IMPROVING LANGUAGE AND SOCIAL SKILLS IN AUTISM

SPECTRUM DISORDER USING COMPUTER BASED

TRAINING: A CASE STUDY

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A Thesis

Presented

to the Faculty of

California State University, Chico

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In Partial Fulfillment

of the Requirements for the Degree

Master of Arts

in

Teaching International Languages

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by

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Fall 2013

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DEDICATION

I would like to dedicate this thesis to my sons,

Eric and Sean

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I would like to express my sincere gratitude to Dr. Hilda Hernández for her continuous support during the Teaching International Languages Master's Program and while serving as committee chair for this thesis. Professor Hernández's passion and excitement for teaching and research will always stay with me. She planted the seed for this thesis and it grew. Without her supervision and constant help, this thesis would not have been possible.

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I would like to thank all my family members, especially my sisters, for believing in me and saying that I could do it. Finally, my special thanks go to my husband Charlie for his patience, understanding, and unending support. Without his encouragement, I would not have been able to pursue this degree.

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ABSTRACT

IMPROVING LANGUAGE AND SOCIAL SKILLS IN AUTISM

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There has been increasing incidence and awareness of autism spectrum disorders in recent years. Improved outcomes due to early intervention and continued assistance throughout the school years have created the need for ongoing support for adults on the autism spectrum. Recent advances in computer technology and understanding of the human brain offer the possibility that specific computer based training may provide a cost effective means to deliver this necessary support. The affinity of individuals with autism towards all things computer combined with the limited side effects and availability anywhere, anytime, are a winning combination.

This case study examined to what extent, if any, training software produces improvements in the language and social skills of a bilingual, young adult who has autism. Primary focus was on working memory, sequencing, and facial recognition. This

study involved pre and post testing, using real-world tasks, to measure the effects of using the Posit Science computer based training programs designed to improve language and social skills. Results suggest that computer based training was beneficial for the participant in these areas.

Previous research conducted in this field has been encouraging, but limited in scope or generalized from individuals with related neurological conditions. More research is needed in this area and it is recommended that software designed specifically for individuals with autism be developed and used. Larger populations and longer time commitments are also necessary to determine if programs like this could be beneficial for other individuals on the autism spectrum.

CHAPTER I

INTRODUCTION

Background

This research is a case study of a thirty-year old bilingual male, who has autism and his response to a computer based training program. The participant's mother is a German native living in the United States and fluent in both English and German. His father, a native English speaker, spoke both English and German with the participant. The participant responded to and spoke both languages without difficulty for the first three years of his life. Based on regular pediatric visits and reports from his parents, the participant's development and language skills were completely typical for his age. Parents reported significant changes in development occurred shortly after turning three years old.

The participant began his education in a parent-participation pre-school that required a parent accompany him anytime he was there. In kindergarten, the participant attended a special school primarily for Down syndrome students and others with severe disabilities. In first and second grade, the participant was in a self-contained special education classroom at a Department of Defense school in Japan with four other students, a teacher, and an aide. The participant's school day was reduced to 2 ½ hours. During this time, the pediatric neurologist first used the label "PDD" (Pervasive Developmental Disorder) to describe the participant's condition. The school psychologist suggested at

1

an IEP meeting that the participant would never be able to read or write and his training should focus on survival skills.   He suggested that time spent on attempting academics would be a waste. Years later, when the participant attended high school in Japan, this same school psychologist was forced to admit that he was mistaken about the participant's abilities.

Beginning third grade at a Department of Defense school in Germany, the participant was mainstreamed in a regular classroom with a one-on-one aide and attended some classes in the resource room. He received intermittent speech therapy and occupational therapy. This pattern continued until his high school graduation from a Department of Defense high school in Japan. By this time, the PDD diagnosis had been altered to high functioning autism disorder. In 2001, he attended a community college where he had support from the disability office in the form of note takers, occasional tutors, and extra time on tests in a quiet location. He taped all lectures. The participant completed his AS degree in computer electronics in 2005 with a GPA of 3.98.

The participant still lived with his parents and had several short periods of employment. During this time period, he took additional classes at the junior college to finish Cisco and Microsoft certifications. He also received his driver's license in 2007, though he still drives with a parent in the car for navigational and general driving support. Due to the economic environment and limited job opportunities, the participant decided he wanted to complete a Bachelor's degree in computer science at California State University, Chico. In order to qualify for the junior transfer program to CSU Chico, the participant had to take additional courses at the two-year college. His parents and college

counselor advised that he take the less rigorous computer information system major, because the computer science major required calculus and physics and the participant's high school math preparation barely went past Algebra 1. Upon completion of a survey of calculus course and statistics course, the instructor convinced the participant he should try full-blown calculus for the higher major. Subsequently, the participant aced three semesters of calculus and two semesters of physics. He is currently a senior at CSU Chico, majoring in computer science, and expected to graduate in December, 2013.

Despite the participant's academic successes, autism still severely limits social interaction. He shares an apartment with his parents in Chico. They provide a great deal of support at home with organization and time management. His struggle with facial recognition and other social skills remains problematic. Among other areas, he has difficulty with interpreting non-verbal communication, auditory processing, and task sequencing. Even though the participant has surpassed expectations, his parents still seek ways to help him lead a more normal life.

When the participant first started working on driving and taking difficult classes at the junior college, his father heard about Posit Science's success in a number of cognitive functions using computer based training programs. The participant used a visual enhancement program that reportedly helped his field of vision for driving and reactions. He also took a brain fitness course and reported that it helped him with listening and understanding in college classes, though there was no scientific study involved at the time.

The participant agreed to participate in this case study, hoping to benefit from the new Posit Science programs focusing on language and social skills. Though the

participant is legally independent, his parents are fully supportive of his involvement with this project. He completed the program during summer break.

Statement of the Problem

This study seeks to determine the effectiveness of Posit Science computer based training in improving language and social skills for a bilingual participant with autism. Previously, the programs have been mostly researched with other disorders related to aging, stroke, traumatic brain injury, and similar neurological events. Results have been positive for people with these disorders and reportedly have improved their quality of life. The participant previously reported visual and cognitive improvements using a different set of programs from Posit Science, though there was no scientific examination of the data at the time.

This study was designed to investigate whether the new programs can produce improvements in language and social skills for a subject with autism and possibly other individuals with similar conditions. This type of computer based training has only been recently developed, and there seems to be scarce research using it with individuals with autism. The focus of most research has been on other neurological conditions. If the program yields significant improvements in language and social skills for the participant, it could increase the likelihood of successful employment and a more independent life.

Purpose of the Study

The purpose of this study is to answer the following questions:

1. To what extent, if any, does training software produce improvements in the language skills of a bilingual, young adult who has autism?

2. To what extent, if any, does training software produce improvements in the social skills of a bilingual, young adult who has autism?

Distinctive features of autism, such as hand flapping or insistence on sameness, can also occur in typical children. However, the main feature of autism is uncommon social interaction. Severity of this impairment may vary among individuals, but is so unusual that it cannot be considered to be typical behavior (Benaron, 2009, p. 4). Language difficulties, such as sequencing, expressive and non-verbal communication, are major problems for people on the autism spectrum. This study's main goal is to investigate whether online computer training can improve language and social skills in a bilingual participant who has autism. Another purpose is to raise awareness in parents, educators, and caregivers of this method of training for individuals with autism.

Definition of Terms

Asperger's syndrome

Asperger's syndrome is a subtype of autism. With Asperger's syndrome, people display autistic characteristics, but no delay in language and intellectual development (Frith & Happé, 2005, p. 787).

Autism spectrum disorders

Autism spectrum disorders (ASDs) are described as "a group of developmental disabilities characterized by impairments in social interaction and communication and by restricted, repetitive, and stereotyped patterns of behavior" (Centers for Disease Control and Prevention, 2012, p. 1). While many characteristics of autism are the same, there are also many differences in individuals. This is "referred to as a spectrum disorder – that is, one in which symptoms can occur in many forms and with varying degrees of intensity" (Paula Kluth, 2003, p. 533). Autism spectrum disorder includes "autistic disorder, Asperger disorder, and pervasive developmental disorder not otherwise specified" (Centers for Disease Control and Prevention, 2013, p. 1)

Executive functioning

Executive function is a term used for thinking processes, such as designing a plan and steadily following it to reach a goal. Working memory is part of executive functioning.

High functioning autism

The term High Functioning Autism (HFA) has been used mainly in the U.S. as a label for diagnosis and to receive services (Attwood, T., 1998, p.150); however, it usually describes a person who is more capable and places in the advanced region of the autism spectrum continuum.

Working memory

Working Memory (WM) is the ability to remember steps in a sequence and follow them.

Limitations of the Study

As with any research, there are limitations to this study. In order to get an in-depth view of the problem, a qualitative method case study design was used for this research. However, because this study focused on only one individual and a limited number of studies were consulted, not all perspectives may be included. Another limitation might be that the researcher worked one-on-one with the participant, and, therefore, some investigator bias might be associated with the study. The online training involved considerable time. In order to administer the programs consistently, the participant and his parents agreed it would be best to participate during summer break from college. Because of time constraints, not all programs were finished. This may be reflected in incomplete data. The participant had previous experience with Posit Science, and, therefore, the same company was selected for this study. The software programs used, however, are designed for a broader range of individuals and not specific to the autism spectrum. The impact of the program's application on other individuals with autism cannot be determined.

CHAPTER II

LITERATURE REVIEW

Introduction

This study investigated what, if any, improvement can be achieved using computer based training in a bilingual, young adult who has autism. Two areas were examined: social skills (focusing on facial recognition) and language skills (auditory processing, non-verbal communication and working memory/sequencing).

Individuals with autism have many needs in the area of language and socialization. Some are addressed while in school through training and/or clinical interventions in the form of medication. When individuals reach adulthood, many of the services they receive cease (Sullivan, 2007): "After aging out of school, adult sons and daughters with autism typically either sit at home (and need a caretaker) with no programs, or participate in those which poorly serve their unique needs" (p. 6). Concerned parents look for other alternatives or approaches to improve their young adults' skills and lives. There are interventions using different techniques and measures. The method evaluated in this study differs from previous work as computer based training programs are fairly new, and few studies have been done using this method (Mineo, Ziegler, Gill, and Salkin, 2009, p. 179; Faja, Aylward, Bernier, and Dawson 2008, p. 5). However, findings that new tools like this could help people on the autism spectrum are encouraging (Moore, McGrath, and Thorpe, p. 218).

The purpose of this study was to determine if and to what extent computer based software can improve language and social skills in individuals with autism. The scholars I have consulted are organized first by "background information". This section includes facts about the nature of autism spectrum disorder (ASD), Asperger's Syndrome - a variation of autism on the autism spectrum -, Attention Deficit Hyperactivity Disorder (ADD), and Pervasive Developmental Disorder (PDD). The next section, "bilingualism and autism", addresses issues and views about people with ASD learning multiple languages. After this, research on computerized training is discussed. In the last section, "target areas", the objectives of this study, such as facial recognition, sequencing, language, communication, and social skills are discussed.

Background Information

Although autism spectrum disorder had been observed earlier, it was not until 1943 that two natives of Austria, Leo Kanner (1894-1981) and Hans Asperger (1906-1980), described children with unusual social interaction. Kanner was in the United States and Asperger in Vienna, Austria, when they described the same symptoms in their patients and used the term autism (Lyons and Fitzgerald, 2007, p. 2022). "Autos" is the Greek word for "self" (Benaron, 2009, p. 3). While Kanner's work focused on a more severe form of autism, Asperger's cases dealt with more able children. Asperger was not credited with his accomplishments until after his death in 1980. Lorna Wing, a British psychologist and mother of a child with autism, coined the term Asperger's Syndrome and used it in a paper published in 1981 (Attwood, 1998, p. 15; Benaron, 2009, p. 8).

The nature of autism can be explained in many different ways. An example that people perhaps can relate to is the comparison of the person with autism to that of a foreigner who does not understand the language or the culture of the country he is encountering only that "autistic people are 'foreigners' in any society" (Sinclair, 1993, p. 2). Colman, A. M. (2012) described autism in the Dictionary of Psychology as

> A pervasive developmental disorder characterized by gross and sustained impairments of social interaction and communication; restricted and stereotyped patterns of behavior, interests, and activities; and abnormalities manifested before age 3 in social development, language acquisition, or play. Symptoms may include emotional non-responsiveness, lack of reciprocity in social interaction, failure to develop peer relations, delay or failure of speech development, stereotyped and idiosyncratic language usage or non-verbal behavior (including gaze aversion), insistence on sameness, and ritualized mannerisms. The disorder was first described in 1943 by the Austrian-born US child psychiatrist Leo Kanner (1894-1981).

In Moore, McGrath, and Thorpe (2000) autism is described as a 'triad of impairments' in social interaction, communication, and thinking/behavior areas. A person with autism has problems relating to other people and is often unable to empathize with them. He or she finds it difficult to understand verbal and non-verbal communication and is rigid in thinking, language and behavior. Many scientists currently believe that this is caused by a deficiency in theory of mind, understanding or interpreting the thoughts and actions of others (Jordan, 1991a; Wing, 1996, as cited in Moore et al., 2000, p. 218).

Other terms are used for classification and diagnostic assessment, such as autism spectrum disorder or pervasive developmental disorders. According to the National Institute on Deafness and other Communication Disorders (NIDCD, 2010), autism falls under the group of conditions called "autism spectrum disorders" which can

vary in severity and age of onset. Autism may also be called pervasive developmental

disorder (PDD) which is a broader category marked by delays in areas such as

communication and social interaction (p. 1).

Young adults on the autism spectrum disorder (ASD) have many needs which

are not often addressed in research and literature, because the focus is mainly on children

on the spectrum and their needs (Eaves & Ho, 2008, p. 739). This population

experiences a shortage of interventions which are proven to be effective in improving

social skills (Kandalaft, Didehbani, Krawczyk, Allen, and Chapman, 2012, p. 34). Yet,

these individuals and/or their caregivers need to work on solving their problems and

improve their lives. Rabipour and Raz (2012) reported that especially parents are drawn

to computerized training over the internet to avoid "side-effect-laden medication and

other less conventional options" (p. 159).

The incidence of the broad autism spectrum was estimated to be 1 in 88 in

2008, (Centers for Disease Control and Prevention, 2008, p. 1) and 1 in 50 in 2011-12

(CDC, 2013, p. 2) based on parent reports. Liu, Conn, Sarkar, and Stone (2008) state that

"there is an increasing consensus that intensive behavioral and educational intervention

programs can significantly improve long term outcomes for individuals and their

families" (p. 662). Autism is a life-long condition (NIDCD, 2010, p. 1), and parents

constantly look for ways to better the lives of their children with autism and to promote

their independence. Even though resources and guidance are limited, parents contribute

significantly to their children's success (Attwood, 1998, p. 11).

Through parental perseverance, trial and error, intuition, self-motivation,

constant repetition and reinforcement of concepts that come naturally to typical children,

and daily, often even hourly planning, small steps on a long road are achieved. This is in agreement with Rutter's (2006) assessment that "Despite the urgent need and societal import of intensive treatment (as cited in Liu et al., 2008, p. 662), appropriate intervention resources for children with ASD and their families are often difficult to access and highly expensive" (Tarkan, 2002, as cited in Liu et al., 2008, p. 662). Often it is left to the parents to take the full initiative and explore other alternatives. Options are available, such as the software packages of the advancing computer technology, which address specific deficits in autism, such as social communication and other areas (Liu et al., 2008, p. 663).

One of the biggest problems individuals with ASD face in real life communication is that social situations tend to bewilder them and interpreting gestures or emotions are difficult for them (Hobson et al., 1989; Prior & Ozonoff, 1998; Volkmar et al., 1989, as cited in Bernard-Opitz et al., 2001). One of the positive aspects of computer training programs is that, unlike real life situations, the environment is controlled, proceeding in stages that become incrementally more complex as the program progresses without overwhelming the participant.

Several studies, such as Mineo, Ziegler, Gill, and Salking (2009) state a need for more research about learning if successful findings from computer programs can be transferred to real life contexts (p. 185). In the meantime, there are other benefits for this kind of learning. An example is Bernard-Opitz, Sriram, and Nakhoda-Sapuan's (2001) observation that, "Although real-life practice remains the most important part of social problem solving, computer based simulations might be a non-threatening starting point

for individuals with autism, contributing to the facilitation of better social and communicative competence" (p. 384).

Bilingualism and Autism

Given the constraints of living with autism, it is difficult for many parents to decide if they should raise their child bilingually. Little information is available on this topic. Children with autism may not have the opportunity to learn a second language, because their parents receive discouraging advice from professionals towards bilingualism (Kay-Raining Bird, Lamond, and Holden, 2011, p. 52). This is especially problematic for children who need to be bilingual so that they can fully participate in their family's community and social life. Research revealed that while there are difficulties, children with autism can become bilingual, especially if raised in a bilingual family setting (p. 63). Among the many benefits of bilingualism reported are enhancements of metalinguistic skills such as those found with typically developing children. As far as the authors knew, only one case study of a Korean and English speaking child with autism had been conducted (Seung et al., 2006, as cited in Kay-Raining Bird et al., 2011, p. 53).

Little is known about how children with autism acquire language (Seung, 2006). Research on bilingual language developments in children with ASD is very limited (Hambly & Fombonne, 2011, p. 1342). The authors studied whether there were additional delays if children on the spectrum learned another language and found that this is not the case (p. 1342). Furthermore, they advised that "caregivers should not be discouraged from maintaining bilingual environments or introducing a second language

where necessary for the child or family, although little is currently known about the pace of learning or bilingual achievements for children with ASDs" (p. 1349).

Another view of this issue is presented in the research of Toppelberg, Snow, and Tager-Flusberg (1999). These authors questioned whether children with severe developmental disorders, such as autism, should learn different languages and maintain heritage languages as is recommended for typically developing children (p. 1197). The authors pointed out that children with ASD have a much more difficult time acquiring the first language and that they require a "high quality of language input. Together with their unique social and communicative difficulties, acquiring L2 for these children is exceptionally arduous" (p. 1198).

However, there might be benefits for a bilingual individual with ASD, because of the positive effects multiple languages can have on the brain. As Crinion et al. (2006) point out, using different languages stimulates the brain in different ways (p. 1540). Research also revealed that second language development changes the brain's structure (Bot, 2006, p. 129) and makes it more efficient (Kluger, 2013, p. 42). There is also clinical evidence that languages are not housed in the same part of the brain. Paddock (2009) cites the findings from a case study of a bilingual with brain damage to one side of his brain and concludes that the evidence suggests "that a person's first and second language are represented in different parts of the brain". In this research, Raphiq Ibrahim (2009) studied a 41 year old bilingual man whose L 1 was Arabic and L 2 was Hebrew, who suffered brain damage. In his conclusion, Ibrahim reported that the individual's first language had suffered much less damage than his second language.

Issues of bilingualism and heritage language maintenance were discussed in Yu (2013). The author found that minority language parents do not feel comfortable speaking to their children with ASD in their native language. They fear that this would be an additional burden on their children and worsen their lives (p. 10). Families seeking advice from professionals in the educational and health sectors are often told to only speak English with their children, which is in disagreement with what experts in the field of bilingualism and heritage languages recommend (p. 11). Parents often felt they had no other option than to speak English with their children on the autism spectrum, because they needed the language for special education and related services and to do well in general (p. 20). This caused many mothers intense stress. Yu (2013) concluded, "Language use between parents and children is a complex matter that is unique to each family. Parents need to be supported to make language use decisions that are self-enhancing and congruent with their families' needs" (p. 10).

Computerized Training

Computer aided learning could potentially have a great impact on students with autism (Moore et al., 2000). The authors stated that many people on the autism spectrum like working with computers and that this could be a vehicle to promote their learning, enrich and empower their lives (p. 218). In this study caregivers were addressed as having the goal and challenge of equipping the person with autism to lead a 'happy and satisfying life' (Carlton, 1993, as cited in Moore et al., 2000, p. 218). To achieve this goal, education is of great importance. Individuals on the autism spectrum

need to be taught and guided in special ways and computers could have an important role in providing this (Trevarthen et al., 1998, as cited in Moore et al., 2000, p. 218).

Many individuals on the spectrum seem to have special interests, such as computers, games, and programs. Relatively few studies have been conducted on the impact of technology enhanced computer programs, but research has revealed that most participants were highly engaged (Mineo, Ziegler, Gill and Salkin, 2009, p. 172). This affinity for computers could be beneficial for learning in general, such as helping students with ASD address difficulties in the curriculum (Moore et al., 2000, p. 218). Social skills and language skills might also be enhanced using computer assisted technology (Bertram et al., 2013, p. 301). It is important to encourage a special interest, such as computers, because "some interests can eventually become a source of income and employment" (Attwood, 1998, p. 97).

Klingberg et al. (2004) studied the effects of computerized training on working memory in children with ADHD. They described working memory as "the ability to retain information during a delay and then to make a response based on that internal representation" (p. 177). According to Hill (2004), working memory is part of executive functioning, which is responsible for such brain processes as planning and persistently following a goal (as cited in Baltruschat et al., 2011). This is an area the participant of this study also has difficulty with, especially in sequencing tasks, which is part of working memory and executive functioning. Klingberg et al.'s study (2004) revealed that "the treatment group that participated in the high-intensity training of working memory improved significantly more than the comparison group". The study

concluded that training can improve working memory and suggested that it could be useful in other individuals with executive functioning deficits (p. 185).

Faja, Aylward, Bernier, and Dawson (2008) studied the effects of computerized face-specific training on adolescents and young adults with autism and noted that directing their attention to faces may lead to better processing ability (p. 4). To their knowledge, there was no previous research indicating that training programs actually helped with facial recognition of unfamiliar faces in individuals with ASD (p. 5). Their present study suggested that face expertise training is feasible and can influence facial recognition (p.17). Moreover,

> computerized training may be criticized for lack of ecological validity, but the artificial nature of the training may be exactly the factor that enhances face processing ability with unfamiliar faces for individuals who have not developed face expertise naturally. (p. 19)

Barnes et al. (2009) studied 47 participants with mild cognitive impairment in a computer based cognitive training program from Posit Science Corporation, the company that developed the programs the participant used. While their research did not find any significant difference between groups, they reported that similar computer based programs are feasible in individuals with mild cognitive impairment and that further research is warranted (p. 1).

Another study that used programs from Posit Science was done by Rosen, Sugiura, Kramer, Whifield-Gabrieli, and Gabrieli (2001). This study focused on memory and brain function in participants with mild cognitive impairment using the cognitive training program from Posit Science to enhance the speed and accuracy of auditory

verbal processing. The research found brain changes which suggest that cognitive

training is beneficial (p. 1).

There is limited availability of specific programs designed for individuals with

ASD and their needs. Research by Moore et al. (2000) stated that apparently mostly

generic software is used, but the best option would be to use computer aided learning

systems that target areas unique to autism (p. 219). Autism specific software packages

would address the problems individuals with ASD encounter directly and provide better

support for this population (Higgins & Boone, 1996, as cited in Moore et al., 2000, p.

218). This is also one of the reasons that Posit Science was used in this study. Posit

Science had programs that addressed participant's needs, even though they were not

specifically designed for autism spectrum individuals.

The general consensus from the above studies indicates that computer based

training could be one of the better tools for individuals on the autism spectrum. The

combination of an affinity for computers and ability to use software to break down tasks

to provide the necessary repetition were also cited.

Target Areas

Individuals with ASD have difficulty with non-verbal communication, such as

extracting information from other people's faces as clues for meaning. David et al.

(2008) conducted a study using Simon Baron-Cohen's "Reading-the-mind-in-the-eyes

test" (p. 597). Subjects were to match the correct emotion with pictures of the area

around the eyes to describe the expression of thought and feeling they saw. Data

revealed that the high functioning autism (HFA)/Asperger syndrome (AS) group scored

significantly lower than the control group in interpreting facial expressions and their meanings. These processes are also defined as "mentalizing" or "theory of mind" (Baron-Cohen, 1997, as cited in David et al., 2008) or "mindblindness" (Baron-Cohen, 1996, p. 1). This is a deficit in autism that can lead to awkward, inappropriate, offensive or even dangerous situations, because individuals on the spectrum often fail to recognize non-verbal cues embedded in communication or to channel them correctly. One such incident led to the death of a non-verbal man with ASD who had hypersensitivities to noise and crowds (Sullivan, 2007, p. 5).

Another area of difficulty for individuals with ASD is identifying people by their faces and keeping the faces apart. It is not uncommon for them to remember people by what they wear or what their games or other possession are instead of by their faces. This inability to recognize people can cause problems in all phases of daily life. Temple Grandin (1995), autism spokesperson, university professor, and autistic person, stated that unless she has seen people many times or they have distinct features, she will not recognize or remember them. To further illustrate this disability, Grandin writes about a woman with ASD in her book who identifies cancer cells in a laboratory, but must see people as many as 15 times to remember their faces. The reason she can spot irregular cells immediately is that they literally "jump out at her" (p. 74).

This is not to say that individuals with ASD cannot recognize differences in other things, especially when it comes to cartoon characters. Grelotti et al. (2005) tested an individual with autism who had an extreme interest in Digimon (digital monster), a cartoon that originated in Japan. He was able to identify the different animated Digimon characters faster than familiar faces or objects. This study revealed that the individual's

brain regions responsible for face and emotional processing responded more strongly to Digimon characters than to familiar faces or objects. Instead of becoming an expert in faces like most of us are from very early on in life, this person developed an expertise of Digimon (p. 380).

As adults, typically developing individuals are able to categorize and remember faces holistically rather than by different features (Faja et al., 2008, p. 2).   The authors reported on studies suggesting that individuals on the autism spectrum may not use the same strategies as typically developing individuals when processing faces (p. 1). The study also cited the example of the participant with the unusual interest in Digimon (Grelotti et al., 2005, as cited in Faja et al., 2008, p. 5), noting that individuals with ASD have the ability for facial recognition, but do not use it. One of the reasons might be that ASD individuals are not motivated to pay attention to faces (p. 17). The authors stated that their research was the first to empirically support investigating "specialized face perception mechanisms" (p. 18). Their study explored the effects of face expertise training in adults with high functioning autism spectrum disorders. The found that individuals with ASD can improve their facial recognition skills and become face experts through training (p. 1).

In another investigation, Faja et al. (2012) focused on matching pairs of faces (social) and non-social objects, and reported the same findings as in their study of 2008. With training, individuals with ASD can become face experts with training (p. 289). The comments of some of the participants were of particular importance and interest, because they showed a different aspect of facial recognition not mentioned before. In this study, participants used static pictures instead of dynamic stimuli. Participants favored the

pictures, because they did not have to deal with movement or other distractions, such as having a live person in front of them who talks and displays emotions which are perplexing. While it was felt that this is a good first step for individuals with autism to learn how to read faces, the study called for further research under more complex and natural circumstances (p. 291).

Very little literature exists on improving another difficult area, working memory, for individuals with autism (Baltruschat et al., 2012, p. 550). Working memory is "the ability to retain information during a delay and then to make a response based on that internal representation" (Klingberg et al., 2005, p. 177). Working memory can range from simple tasks to sophisticated stages of solving problems (Williams, Goldstein, Carpenter, and Minshew, 2005, p. 747). Specific examples of working memory in everyday life are activities with multiple steps, such as grocery shopping, looking for lost items or staying on track in a conversation (Baltruschat et al., 2012, p. 550). The study used a German computerized working memory test, "Arbeitsgedächtnis Testbatterie" (AGTB), at the beginning and end of the study (p. 555), and reported that the AGTB posttest showed that performance had improved. However, no real-life applications were made to see if working memory could be improved in participants with ASD in their day-to-day activities (p. 559).

Further support for the idea that working memory (WM) can be improved with training is provided by Klingberg et al. (2005). In their study of children with ADHD, a related disorder, they found the following:

> Although the training effect remained relatively stable for several months, we expect that it will eventually be necessary with a shorter period of retraining to maintain the effect. However, if WM and executive functions improve by practice,

as this study indicates, then we would expect some degree of practice effect also from everyday activities with very high WM loads, such as mathematics and other demanding academic activities. It is theoretically possible that improvement of WM and executive functioning by an intensive training program would enable the children to perform better and hence to participate more in such WM demanding activities. This would lead to more WM practice in everyday life, and the children would enter a positive feedback loop that would reduce the need for retraining with a training program. (p. 184)

While there is general agreement that working memory is a problem for people with ASD, researchers put forth a wide variety of ideas as to its nature and causes. Williams et al. (2005) studied high functioning children, adolescents, and adults with autism (p. 747). They found that the problems were likely not their verbal and spatial working memory, but problem solving. While this may apply to this specific situation, the working memory issues they describe are in spatial problem solving as opposed to working memory related to lists of tasks or event sequencing. The authors suggested that verbal working memory may be fine in individuals with ASD, while spatial working memory is not (p. 753). This seems to contrast the ideas presented by Grandin (1995), who sees in pictures and demonstrates excellent visual spatial problem solving in her intricate designs. It could lead one to question whether there are distinct visual versus verbal strengths or weaknesses within individuals on the autism spectrum. This might explain the variances between different research groups in this area.

Further evidence of contradictions about working memory in individuals with autism can be found in Nakahachi et al. (2006). The authors of this study pointed to distractions caused by external factors in the testing area as interfering with performance on working memory tasks. They suggested testing in a distraction free environment to achieve a clearer picture of performance (p. 317).

A separate study by Ozonoff and Jensen (1999) examined difficulties with working memory in individuals with autism, ADHD and Tourette's syndrome. They indicated that these have long been looked at as similar, due to executive function problems. After closer examination, they discovered that while all of the groups had difficulty in the area of working memory, the nature of the difficulties were unique to each disorder. The authors felt that these unique characteristics in working memory held potential for the diagnostic process in separating individuals in these groups and possibly increasing treatment effects (p. 175).

Impairments in social skills are one of the core characteristics of autism. This is often a main reason why individuals with ASD have difficulty relating to classmates, neighbors, and people in general. This leads to failure to make friends and separation from society. Bernard-Opitz et al. (2001) investigated whether social skills in children on the autism spectrum could be improved using software packages. Eight normal and eight autistic children were tested using distinct social problems. While the group with autism was far less successful in finding solutions, results showed that young children with ASD can be taught to navigate the social world using computer interfaces (p. 377). This study also stated that the children on the spectrum "enjoyed the programs", while their typically developing peers "showed signs of boredom in the later sessions of the study" (p. 383). This agrees with the fact that the participant in this study also enjoys these computer programs. He is always motivated to start the training with the software. Even though the tasks are repetitive and monotonous at times, he has to be reminded when it is time to stop. When he interacts with the program, his full attention is fixed on the screen, and he

seems to forget everything around him. This intense engagement with the material is an important criterion for a positive outcome of the learning experience.

Other studies, such as Hopkins et al. (2011), have explored the use of computer based intervention (e. g., avatar assistants) to improve the social skills of individuals with ASD. The importance of improving social skills was highlighted by the American Psychiatric Association (1994): "children with Autism Spectrum Disorders (ASD) are particularly affected by this impairment as evidenced by their difficulties in reciprocal social interaction skills" (as cited in Hopkins et al., 2011, p. 1543). The authors maintained that even though faces have the same parts, such as nose, eyes, and mouth, most people can distinguish between them and are able to identify individuals by certain differences. Individuals with ASD, however, process faces by concentrating on the distance between the features rather than by the impression of the whole face (p. 1544). The interactive avatar assisted "FaceSay" computer program gives participants a chance to practice eye gaze and facial recognition (p. 1543). The features of working with computers, such as the environment being controlled and structured, can help individuals with ASD (p. 1544).

The participant's parents reported that teaching social skills through rehearsing social rules has been an almost daily practice. It entails planning every detail of a given situation and discussing the outcome afterwards. The problem with this is that "no set of rules can be drawn up to cover every contingency" (Tantam, 1993, as cited in Moore et al., 2000, p. 219). Even though he prepares for numerous situations, the participant inevitably encounters unexpected and unrehearsed scenarios. According to the parents, teaching social rules has helped the participant tremendously, even enabling

him to make some correct decisions on his own. The participant and his parents hope that the computer software programs used for this study will further assist him in this area.

Conclusion

Autism is much more common now, and there is no cure at this time. Public awareness has increased. Unlike the past, autism is now seen as an affliction that could affect any family (Benaron, 2009, p. xi). Doctors, schools, caregivers and parents work diligently one day at a time to give individuals with ASD a chance for a better life. Additionally, they have dire needs in communication and social skills. Although more is now known about this lifelong disorder than just a few years ago, research is needed to better understand and help individuals on the spectrum.

According to the literature reviewed, there has been some success using computerized training programs with autistic and neurological disorders. However, many disagree as to the areas where training is appropriate and most effective. The general consensus is that computerized training programs can improve the lives of people with autism. There have been positive results using Posit Science software for language and social skills training in a variety of neurological conditions, but no specific research has been done on individuals with ASD.

Social skills are problematic for individuals on the autism spectrum due to difficulties in facial recognition, understanding social norms, and interpreting gestures and other social cues. Individuals with autism frequently have difficulty recognizing people that they interact with on a regular basis, but can readily differentiate between

numerous cartoon characters in ways that the rest of us either would or could not do. Individuals with autism often behave inappropriately in situations, because they lack the ability to read emotions in people's faces. This often leads to social isolation in school specifically and the community in general.

Language difficulties, including sequencing, working memory, expressive and non-verbal communication, are a major problem for people on the autism spectrum. Researchers offer varied opinions as to the cause of problems with sequencing and working memory, but the end result often leads to frustration for the person with ASD and the individuals they encounter. Tasks that would be routine for most of us at an early age, may still elude adults with ASD, even though they may have a high degree of intelligence. This often necessitates specialized support for education and potential employment. The failure to express feelings and inability to perceive non-verbal communications can create difficult situations for people on the autism spectrum. Combined with hypersensitivity and crowd anxiety, these communication difficulties have sometimes escalated to the point of altercations, arrest, and on occasion even resulted in death.

Children are usually the main focus of autism related programs, such as early intervention in education and treatments in the medical field. Therefore, much of the literature is also concerned with younger age groups and their problems. With emerging knowledge about autism, interventions are helping children with autism grow up and lead more productive lives. However, much more needs to be done, especially for young adults with autism who lack support from the education system and other public resources. With the advancing technology, computer training programs are being

designed to help individuals with disabilities improve conditions through planned activities. These measures are cost effective and non-invasive. They can be self-administered at home or at other locations, and do not have the side effects and other negatives associated with medications. Combined with minimal community support, these resources can go a long way toward creating meaningful adult lives for people on the autism spectrum.

CHAPTER III

METHODOLOGY

This study assessed whether language and social skills in autism could be improved using computer based training. A qualitative method case study design was implemented. According to Gall (2010), a case study "is conducted to shed light on a particular phenomenon – that is, a set of processes, events, individuals, programs, or any other events or circumstances of interest to researchers" (p. 339). This is the appropriate method for this study, because unlike other methods, a case study can focus on a particular individual in his natural setting and yield rich data. In a case study, the participant and researcher are part of the investigation providing emic (insider) and etic (outsider) views and offer insights into the complexities of the case. This study involves triangulation, using multiple measures to collect and evaluate data from Posit Science, the participant and his parents, and the researcher in an effort to show a more complete view.

Participant

The subject of this case study is a 30 year old bilingual male with high functioning autism. He is a senior at CSU Chico, majoring in computer science. He was raised in a bilingual household with a German mother and a U.S. native English speaking father. The study involves his progress participating in "People Skills Training" and some auditory/language focus activities from Posit Science. He utilized another program from this company several years ago which proved beneficial.

The purpose of this study is to take an in-depth look at improving language and social skills in autism using People Skills Training and Auditory/Language Focus Activities from Posit Science. The questions to be answered are:

1. To what extent, if any, does training software produce improvements in the social skills of a bilingual, young adult who has autism?

2. To what extent, if any, does training software produce improvements in the language skills of a bilingual, young adult who has autism?

Instruments

Posit Science Online Training Program

This study utilized seven online training programs from Posit Science. Three programs taught language skills: Memory Grid, To-Do List Training, and Syllable Stacks. The remaining four programs addressed social skills: Face to Face, In the Know, Recognition, and Face Facts. The different programs are described as follows (Posit Science, 2003):

Language Skills Training

The Memory Grid Training Program required the participant click on cards, listen to the sounds they produce, and match the syllables in order to clear a grid.   These syllables represented the most commonly used English sound combinations in different examples of speech, such as male or female voices, different accents, different timing, etc. Eventually the sounds became more similar, making the tasks more difficult. As the participant improved, he was given more cards to match.

The To-Do List Training Program involved listening to a set of instructions, remembering them, and following them in order. As the program progressed, the list of instructions grew longer and more complex, the items that had to be gathered were more similar and more instructions had to be remembered.

The Syllable Stacks Program required listening to a series of sounds, and then clicking on the words to reproduce the sounds in the exact order. The number of syllables increased and it was harder to discern between the syllables. There were distracters not matching any sounds and the speed transitioned from slow to faster than normal speech. With improvement, more sounds in the series were given.

Social Skills Training

In the Face to Face Program, the participant watched as a face with an expression flashed briefly on the screen. He then saw a set of faces and had to pick the right match. For instance, if the person in the first picture looked happy, he had to find the happy face in the second set. The exercise changed as follows: more emotions were added; the intensity of the expressions decreased; and the number of faces to choose from increased from 3 to 6. As the participant advanced, the faces flashed for fewer milliseconds on the screen.

The In the Know Program involved listening to a conversation, and then answering questions based on the details heard. As the program progressed, the speech processing level changed, and the sentences became more complex. The pauses between sentences decreased. As the participant improved, he was given longer conversations with more difficult and elusive details (e.g., he had to distinguish between rumors, denials and facts to arrive at the correct answer).

In the Recognition Program, the participant watched a face appear briefly on the screen. Only the oval of a face, from forehead to chin without any hair, was shown; no other parts were featured. The participant had to remember features of the face and was asked to identify who he saw from a selection of faces in the next screen. Then the angle of the faces changed, the number of faces to choose from increased from 3 to 6, and the faces became gender-matched instead of having male and female faces mixed together. All these changes increased the level of difficulty. As the participant advanced, the faces flashed for fewer milliseconds on the screen.

In the Face Facts Program, the participant looked at faces and read facts such as names, occupations, places where they live, their preferences, their families and pets. In the testing, he had to recall which facts go with which face. In later levels, the names and facts became more similar, and the gender changed (first men only, then women only, then both genders) making it harder to keep them apart. As the participant improved, he had to remember more and more faces, names, and facts.

The Posit Science People Skills and Memory programs have built-in baseline assessments and record incremental progress throughout the process which have been reported as part of the data collection.

Researcher's Measurement Activities

The researcher designed two measurement activities to mirror the Posit Science training programs in language and social skills to collect data and allow for triangulation. The first part is comprised of eight everyday tasks to test the participant's sequencing abilities. The resulting data was used in assessing language skills. For the second part, the researcher designed a PowerPoint of twenty pictures of people familiar to

the participant to teach and test social skills in the form of facial recognition. The scores were used as social skills data. Baseline and post-tests were administered before and after implementing the Posit Science language and social skills training, so the researcher could calculate overall growth by comparing the scores on the pre and post-tests.

Language Skills Measurement Activities

The following eight tasks were designed by the researcher to collect data before and after implementing the Posit Science Memory Training as baseline and progress language assessment (receptive, spoken, and written):

1. Get your cell phone first and then your coat

2. Find the milk, salt and pepper, and the cutting board and set them on the table

3. Find the key to the mail box, get the mail, set it in the office, and return the key where it belongs

4. Tell me, in order, what you have done in (a specified time period)

5. What homework/chores will you do first, second, and third?

6. Write a plan of four things you will do today

7. Tell me three things you need to do to set the table and do them

8. Call a sibling, talk to him for 5 minutes, and tell me three things he talked about

Social Skills Measurement Activities

To determine baseline and progress in the social skills assessment portion of the study, the researcher used the following measurements before and after implementing the Posit Science People Skills Training program:

1. 20 pictures of family members, church members, teachers, and others the participant should be familiar with were collected and randomly arranged in a power point format.

2. The training consisted of showing the pictures to the participant for 10 seconds while researcher named the individual.

3. Testing was done 30 minutes later by randomly showing each of the 20 photos and giving participant 10 seconds to name each individual. The number and identity of correctly identified pictures were recorded.

4. Three days later, each of the 20 photos were randomly shown again and participant was given 10 seconds to name each. The number and identity of correctly identified pictures were recorded.

5. Six days later, each of the 20 photos were shown again at random and participant was given 10 seconds to name each. The number and identity of correctly identified pictures were recorded.

In addition, researcher kept a journal of the daily training, observations, reflections, and input from the participant, his parents, and herself. This served as anecdotal data for triangulation purposes and provided a more holistic view of the situation. Results from the pre and post multiple measures were compared and analyzed to identify any changes that resulted from the training.

CHAPTER IV

FINDINGS AND RESULTS

The purpose of this study was to investigate whether online computer training could improve language and social skills in a bilingual, young adult who has autism. The instruments used were the Memory Training and the People Skills Training programs from Posit Science. These programs were selected, because they were the best fit for the participant's language and social skill goals. In addition, the researcher designed two measurement activities to collect data for assessing language and social skills before and after implementing the Posit Science programs. The following is an analysis of the data collected from Posit Science and the researcher.

Posit Science Training

The participant started the Posit Science online language and social skills training on June 17, 2013 and finished August 27, 2013. He participated approximately 30 minutes per day for 57 days. During this time period, he completed 658 subtests averaging 2.76 minutes per test, with the shortest test taking 49 seconds and the longest 22.68 minutes. Total actual training activity was 30.32 hours from the time the participant clicked "start" to the completion of each subtest. This does not reflect the time spent reading instructions, seeing results, selecting the next level of activity, etc. The participant continued to make progress throughout the period of the study. The

number of levels completed reflects the time limitations of the study and not difficulty

completing additional levels.

Language Data

The participant's percentile ranking for the language activities improved from

a baseline at the 44.6th percentile to the 84th percentile during the time period. Because

this portion of the training involved varying degrees of difficulty across the 92 subtests or

levels, there is no clear linear view of progress. The Posit Science software is designed to

allow users to move to the next level after improving over their baseline score on a

particular activity. When users complete a level by showing improvement over their

baseline attempt, they are permitted to move to the next higher level of difficulty. In the

early stages of the program, the participant repeated activities attempting to achieve

perfect scores on each subtest (level), rather than moving to the next level. When the

researcher realized this, participant was encouraged to move to the next level when

eligible, instead of seeking perfection at each level. An overview of the results can be

seen in Table 1 below.

Table 1

Results from Posit Science Language Skills Training

Activity	Levels Completed	Average Improvement over Baseline	Trials/Stars Earned	Average Stars/Trial
To-Do List	38/38	1.02 levels	122/371	3.04
Memory Grid	29/40	1.01 syllables	111/297	2.68
Syllable Stacks	25/40	.54 syllables	24/47	1.96
Overall	92/118	N/A	257/715	2.78

Posit Science, 2013

The trials' category represents the number of individual activities the participant attempted. This number is skewed higher by the participant's attempts for perfection in the early stages. Posit Science breaks each activity mentioned in Table 1 above into several stages. These stages are then divided into a variety of levels with increasing difficulty both horizontally and vertically. For example, in the To-do List Training, the complexity of instruction increases horizontally, while similarity to distracters increases vertically. In Syllable Stacks, the difficulty of the syllable category increases horizontally, while the voice changes vertically. The participant can choose whether to move vertically or horizontally after completing a level, but must complete all levels before moving to the next stage.

The Average Improvement over Baseline column in Table 1 above reflects the mean improvement over the baseline for each of the levels attempted. Between $0 – 5$ stars were awarded for each trial, based on the speed and/or accuracy of task completion. These stars provide the participant with a general measure of success and are intended to provide some motivation. As mentioned previously, a number of the 257 trials to complete the 92 levels involved the participant voluntarily repeating levels to increase his score. It takes a minimum of 184 trials to complete 92 levels as each level requires a minimum of a baseline and mastery score.

Social Skills Data

The participant's percentile ranking for the social "People Skills" activities improved from a baseline at the 37.5th percentile to the 66th percentile. As mentioned above in the language training, this portion of the training involved varying degrees of difficulty throughout the 72 subtests or levels. There is no clear linear view of progress.

The participant's tendency to repeat activities in the earlier stages of the training to achieve a perfect score was addressed in the previous section. An overview of the results can be seen in Table 2 below.

Table 2

Results from Posit Science Social Skills Training

Activity	Levels Completed	Average Improvement over Baseline	Trials/Stars Earned	Average Stars/Trial
Recognition	17/24	197.9 ms	130/346	2.66
In the Know	18/18	1.28 levels	102/325	3.19
Face to Face	17/24	250.7ms	111/207	1.86
Face Facts	6/6	.5 people	24/27	1.13
Overall	58/72	N/A	367/905	2.47

Posit Science, 2013

In Recognition and Face-to-Face activities, the scores are listed in milliseconds (ms), reflecting the amount of time an object is flashed on the screen from a low of 32 ms to over one second. The participant was able to reach this minimum time several times in the early stages. Difficulty increased horizontally and vertically as it did in the language skills section. For example, in the Face-to-Face activity the time the face was seen was reduced horizontally, and the number of emotions to match increased vertically.

The social skills portion of the program seemed more difficult for the participant. This may be reflected by differences in the percentile ranking, stars per trial ratio, and the greater difference between the minimum possible trials 116 and the 367 trials actually completed. This ratio of more than three times the minimum number of trials to advance is much greater than the ratio in the language skills area (minimum 184

trials : 257 actual trials = 1.4) This would support research that reports difficulty in

social skills on the autism spectrum (David et al., 2008; Grandon, 1995; Grelotti et al.,

2005; Faja et al., 2008).

The participant stated that the language skills training was easier than the

social skills training. He said that it is harder to distinguish between the faces than to

understand the words. The To-do List was very challenging in the beginning, but became

easier with practice. At first he only remembered the first two items and had to guess

what the third one was. After a while, he figured out a strategy, which the researcher also

observed, of repeating the instructions. For instance, if the voice said, "Get the screw,

then the bag, and then the shovel", the participant immediately said aloud, "Screw, bag,

shovel" and clicked on the pictures of the items in order to accomplish the task. He

reported that this seemed to help him. In the Memory Grid Training, the participant had

to match sounds and tell them apart from really close sounding choices. He reported he

got better by listening closely, but it was hard to improve, because he often had a high

baseline which was difficult to match or surpass. The participant also found the

emotions, especially fear and surprise, of the Face to Face Training, difficult to match.

He reported that he used eyebrows and color of hair and skin to identify the faces. In the

Know involved remembering details of a conversation. The participant reported that it

was very difficult to distinguish between rumors and true bits of conversation, but as he

progressed, he was able to ignore the distracters better.

The parents reported that the participant independently made time for the

online training on most days. He was focused on the training and always motivated to

improve his skills. On a few occasions, he was frustrated, e. g., at some stages of the

social skills programs, but often he could be heard cheering when he was able to pass a level and access a new one.

At the end of the online training, the researcher asked the participant what he was able to gain from this experience. He answered that identifying faces was easier after the training. He had learned strategies, such as picking up additional cues, either from the eyes or the hair, in order to recognize people. He was also able to process sounds better. In addition, he thought he improved his ability to listen to details and recall them better, even though sequencing is still difficult. Without the training, his skills would have stayed the same.

<div align="center">Researcher's Testing</div>

Language Data

The participant was able to complete the eight language tasks in both pre and post-testing. The subject's parents were surprised the participant was able to be successful in all eight activities. They felt that he would not have completed these tasks in a normal day-to-day situation. The parents stated that because the participant knew it was a test, he paid closer attention to the instructions and was able to complete the tasks. Based on this information, it may have been a better design to have the parents administer the pre and post-tests without the participant's knowledge. Their anecdotal reports indicated that the participant has shown improvement in similar tasks in daily life during and since the completion of the training. For example, he seems to be able to carry out tasks that involve several steps, such as collecting items for his backpack for school, on

his own more reliably now. It was also noticed that after the training emails to his instructors contained more sequenced, detailed, and focused wording.

The following is a description of the testing, the eight baseline and post-test language tasks, and the results:

Before each task, the participant was informed of the upcoming test and the researcher read the question to him. While the participant performed the task, the researcher observed and took notes in a journal. There were no other people present besides the participant and the researcher, and except for the testing, nothing else was going on.

For Task 1, the researcher instructed the participant to get his cell phone first and then his coat. He had no problem accomplishing this in about thirty seconds. Similarly, the participant was successful following the instructions for Task 2 to get the milk, salt and pepper, and the cutting board and set them on the table within fifty-two seconds. The participant found the key to the mailbox in the kitchen of his home, went outside and across the street, opened the correct mailbox, retrieved the mail, closed and locked up the mailbox, crossed the street, entered his home and set the mail on top of a desk in the office; then he hung the mailbox key back up in the kitchen. The participant took about two minutes to accomplish this task. Because there was no notable difference in performance in pre and post-tests for Tasks 1 through 3, they are not noted separately.

For the fourth task, the researcher asked the participant what he had done this morning. In the pre-test, his answer was, "Got up, ate, brushed teeth, got clothes on, shaved, went to work-out club, did several different machines, came back to house, did stuff on computer, went to do testing." He said this in about one minute. For the post-test

of this question, he listed the following: "Saw the teacher during office hours, got ready for security class, ate afterwards, worked out, saw Kevin [a student], home, worked on laptop." This also took about one minute. For question 5, "what homework/chores will you do first, second, and third?", the participant answered in about one minute in the pretest: "First, mowing lawn; second, helping dad with sprinklers; third, cooking spaghetti" (he forgot he mowed the lawn the day before). In the post-test, the subject took time to think and answered in about two minutes: "Work on security thing, find different websites and operating systems, work on capstone program more and after that…probably work on databases, work on quiz for biology."

The participant had to "write a plan of four things you will do today" for Measurement 6. He wrote: mowing lawn, reading library book, drawing art, playing my computer. This took about two minutes. In the post-test he wrote: visit teacher in biology during office hours; work on my project for capstone in Rails; go to my security class; go to hack this site. He wrote this down in two minutes. The instructions for Task 7 were "tell me three things you need to set the table and do them". In the pretest the participant said, "Get plates, forks and knives and glasses, glasses in front, plate below glass, forks and knife left and right." He forgot about the researcher's instructions 'and do them'. The researcher repeated the instructions. After that, the participant set out three plates, glasses, and utensils (finished in approximately five minutes). In the post-test, the participant said, "Placemats, plates, glasses." He gathered these items and set the table in about two minutes.

For the final Task 8, the participant called his brother for five minutes and told the researcher three things he talked about. In the pretest, his answer was, "Kai fine,

trimming bushes this morning, Melissa deal with him and Kai is hard." There were long pauses in which he said several times, "That's as much as I can remember." This took about five minutes. The researcher took the following notes as she listened to what the brother said in the pretest on a second telephone: He was talking about work and that different people from the company were coming to town today to compare their ideas. When he drove home, he went to the $5-Store and bought swimming trunks and sandals for his trip to Las Vegas. In a radio contest, he won tickets for tomorrow's concert "Of Monsters and Men". He ate beef Pho Vietnamese noodle soup. Kai is bigger now and will be probably one of the biggest dogs the participant has ever seen. He has to pack for Las Vegas tonight, because they are going to the concert tomorrow. Kai can do tricks like lay down, paw, roll-over. They are gathering trash and recycling today for tomorrow's pickup. Melissa is not in class, but that's good, because to take care of him and Kai is a full-time job. He trimmed the bushes yesterday.

After the training, the researcher conducted the post-test in the same way and the participant answered, "Kai is not feeling well, has new diet for six months (corrected himself and said correctly six weeks), will see if it works and see what happens. If he is fine, they will keep him on that diet otherwise find a new diet. Doctor didn't see anything wrong in the tests. I asked about the cake, has some left and will eat it today. Filled up fridge with meat and groceries today, had eaten everything down" (about 3 minutes). The researcher's post-test in notes about the conversation were: Brother talked about Kai being sick, but doing better, had blood in stool on Thursday. X-ray, blood and stool sampling was done, he takes probiotics, medications in pill form and powder, and is on a diet of rice and chicken. Call back from doctor, all tests negative, keep dog on

special bran diet for six weeks. He could be allergic to something. Is energetic and it's

hard to tell something is wrong if it wasn't for the blood in the stool. About work:

convinced boss to buy instead of renting to save money. He was very happy idea was

accepted. Today he and Melissa went to Bed, Bath & Beyond to return knives and pots.

They exchanged china and got 42 pieces for $200. Participant asked if any cake was left.

Brother said yes, it's in the fridge and they will eat it tonight. He and Melissa went to

Costco, Aldi and Giant Eagle today for five hours to buy food (meat and veggies), were

totally out of everything, had eaten up all the leftovers and had nothing in the fridge.

According to the parents, sequencing has always been a challenge for the

participant, and he usually needs several prompts to complete these activities in real life

situations. Reportedly it is not unusual that tasks will not be completed, even though

there is ample practice doing similar tasks on a daily basis. Because of his distinct

sequencing difficulties, the researcher selected a type of training program that would

target these problems. As the results showed, the participant was particularly successful

in Tasks one through seven, being able to complete all of them in a short time and very

satisfactorily. Task 8 was also completed in the sense that the participant was able to

recall three things his brother talked about. However, when investigating what was

actually said during the telephone conversation, several aspects came to light.

In the pre-test, the participant recalled, almost echoed, only the information of

the very last segment of the conversation about Kai, Melissa and trimming the bushes.

He used very few words, "Kai fine, trimming bushes this morning, Melissa deal with him

and Kai is hard." It was noticeably frustrating for him to produce this much, as

demonstrated by the fact that he took several breaks and insisted that was all he

remembered, then added another piece of information. The participant's recall of the conversation was very limited in detail, and he did not state details correctly (trimming bushes this morning instead of yesterday). He did not mention the tickets his brother won, even though this was a highlight of his day and of the next day's activities. The parents reported that sequencing events, stories or conversations has been particularly difficult for their son, and that he used to be unable to tell them what happened, e.g., in school. The information he provided could not be put together to make sense. This has improved over the years, but is still problematic.

In the post-test, the participant provided more information and details than in the pretest, and he used a more narrative, interesting style. The focus was still narrow, but improved, and he seemed much more comfortable with the task. There were no pauses and no noticeable frustration as in the baseline testing. Furthermore, not only did he pay attention to time factors, he also caught his own mistake (six weeks instead of six months). Additionally, he started recalling many details contained in the beginning of the conversation, left much of the middle part out, and focused again on two items at the end of the call. The parents stated that if the participant is interested in the subject (Kai) and the nature of the information (the welfare of the dog), he is likely to be more engaged and supply more information.

Social Skills Data

The parents provided the researcher with 20 pictures of family members, church members, teachers, and others the participant should be familiar with. The researcher created two different PowerPoints with the same pictures in random order. The pictures were timed to be seen for 10 seconds each before going to the next slide.

For the pre and post-tests, the participant was first trained by showing the presentation, while the names of the individuals in the pictures were read to him by the researcher during the 10 seconds. Thirty minutes later the participant was tested (Trial 1) by viewing the PowerPoint and identified the individuals he knew. This testing process (without reading the names to him first) was repeated three days (Trial 2) and six days (Trial 3) later, and the results are found in Table 3 below.

Table 3

Results from Researcher's Social Skills Testing

Trial	1	2	3	Mean
Pre-Test Photos Identified	4	3	4	3.7
Post-Test Photos Identified	6	5	8	6.3
Improvement	2	2	4	2.6

All testing was based on twenty pictures. The first baseline testing was done June 10, 2013, and the participant correctly identified four pictures. On June 13, 2013, the second baseline testing revealed that three were named correctly, one less than three days before. During the last pre-test on June 16, 2013, four were identified, matching the number of the first day of baseline testing. After the computer training, the post-testing was conducted and compared to the results of the baseline testing to determine if there was any change in recognition. The first post-testing was conducted August 29, 2013, and showed that six faces were recognized, an improvement of two additional faces. On the second post-test which took place on September 1, 2013, the participant recognized five faces, an increase of two. On the last post-test on September 4, 2013, the participant

was able to recognize eight persons as opposed to four, doubling the results of the baseline test.

The parents were surprised at how few pictures the participant was able to identify. They expected he would miss some, but not so many of the people he had regular contact with. However, the participant's post-tests showed improvement when compared to the baseline tests. Both pre and post-tests showed a decrease in trial 2 before the increase in trial 3. The parents described this as one of their son's unique patterns. In many other examples of his past learning, the participant often displayed either no immediate gains from instruction or a set-back before a definite improvement could be registered. This trend was repeated in this testing.

Other results of the researcher's testing were that the participant was able to recognize the face of a family friend that passed away seven years ago. In contrast, he was unable to identify an instructor from two semesters ago. However, he was able to name one person on the third trial of baseline and then reliably in all three post-tests. Similarly, he was able to identify another person on his first and third trial in the post-testing. However, in the last trial of the post-tests, the participant was able to name two additional persons besides the six previously identified images. He was not able to identify these two pictures in any of the baseline and post-tests before. This outcome was very unpredictable and unexpected. The participant did not comment or show any signs of surprise or joy about recognizing two additional people. When the researcher asked him specifically, he answered that, "Recognizing people is very hard, maybe something clicked." The researcher also observed that the participant came up with strange names that had no connection to any of the people he knows during the facial recognition

testing. The parents noted that he has done this many times before, usually when he is guessing and has no idea of what to say.

Discussion

It was noticeable that the Posit Science Social Skills results somewhat mirrored the researcher's social skills testing in that facial recognition can be a difficult area for people on the autism spectrum (Attwood, 1998, p. 55; Bogdashina, 2005, p. 62; Benaron, 2009, p. 135). Researchers claimed that gaze abnormalities prevent children with autism from becoming "face experts". They use different areas of the brain than other children for facial recognition. However, it is possible for individuals with ASD to recognize people who are important to them by processing their faces in the fusiform gyrus. This is the area of the brain typically used. Unfamiliar faces can be learned through intervention programs, which form alternative pathways in the brain circuitry (Benaron, 2009, p. 135). Despite significant difficulties in this area, the participant improved. Results from the language skills training of Post Science and the researcher's testing revealed that this area is less difficult for the participant. The participant showed improvement in both the program's and researcher's data. As research has shown, people who are multilingual use different parts of the brain for each language (Ojemann, 1991, p. 2282). This raises the question as to whether it is possible that being bilingual gave the participant better language skills in two brain areas.

Due to time constraints, not all of the Posit Science activities in the language and social skills area could be attempted. The results are incomplete and do not reflect what might have emerged had it been possible to finish all the levels and stages in both programs. Gains could be related to how often the program was used (Silver & Oakes,

2001, p. 299). The software used is designed to address a wide variety of neurological issues from simple aging to Alzheimer's, traumatic brain injury, stroke, and more. The researcher's language testing may have been flawed to some extent and not reflected the actual disability of the participant. The results imply, as hoped, that computer based training could be useful for other individuals with similar conditions as the participant. However, generalization of these findings to a wider population is most likely not feasible, because they are based on only one case study with a very specific focus. It was not the purpose of this study to assess generalization to real life settings.

CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

This research study hoped to identify possible benefits in language and social skills using computer based training programs for a bilingual individual with autism. Social skills and language issues with sequencing, and working memory are extremely problematic for individuals on the autism spectrum and negatively impact their quality of life and employment opportunities.

Grasping social cues and displaying social awareness is difficult for individuals with ASD. Facial recognition, interpreting gestures, understanding social norms, and gaining information from social cues are challenging for them. This can lead to awkward situations, inappropriate behavior, inability to form friendships, and integration problems in school and society.

Another area of difficulty for individuals with ASD is language, such as sequencing, working memory, expressive and non-verbal communication. Impairment in this area often leads to frustration for individuals with autism and the people they encounter. For most of us, these language functions develop naturally in early childhood, but individuals with ASD need to be taught.

This case study examined to what extent, if any, training software produces improvements in the language and social skills of a bilingual, young adult who has

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autism. Based on progress in the Posit Science activities, the researcher's testing, and anecdotal data from the participant, his parents, and the researcher, one can conclude that training software produced improvements in both language and social skills in a bilingual participant with autism. The extent of the improvement is difficult to calculate based on the limitations of this study. The data looks promising, but actual improvement would need to be measured by the participant's increased ability to recognize faces, interact appropriately in social situations, and follow verbal instructions in his daily life. While the transfer of gains to real life situations is difficult to quantify, it does not lessen the obvious benefits experienced by the participant. For instance, by focusing on these difficult areas, the programs elicited the participant's attention to the problems. Through training, he was able to develop strategies which can help him respond appropriately. This study agrees with the literature (Moore et al., 2000; Attwood, 1998; Faja et al., 2008; Bernard et al., 2001): computer based training has some promise for individuals on the autism spectrum and could provide a cost effective, non-invasive, non-threatening avenue for improvement in these areas.

Recommendations

This research used a qualitative case study design focusing on one individual with ASD to find answers to the research questions. Due to limited time, not all programs could be finished. While the programs attempt to simulate realistic situations, activities are planned and programs do not involve real people or problems. Further research involving larger groups, greater time commitment, and investigating whether

benefits from computer based training would generalize to non-trained situations in real-life contexts is needed.

This study used generic software primarily designed to help individuals with related neurological problems. To specifically address the needs of individuals with ASD, it would be beneficial to apply customized software. Further research should be conducted to identify ways to create a heightened sense of alertness in individuals with ASD prior to giving instructions or other input. In this study, the use of "this is a test" seemed to trigger careful attention and follow-through by the participant. Duplicating that increased level of attention could be a powerful tool in education and daily living.

Future directions for the participant in this study are to use the other programs from Posit Science. Each of them trains different areas. The participant and his parents are interested to see the effects of finishing all the programs offered. The hope is that the continued use of these programs will be beneficial.

After all support from the educational system has ceased for young adults with ASD, this type of intervention may be very useful. It provides people with autism a way to learn on their own, thus boosting self-confidence (Attwood, 1998, p. 98). Moreover, learning is focused and purpose driven. Another advantage is that computers are special interest items (Attwood, 1998, p. 93) for many people with ASD. This can provide motivation (Moore et al., 2000, p. 218) to participate and facilitate learning. Given the improvement shown in this study, it is possible that other individuals on the autism spectrum with similar problems may also benefit from training. The recommendation is that parents of individuals with ASD evaluate similar programs.

Each person with ASD has different needs, and finding suitable software is important. Often companies offer free trial runs to explore programs and test if they are a good fit. Utilizing computer training for specific areas of difficulty exposes people with ASD to another way of learning. As with most people, a different approach is often a good way to acquire knowledge. The benefits of utilizing online training include a distraction-free, controlled environment and learning at individual pace. Additionally, computer based training allows repetition needed by individuals with ASD to learn difficult concepts. This researcher hopes that this study raises awareness of computer aided training for people with autism as an option for learning.

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