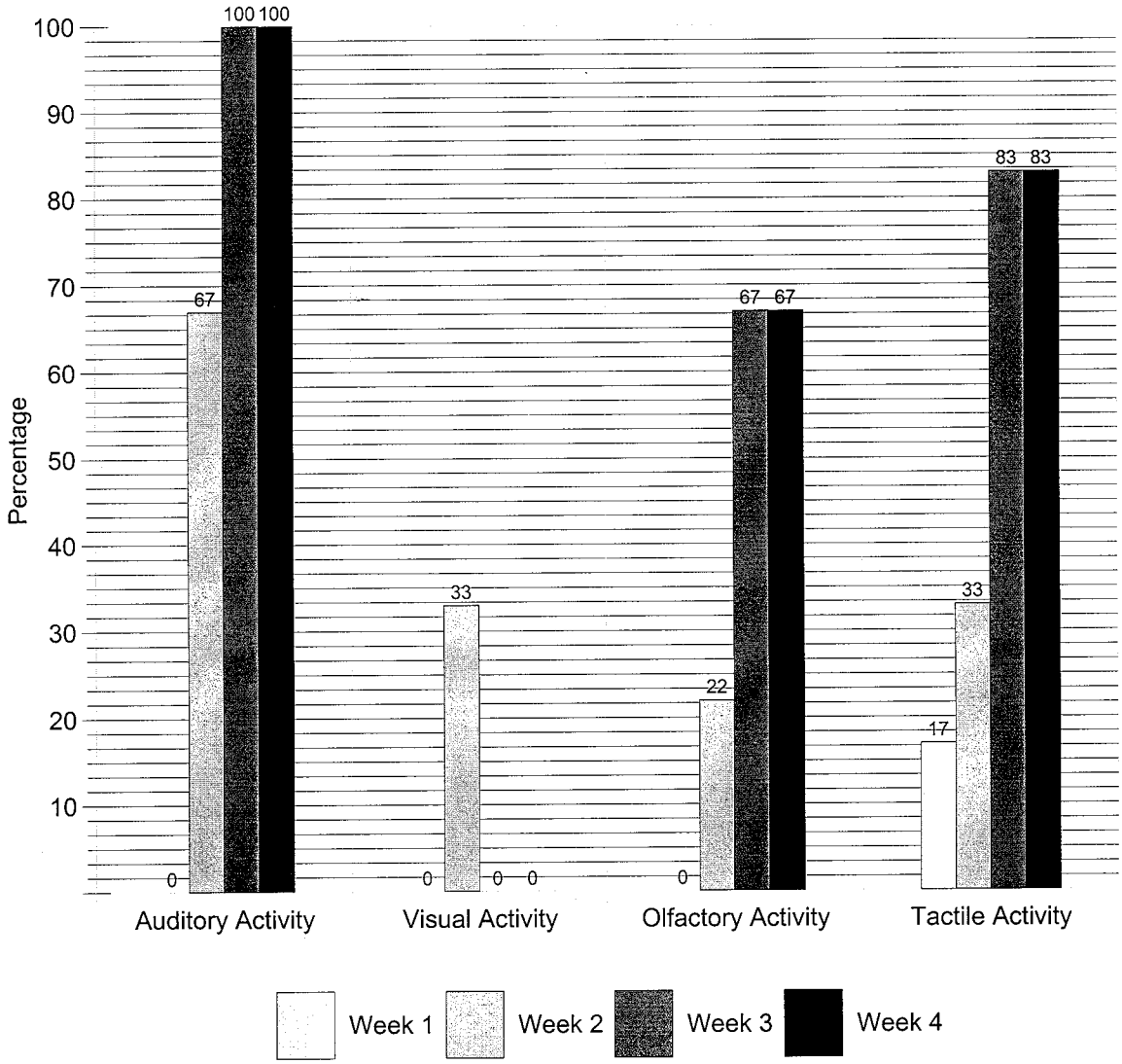


Figure 7

Student D – Sensory Stimulation Communication Activities

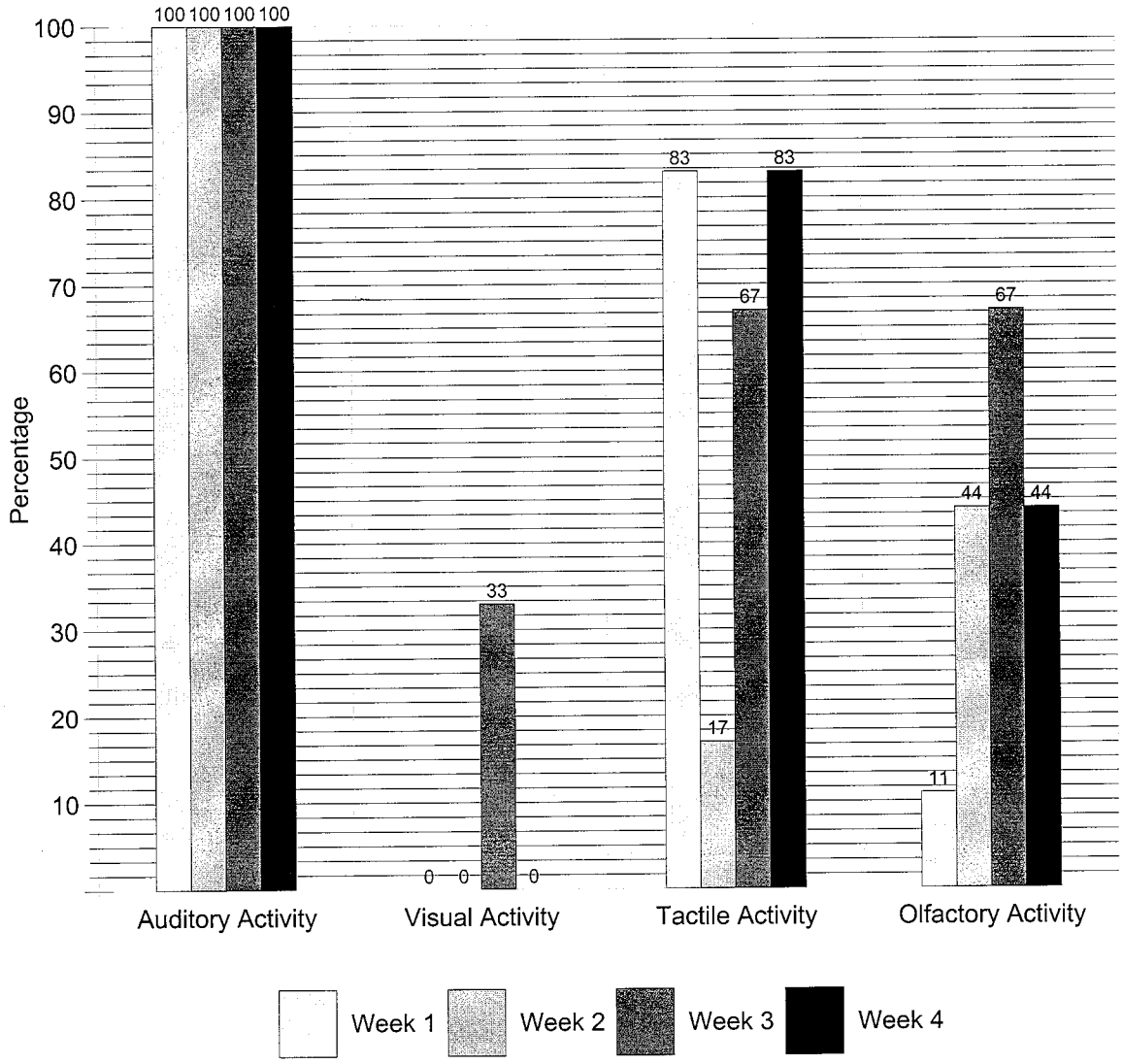
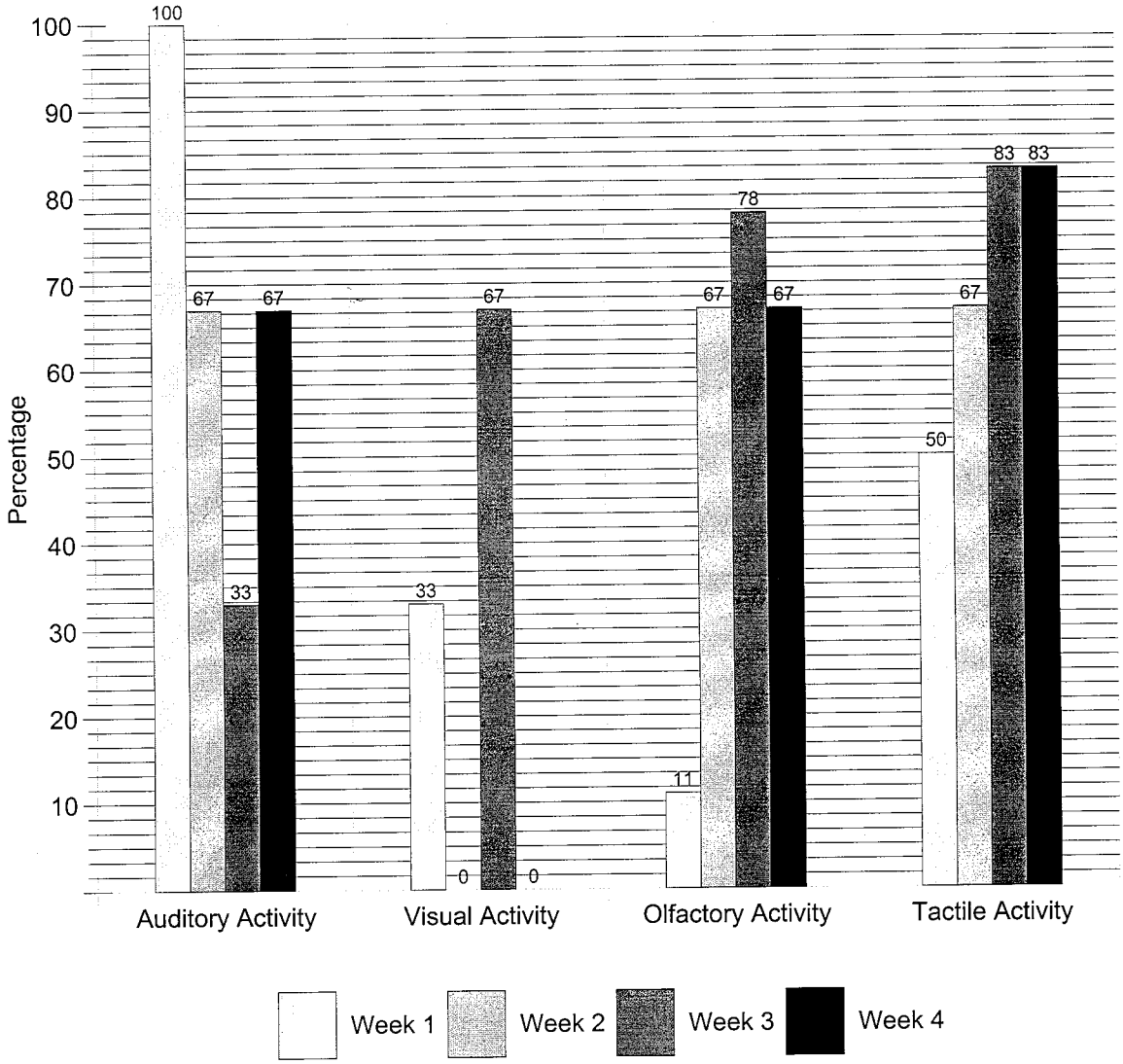


Figure 8

Student D – Sensory Stimulation Motor Development Activities



CHAPTER V

SUMMARY AND CONCLUSION

The research question that was examined in this study was, does Sensory Stimulation have an effect on communication skills and motor development in students with Traumatic Brain Injury as compared to the Individuals with Developmental Disabilities?

It was hypothesized that sensory stimulation has an effect on the communication skills and the motor development of the students with Traumatic Brain Injury as compared to individuals with Developmental Disabilities. In this study, I have found Sensory Stimulation to be most beneficial. All four students showed some type of improvement with the Traumatic Brain Injured students responding significantly higher than the Developmentally Disabled student.

Student A's, (Traumatic Brain Injured), responses to the Auditory Stimulation Communication Activities were consistent throughout the four weeks. He showed an increase to all stimuli presented.

Student B's, (Traumatic Brain Injured), responses were consistent all four weeks in the Visual Stimulation Motor Development Activities and the Olfactory Stimulation Motor Development Activities. She steadily increased in all other activities presented.

Student C's, (Developmentally Disabled), responses to the Auditory Stimulation Communication Activities and the Visual Stimulation Communication Activities remained the same for the four weeks. He did show improvement in all but two areas of

stimuli. These were the Visual activities. This was most likely due to his diagnosis of cortical blindness.

Student D, (Developmentally Disabled), had both verbal and non-verbal responses to stimuli. She responded more often to the Auditory Stimulation Communication Activities. Overall, her responses to all the activities increased with the exception of the Visual activities.

There was a noticeable difference in the responses of students A and B as compared to students C and D. The fact that the two Traumatic Brain Injured students A and B did so well reinforces Kater's (89) study. She explains in her study that patients who were exposed to "enriched environment" before their injury faired better than those individuals who did not have such experiences.

The two Developmentally Disabled students, C and D, showed some improvement during this study. In chapter two, Doman (80) advocates the need for a full sensory stimulation program. According to him, the degree of success in how a patient recovers to his fullest potential depends on the intensity of the sensory stimulation that the individual receives.

Limitations

Although the results of this study were positive, it had some limitations. Some of the variables that impacted the study were sickness. fatigue, teacher adjustment, and student agitation. At one point, student A was tutored at the bedside rather than the classroom due to illness. This may have effected his responses to the sensory stimulation. The following day he was hospitalized.

Student B was not a student in my classroom. She had to adjust to me as a teacher. However, she was always cooperative. At times, she was tired and sleepy. Her responses decreased at times due to fatigue.

Student C didn't response to the Visual Stimulation Communication Activity because he is cortically blind. However, he had an overwhelming positive response to the Auditory Stimulation Activities. He appeared joyful and happy.

Student D was almost always agitated and didn't want to be bothered with the Visual Stimulation.

All of the students attended every school session. However, illness, fatigue and agitation impacted the results of the study. Because of these variables, the students had difficulty at times concentrating on the activities presented.

Recommendations

Because my study was of short duration, three times a week for four weeks and had such a positive outcome, I recommend that further scientific research be continued in this area. A structured sensory stimulation program could be developed. This program could have two groups that would include a Traumatic Brain Injured Group and a Developmentally Disabled Group. The students could be taken from a larger population with more teacher and classroom involvement. The program could be expanded to five days a week for six months and then evaluated to see how the two groups compared.

I also advocate teaching the use of sensory stimulation to families and caregivers of these students as an extension of this program. This is important because stimulation of the senses will help pathways to be reestablished in the brain. With these new

connections, the students quality of life will be improved thus enabling the student to express his needs through newly developed communication and motor skills.

Conclusion

In conclusion, sensory stimulation did have an effect on the motor development and communication skills of all four students participating in the study. All the students showed some improvement. However, the Traumatic Brain Injured students responded significantly higher than the Developmentally Disabled students. Therefore, this researcher advocates the continuation of increased sensory stimulation to all senses to the Brain Injured population. These individuals deserve every opportunity to reach their fullest potential.

Although there were many variables with the students, this study demonstrated the effectiveness of sensory stimulation on a small diverse population in a very short period of time. These children need more sensory stimulation to the brain in order to survive, grow, and develop. As teachers, we must meet the challenge to do everything possible to help and enhance the students recovery.

BIBLIOGRAPHY

Ansell, B. J. (1991). Slow-to-recover brain injured patients: Rationale for treatment. Journal of Speech and Hearing Research, 34, 1017-1022.

Baker, J. (1988). Explaining coma arousal therapy. The Australian Nurses Journal, 17(11).

Chaney, R. H., Givens, C. A., Aoki, M. F., & Gominer, M. L. (1989). Pupillary responses in recognizing awareness in persons with profound mental retardation. Perceptual and Motor Skills, 69, 523-528.

Chase, M. (1999, October 29). New behavior therapy for kids uses touch, tones trampolines. The Wall Street Journal, p. B1.

DeYoung, S., & Grass, R. B. (1987). Coma recovery program. Rehabilitation Nursing,12(3), 121-124.

Doman, R. (1982). Coma. Journal of the National Academy for Child Development, 2(1).

Doman, R. (1980). Sensory stimulation. Journal of the National Academy for Child Development, 1(1).

Doman, R. J. (1984). Sensory deprivation. Journal of the National Academy for Child Development, 4 (3).

Glover, E., & Mesibov, G. B. (1978). An interest center sensory stimulation program severely and profoundly retarded children. Education and Training of the Mentally Retarded 13 (2), 172-176.

Houghton, S., Douglas, G., Brigg, J., & Langsford, S., et al. (1998). An empirical evaluation of an interactive multi-sensory environment for children with disability. Journal of Intellectual & Developmental Disability 23(4), 267-278.

Kater, K. M. (1989). Response of head-injured patients to sensory stimulation. Western Journal of Nursing Research 11(1), 20-33.

Kater, K. (1989). Sensory stimulation in head-injured patients. Nursing Times, 85(32), 61.

Kirkman, S. (1992, February 21). Scent and sensibility. The Educational Supplement, 3947.

Kraemer, B. R., & Blacher, J. (1997). Acquired Brain Injury. Chapter 1. Maryland: Paul H. Brooks.

Mitchell, S., Bradley, V. A., Welch, J. L., & Britton, P. G. (1990). Coma arousal procedure: A therapeutic intervention in the treatment if head injury. Brain Injury, 4(3). 273-279.

Nicolls, J. (1986, August 27). A viable approach to long-term coma care. Physical Therapy Forum with Occupational Therapy Forum, V 35, A1.

Silverman, R. (1984). Trauma recovery. Journal of the National Academy for Child Development, 4(1).

Wells, M. E., & Smith, D. W. (1983). Reduction of self-injurious behavior of mentally retarded persons using sensory-integration techniques. American Journal of Mental Deficiency, 87(60), 664-666.

Zasler, N. Ask the doctor. Brain Injury Source, 1(1) [www.biausa.org/Askdoctor/comastim.htm].