

**EFFECTIVENESS OF PROLOQUO2GO™ IN ENHANCING COMMUNICATION IN
CHILDREN WITH AUTISM DURING ABA THERAPY**

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Degree
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DEDICATION

This dissertation is dedicated to all families affected by autism spectrum disorder. I was lucky to fall into this career path at a young age, allowing it to mold my very identity. Through it, I have had the distinct honor of meeting some of the world's most inspirational individuals. You have shaped how I think, how I act—who I *am*. I live more in the moment. I appreciate the small things, and I don't fear the big ones as much. I am more patient. I am more empathetic. I am less judgmental. I celebrate all of life's quirks. I am a better person. Thank you for taking me along on your journey and allowing me to create my own.

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ABSTRACT

Autism is a bio-neurological developmental disorder presenting in early childhood that has a profound effect on an individual's ability to communicate. The iPad® with the Proloquo2Go™ app is a multilingual Augmentative and Alternative Communication (AAC) solution designed to assist people who have difficulty speaking or cannot speak at all. This study examines the effectiveness of the Proloquo2Go™ app delivered via iPad® to enhance the tacting, manding, and verbal completion repertoires of children with autism. Participants included five children between the ages of three and four years old diagnosed with an autism spectrum disorder (ASD) and with low to moderate receptive and expressive language skills. Prior to the study, participants were assessed using the Verbal Behavior Milestones Assessment and Placement Program (VB-MAPP), the Communication and Symbolic Behavior Scales (CSBS) Joint Attention and Constructive Play subscales, and the Motor Imitation Scale (MIS). Three participants (Group 1) scored low (2, 7, and 8 on the MIS; 1 on the CSBS; and Level 1 on the VB-MAPP), and two participants (Group 2) scored mid-range (18 and 20 on the MIS; 3 on the CSBS; and Level 2 on the VB-MAPP) on assessments of joint attention, constructive play, and motor imitation. A multiple baseline across behaviors design was employed to assess the effectiveness of Proloquo2Go™ in enhancing tacting, manding, and verbal completion during Applied Behavior Analysis (ABA) therapeutic sessions for both groups. The Proloquo2Go™ intervention was compared to American Sign Language (ASL) at baseline. Results of this study provide insight into the usefulness of Proloquo2Go™ in enhancing communication skills for children with ASD and complex communication needs during Applied Behavior Analysis (ABA) therapy. Specifically, this study provides evidence that using Proloquo2Go™ with some children with ASD and complex communication needs who are in early preverbal stages may be useful in enhancing tacting, manding, and verbal completion skills during ABA therapy, and using Proloquo2Go™ with children who are in later preverbal stages may be useful as a more accessible form of communication in addition to ASL.

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CHAPTER 1: INTRODUCTION

Background

Social workers provide a multitude of services to individuals living with developmental disabilities in the United States (Mackelprang & Salsgiver, 1996). In fact, seventy-five percent of social workers report working with someone with a developmental disability (NASW, 2006). Autism Spectrum Disorder (ASD), a developmental disability in the category of pervasive developmental disorders, has significantly increased in prevalence (American Psychological Association, 2013). The role of social workers in the lives of people with developmental disabilities may be increasing in part due to the swell in autism diagnoses.

Areas of social work assistance to this population include community-based housing, employment and training, education, medical, and psychological services (National Association of Social Workers, 2006). Management of ASD often includes treatment for impression management (helping those with ASD become more aware of their appearance and environment), interview skills training, prosocial competence (e.g., perspective taking), empathy training (help reading facial expressions and emotional recognition), counseling/therapy (including evaluation, sexual counseling, benefit counseling, and career counseling), social integration (to reduce social and emotional isolation and depression), social skills training, academic support, and transition planning (e.g., transition to college) (Tantam, 2011).

Social workers are part of a team of professionals affiliated with 14 hospitals nationwide which offer a comprehensive care model for the treatment of autism through the Autism Treatment Network (www.autismspeaks.org/science/programs/atn). They are also affiliated with Leadership and Excellence in Neurodevelopmental Disabilities programs (LEND) in 67 University Centers for Excellence in Developmental Disabilities (UCEDD), which are federally funded centers established to conduct research and provide services to individuals with developmental disabilities and their families (www.aucd.org).

Families of individuals with disabilities are often stressed, with families of children with autism reporting the highest levels of stress (Neely-Barnes & Dia, 2008), and are more likely to be living in poverty (Denavas-Walt, Proctor, & Smith, 2011). With the September 30, 2011 reauthorization of the Combating Autism Act, and the passage of the Autism Collaboration, Accountability, Research, Education, and Support Act of 2014, professionals were afforded \$693 million in continued investments for: Increasing awareness; reducing barriers to screening and diagnosis; supporting research on evidence-based interventions; promoting evidence-based guideline development for interventions; and training professionals to use valid screening tools to diagnose and to provide evidence based interventions (P.L. 113-157). Due to the aforementioned factors, it is vitally important that social work play a vigorous role in advocacy efforts and continued research examining evidence-based interventions for individuals with autism and their families.

While individuals with ASD have a great deal of variation in symptomology, prognosis, and comorbidity, there are generally three identifying features in ASD: social interaction impairment, language/communication impairment, and restricted or repetitive range of interests and activities (American Psychiatric Association, 2013.) The American Psychiatric Association's Diagnostic and Statistical Manual, Fifth Edition (DSM-5) provides standardized criteria to help diagnose ASD. As defined in the DSM-5, the criteria required for an ASD diagnosis are:

A. Persistent deficits in social communication and social interaction across multiple contexts, as manifested by the following:

- 1. Deficits in social-emotional reciprocity, ranging, for example, from abnormal social approach and failure of normal back-and-forth conversation; to reduced sharing of interests, emotions, or affect; to failure to initiate or respond to social interactions.*
- 2. Deficits in nonverbal communicative behaviors used for social interaction, ranging, for example, from poorly integrated verbal and nonverbal*

communication; to abnormalities in eye contact and body language or deficits in understanding and use of gestures; to a total lack of facial expressions and nonverbal communication.

- 3. Deficits in developing, maintaining, and understand relationships, ranging, for example, from difficulties adjusting behavior to suit various social contexts; to difficulties in sharing imaginative play or in making friends; to absence of interest in peers. Insistence on sameness, inflexible adherence to routines, or ritualized patterns of verbal or nonverbal behavior (e.g., extreme distress at small changes, difficulties with transitions, rigid thinking patterns, greeting rituals, need to take same route or eat same food every day).*

B. Restricted, repetitive patterns of behavior, interests, or activities, as manifested by at least two of the following:

- 1. Stereotyped or repetitive motor movements, use of objects, or speech (e.g., simple motor stereotypies, lining up toys or flipping objects, echolalia, idiosyncratic phrases).*
- 2. Insistence on sameness, inflexible adherence to routines, or ritualized patterns of verbal or nonverbal behavior (e.g., extreme distress at small changes, difficulties with transitions, rigid thinking patterns, greeting rituals, need to take same route or eat same food every day).*
- 3. Highly restricted, fixated interests that are abnormal in intensity or focus (e.g., strong attachment to or preoccupation with unusual objects, excessively circumscribed or perseverative interests).*
- 4. Hyper- or hyporeactivity to sensory input or unusual interest in sensory aspects of the environment (e.g. apparent indifference to pain/temperature, adverse response to specific sounds or textures, excessive smelling or touching of objects, visual fascination with lights or movement).*

- C. *Symptoms must be present in the early developmental period (but may not become fully manifest until social demands exceed limited capacities, or may be masked by learned strategies later in life).*
- D. *Symptoms cause clinically significant impairment in social, occupational, or other important areas of current functioning. These disturbances are not better explained by intellectual disability or global developmental delay. (APA, 2013 p. 50-51).*

Additionally, the DSM-5 requires the specification of severity level. Level 3 is described as “requiring very substantial support;” Level 2 is described as “requiring substantial support;” and Level 1 is described as “requiring support” (APA, 2013, p. 52).

The term *autism* is frequently meant to refer to a continuum of disorders including: autistic disorder, pervasive developmental disorder not otherwise specified, Asperger syndrome, childhood disintegrative disorder, and Rett's disorder. These were all separate diagnoses in the DSM-IV-TR under the category of Pervasive Developmental Disorder (APA, 2000). The aim of the DSM-5 and the Neurodevelopmental Disorders Workgroup that proposed the initial changes to the autism diagnostic criteria was to make changes to the DSM-IV-TR and to capture all individuals with ASD within the diagnostic criteria (Swedo et al., 2012). It is still unknown whether neurological research supports or challenges the collapse of the diagnoses under one ASD diagnosis (Pina-Camacho et al., 2012; Via, Radua, Cardoner, Happe, & Mataix-Cols, 2011; Yu, Cheung, Chua, & McAlonan, 2011) and there is debate among individuals with autism and Asperger syndrome as to the benefits and weaknesses of the changes (Linton, Krcek, Sensui, & Spillers, 2013).

In addition to the core impairments of autism listed in the DSM, there are numerous phenomenological features associated with the disorder. These vary widely from individual to individual, but in general, individuals with ASDs may have the following associated features: peculiar speech patterns or intonations; avoiding eye contact, failure to empathize;

hypersensitivity to sensory stimuli; extreme desire for sameness/routine; self-stimulatory behavior such as hand-flapping; need for less sleep; and extremely limited diet (APA, 2013).

Statement of the Problem

Autism Spectrum Disorder (ASD) is rapidly becoming one of the most common developmental disabilities around the world (Boyle et al., 2011). This steady climb in ASD is one of the most pressing social issues of our time. Advocacy groups such as Autism Speaks call the disorder an "epidemic." The annual cost to society is estimated at \$126 billion, with average lifetime care for an individual with autism costing between \$1.4 and \$2.3 million in the U.S. (Knapp, Mandell, Buescher, & Cidav, 2012). Two decades ago, the likelihood of having a child with autism was one in 10,000 (Fombonne, 2009). The latest report from the 2011-2012 National Survey of Children's Health now estimates the prevalence of autism to be two percent of children ages six to 17, or one in 50 children. The Centers for Disease Control and Prevention estimates the prevalence rate for ASD at one in 68 eight-year-old children, increasing 23% between 2006 and 2008 (CDC, 2014). Comparatively, prevalence rates of developmental disabilities such as Down syndrome (one in 691) and Fragile X syndrome (one in 5,000) are drastically lower and do not show the same dramatically increasing trends in prevalence (CDC, 2014; Parker et al., 2010).

Children diagnosed with ASD exhibit three main impairments: social interaction impairment, language/communication impairment, and restricted or repetitive range of interests and activities (APA, 2013). Of these, social interaction and communication impairments are most commonly treated with interventions within the therapeutic and academic settings. Interventions to enhance communication are of particular importance because the inability to communicate effectively often leads to problematic behaviors such as temper tantrums and aggression that can negatively affect quality of life and impede the delivery of evidence-based interventions (Howlin, Goode, Hutton, & Rutter, 2004; Venter, Lord, & Schopler, 1992.)

Over the past decade, the scientific and clinical communities have witnessed drastic changes in the way services are conceptualized and delivered to individuals on the autism spectrum. Many of these changes have been facilitated, in part, by new technologically advanced treatments and modalities. Within the area of ASD, computer-assisted therapies were introduced nearly 30 years ago (Panyan, 1984), and continue to be a focus for innovative research (e.g, Liu, Conn, & Sarkar, 2008). Not only can computer programs hold an inattentive child's interest because of their interactivity, computer programs and applications may also appeal to the autistic child's need for constant stimulation and visual acuity (Caron, Mottron, Rainville, & Chouinard, 2004).

Drawing on the visual and interactive learning preferences of individuals with ASD and the established use of computer-assisted therapies (Herskowitz, 2009), utilizing an app on a device such as an iPad® may be useful in increasing communication for this population. Current augmentative and alternative communication speech generating devices can cost up to \$8,000. Apps such as Proloquo2Go™, costing \$219, may hold a more cost-effective future for augmentative and assistive communication with this population that may be able to enhance learning opportunities in the therapeutic environment.

Purpose of the Study

The current study asks the question, "Does the utilization of the app Proloquo2Go™ delivered via iPad® enhance communication skills for children with ASD and complex communication needs?" The objective of the study is to determine the effectiveness of using Proloquo2Go™ to teach tacting (labeling), manding (requesting), and verbal completion (fill-in-the-blank) during Applied Behavior Analysis (ABA) therapy to children with ASD.

CHAPTER 2: LITERATURE REVIEW

Introduction

Prevalence

As previously outlined, the Centers for Disease Control and Prevention estimate the prevalence of autism at one in 68 eight-year-olds. The CDC determined from earlier surveillance efforts that age eight years was a reasonable age at which to monitor peak prevalence. The prevalence of ASDs in U.S. children aged eight years was estimated through a systematic retrospective review of evaluation records in multiple sites participating in the Autism and Developmental Disabilities Monitoring (ADDM) Network. Data were collected from existing records in eleven ADDM Network sites (areas of Alabama, Arizona, Colorado, Florida, Georgia, Maryland, Missouri, North Carolina, Pennsylvania, South Carolina, and Wisconsin) for 2006. As a spectrum of disorders, autistic disorder prevalence rates were estimated at 20.6/10,000; pervasive developmental disorder not otherwise specified prevalence rates were estimated at 37.1/10,000; Asperger syndrome prevalence rates were estimated at 6/10,000; and childhood disintegrative disorder prevalence rates were estimated at 2/100,000 (Fombonne, 2009).

Research by the CDC (2010), Fombonne (2009), and Baird et al. (2006) present more recent examples of epidemiological studies that have been conducted surrounding prevalence (the proportion of individuals in a population who suffer from a defined disorder) and incidence rates (the number of new cases occurring in a population over a period of time) of ASD since the 1980s when ASD was first listed in the DSM. These studies have shown the rate of autism is far higher than in prior studies. Previous reports estimated prevalence rates for autistic disorder around 4-5 per 10,000 births (Fombonne, 1999) (in U.S.); 10 per 10,000 (in Sweden) (Arvidsson et al., 1997); 20 per 10,000 (in Japan) (Honda et al., 1996); and 30.8 per 10,000 (in U. S.) (Baird et al., 2000). This increase in prevalence rates was also found in studies within the education system. Between 1994 and 2005, the number of children ages six to 21 receiving

special education services for ASD increased from 22,664 to 193,637 (Individuals with Disabilities Education Act, 2005; Newschaffer, Falb, & Gurney, 2005).

The rates do show a distinct rise in the prevalence and incidence of ASD; however, the limitations of the above epidemiological studies are many. For example, Fombonne (2009) examined 53 studies published in 17 countries between 1966 and 2008 that examined ASD prevalence rates. The age ranges in these studies were anywhere from birth to adulthood, with a median age of eight years old. The variation in the sizes of populations surveyed was vast, and studies with smaller sample sizes tended to yield higher prevalence rates than studies with larger sample sizes. Few of these studies provided an estimate of the reliability or validity of the screening procedure used to diagnose ASD, and the proportion of false negatives was usually not estimated or reported. Estimates of false positive rates have also not been reported.

Because of the large time span that was examined, different diagnostic criteria were used. In literature published prior to the classification of ASD in the DSM, Kanner's (1943) original criteria for autism were used. Other definitions, including Lotter's (1966) and Rutter's (1967), were used prior to 1980, as well. After 1980, DSM-based criteria for diagnosis took over (ICD-10 in countries outside the U.S.). Diagnostic tools such as the Autism Diagnostic Interview and the Autism Diagnostic Observational Schedule were used in studies published post-1980. Kielineen, Linna, and Moilanen (2000) have demonstrated that there is a two to threefold variation in prevalence of autism that results from applying different diagnostic criteria to the same survey data.

It is also important to keep in mind that prevalence and incidence rates are both inflated by broadened case definition and improvement in case ascertainment. There is, additionally, evidence that changes in diagnostic criteria over time, combined with more sensitive diagnostic tools and awareness, have led to an increase in reported cases of ASD (Bishop et al., 2008; Posserud et al., 2010; Shattuck, 2006; Vlassopoulos et al., 2010; Webb, Lobo, Hervas, Scourfield, & Frasier, 1997).

Etiology

Since the first identified cases of autism by Kanner (1943), many theories have been posited surrounding the etiology of ASDs. Although researchers are confident that genetics plays a significant role in autism, there is considerable evidence that autism is epigenetic in nature (Grafodatskaya, Chung, Szatmari, & Weksberg, 2010). "An epigenetic trait is a stably heritable phenotype resulting from changes in a chromosome without alterations in the DNA sequence" (Berger, Kouzarides, Shiekhhattar, & Shilatifard, 2009, p. 781). Autism may be most accurately described as a multi-gene disorder with epigenetic influences (Hu, 2013; Nguyen, Rouch, Pfeifer, & Hu, 2010; Rodier, 2000). The National Autism Association defines autism as a "bio-neurological developmental disorder" (NAA, 2011).

Despite the consensus that autism is highly genetic, the diagnosis of autism remains behavior-based, meaning that clinicians use the DSM-5 to diagnose ASD based on behavioral criteria versus biological-based medical testing. The only ASD that can be diagnosed based on biological factors is Rett syndrome, for which researchers have identified mutations of the methyl-CpG-binding protein 2 (MeCP2) gene in most diagnosed cases (Muhle, Tretacoste, & Rapin, 2004).

Genetics. The last several years have seen unprecedented advances in deciphering the genetic etiology of ASD. Genetics has been implicated in the etiology of ASD through many research studies. Data from whole-genome screens suggests interactions of hundreds of genes in the causation of autism (Muhle, Tretacoste, & Rapin, 2004; Schanen, 2006). However, significant evidence points to interactions among multiple genes with a combined exposure to environmental modifiers as the key to unlocking the mystery behind the etiology of ASD. (e.g., Nguyen, Rouch, Pfeifer, & Hu, 2010; Pickles et al., 1995; Risch et al., 1999).

Similar to schizophrenia, the risk of ASD is increased in children with older fathers and mothers (Wieser et al., 2008). In research using multivariate logistic regression models, it has been suggested that increasing father's age makes an independent contribution in conceptions

where the mother is younger than 30, but in older mothers the risk is entirely accounted for by maternal age at conception, with each year of age adding further risk (Shelton, Tancredi, & Hertz-Picciotto, 2010).

These findings collectively provide compelling empirical data that the genetic basis of ASD is highly heterogeneous, with hundreds of genes capable of conferring varying degrees of risk, depending on their nature and the predisposing genetic alteration. Moreover, many genes that have been implicated in ASD also appear to be risk factors for related neurodevelopmental disorders, as well as for a spectrum of psychiatric phenotypes (Talkowski, et al., 2011; Talkowski et al., 2012). With an increasingly firm genetic foundation, the coming years will hopefully see equally rapid advances in elucidating the functional consequences of ASD genes and their interactions with environmental factors, supporting the development of tailored interventions and potential ways to prevent negative symptomology (Dawson, 2008).

Males are four times as likely as females to develop ASD (Fombonne, 2009). This is similar to rates found for individuals with severe intellectual disability (Gillberg & Wing, 1999). There is no clear explanation for the higher prevalence rates in males versus females because male-to-male transmission in a large portion of families rules out X chromosome linkage. Iacobini and Mazziotta (2007) followed children born to families who already had at least two children with ASD. Subsequent children had a 0.46 risk of developing ASD if they were boys, but the risk for girls was 0.15. The authors concluded that girls have some protective factor that reduces penetrance of that autism genotype to a third child, but that the genotype itself is dominant and almost fully penetrant in boys. It should be noted that these strongly familial cases of ASD, in which almost all of the males in a family are affected, make a disproportionate contribution to the heritability estimates of the whole population of people with ASD. In other words, sporadic cases may still be the majority without much reducing heritability estimates. These sporadic cases may be the consequence of some inheritance from the parents, the consequence of some other biological effect on brain development, or may be better explained

by the two-factor theory of ASD, wherein a genetic predisposition and a subsequent environmental factor are both required (Tantam, 2011).

Another theory of ASD, the extreme male brain theory, is that fetuses that have been exposed to high levels of testosterone in utero are likely to develop ASD. It is argued that 1) male and female brains differ; 2) the difference in male and female brains can be attributed to testosterone levels in utero; 3) the difference has psychological implications that can be tested using measures of “systemizing” and ‘empathizing”; and 4) ASD is the result of an extreme variant of the male brain in which systemizing ability is particularly high and empathizing particularly low (Baron-Cohen et al., 2003; Baron-Cohen et al., 2011; Baron-Cohen & Hammer, 1997; Baron-Cohen & Belmonte, 2005; Baron-Cohen, 2003; Baron-Cohen, 2009; Yamasue et al., 2009).

Twin studies have reported 60% concordance for monozygotic (MZ) twins with a much lower concordance for dizygotic (DZ) twins. The higher concordance for MZ twins suggests genetic inheritance as the predominate causative agent (Muhle, Tretacoste, & Rapin, 2004). More recent research examining twin pairs and autism concordance found 88% concordance for MZ twins and 31% concordance for DZ twins (Rosenberg et al., 2009). To be noted, as well, is the overall higher functioning, psychiatric comorbidity, and Asperger syndrome concordance among MZ twins which suggests differential heritability for different ASD (2009). High heritability means that one in two people with ASD have an affected family member, usually in the male line (Cederlund & Gillberg, 2004).

Scientists in the 1960s and 1970s were naive to the genetic influences on autism. In fact, during the 30 years between Kanner's original study of children with autism referred to his clinic (1943) and those attending a special school (1973) he did not question the heritability of autism. In 1967, Rutter estimated a 2% concordance rate for siblings, which he considered to be very low. However, it came to be understood that even this low rate was enormously higher than the general population. Folstein and Rutter (1977) then undertook the first systematic twin

study, which not only confirmed a strong genetic influence, but also suggested that autism was a multifactorial disorder.

New research is examining the ability to diagnose ASD based on brain scans alone, suggesting a strong neurobiological component to ASD. Building upon previous studies, researchers and physicians can now use scans of the parts of the brain that focus on social communication and social awareness to predict autism while a child is still in the womb (Hobbs et al., 2007) and diagnose autism in children ages 8 to 18 with 92% accuracy (Uddin & Menon, 2009). Neuroimaging studies indicate involvement of specific brain regions, including the amygdala, hippocampus, and corpus collosum (Brambilla et al., 2003; Schumann et al., 2004).

Oberman, et al. (2005) discovered a group of neurons located in human and ape brains termed *mirror neurons* that have been implicated in the etiology of ASD. Mirror neurons play a role in the human ability to learn from modeled behavior, and in turn, allow for predictions to be made based on the intentions, actions, and emotions of others. All of these are key deficits in autism.

Hyperserotonemia. In 1961, Schain and Freedman first postulated that serotonin may contribute to autism after they discovered raised platelet serotonin levels (hyperserotonemia) in patients with autism (as compared to control subjects). This finding has been replicated in several studies, with about one-third of individuals with autism having a diagnosis of hyperserotonemia (e.g., Anderson et al., 1987; Hranilovic et al., 2007). In a study using rats, developmental hyperserotonemia was induced in the offspring of pregnant dam rats by treating them with a serotonergic agonist. The offspring exhibited seizures, spent less time in their dams, experienced decreased maternal bonding, exhibited greater gnawing reactions to novel stimuli, and had fewer behavioral inhibitions than control subjects (McNamara et al., 2008). After conducting postmortem analyses of the rats, it was discovered that rats with hyperserotonemia had a loss of oxytocin-containing cells in the paraventricular nucleus of the amygdala. These results are in direct correspondence with changes found in amygdalae of humans diagnosed

with autism spectrum disorders and are known to account for some of the social and behavioral changes found in autism (McNamara et al., 2008). Several genes involved in serotonin neurotransmission have been shown to be associated with ASD, although few findings have been successfully replicated (e.g., Cho, Park, Lee, & Kim, 2007; Cohen et al., 2003; Orabona et al., 2009).

Environment. As early as 1967, psychodynamic theorists posited the idea of the “refrigerator mother” as a causative factor in a child’s autism (Bettelheim, 1967). The “refrigerator mother” was a cold and insensitive mother who could not demonstrate love and attention to her child, and therefore, reared a distant and removed autistic child. As a result, many mothers of autistic children suffered from blame, guilt, and self-doubt. This theory has since been disproven; however, the concept that autism is caused by some outside environmental factors is still debated.

A number of researchers and autism advocacy groups have implicated potential environmental toxins in the etiology of ASD. A few specific environmental factors are associated with autistic behaviors, including prenatal exposure to thalidomide (Rodier & Hyman, 1998), valproic acid (Christianson et al., 1994), and rubella (Chess et al. 1978). Another environmental toxin implicated in autism is the Measles, Mumps, and Rubella (MMR) vaccination (Furlano et al. 2001; Wakefield et al. 1998). Additional studies have not found an association between autism and vaccinations (e.g., DeStafano & Chen, 2001; Fombonne & Chakrabarti, 2001). It is more likely that vaccinations correlate with the onset of autistic symptoms rather than cause autism itself (Doja & Roberts, 2006).

Allergies and Immunity. A small but growing body of literature is beginning to indicate a role for food allergies in ASD. For example, many parents and advocates claim that autistic children on gluten-free or casein-free diets are better able to control hyperactive and aggressive behaviors (Pennesi & Klein, 2012; Whiteley et al., 2012).

The hygiene hypothesis, which was originally postulated by Strachan (1989), proposes that increases in cleanliness and sanitation are associated with increased incidences of allergies and immune disorders, specifically the elimination of naturally occurring organisms that help regulate proper immune responses. One of these organisms is the helminth. Helminths are worms that live in the human digestive tract and have been significantly reduced since the 1930's with advances in sanitation and hygiene. Treatment with *Trichuris suis* ova (TSO), which are the eggs of intestinal helminths, has been shown to have a beneficial effect in autoimmune irritable bowel disease (Summers et al., 2003). The worms have also been shown to induce the host to produce immune modulatory molecules (Akdis et al., 2004). Combining information from the irritable bowel syndrome literature and evidence of immune dysfunction and increased levels of Th1 dominant pro-inflammatory cytokines in autism, advocates have explored the potential of TSO to address behavioral symptoms of autism. Efforts are currently underway to design a clinical trial and seek permission from the U.S. Food and Drug Administration (Grant, 2011).

Associated Rare Syndromes. Many conditions have been found to be associated with ASD. Clinical associations and epidemiologic findings are often mixed together because there is no method for determining which are chance findings, which are consequences of some other unknown factor that is independently causing ASD, or which are true causes. The likelihood of medical conditions being associated with ASD increases by up to nine times when ASD is also comorbid with intellectual disability (Matson & Shoemaker, 2009). The following is a list of rare syndromes and conditions found to be associated with ASD (Tantam, 2011):

1. Trigenocephaly with compression of frontal lobes
2. Mucopolysaccharidosis
3. Cohen syndrome
4. Goldenhar syndrome
5. West syndrome

6. In-vitro fertilization by intracytoplasmic sperm injection
7. Facial-port wine stain syndrome
8. Very low birth weight
9. Mitochondrial disorder
10. Oculoauriculovertebral spectrum (including CHARGE syndrome , genital hypoplasia, and deafness)
11. Macrocephaly (including Sotos syndrome)
12. Pachydermodactyly
13. Congenital viral infections (e.g., cytomegalovirus and congenital rubella)
14. Brain folate deficiency, creatine deficiency
15. Moebius syndrome
16. Bilateral temporal hypometabolism
17. Neurofibromatosis type 1
18. Cerebral palsy
19. Sensory impairments
20. Muscle disorders such as infantile hypotonia, myotonic and other dystrophies, including Duchenne muscular dystrophy and Becker muscular dystrophy
21. Tuberous sclerosis
22. Hypomelanosis of Ito and other oculocutaneous syndrome with albinism
23. Inborn metabolic errors (e.g., errors in purine or pyrimidine metabolism, Schindler disease, phenylketonuria)
24. Infantile hydrocephalus
25. Down syndrome
26. Disorders of the X chromosome including Fragile X syndrome, Turner syndrome, ring X chromosome, Aarskog syndrome
27. Cerebellar hypoplasias

- 28. Agenesis of the corpus callosum
- 29. Cowden syndrome
- 30. Chromosome 22q13 deletion (Phelan-Macdiarmid syndrome)

Treatment

Treatment for ASD often includes (but is not limited to): therapeutic counseling, vocational counseling, social skills training, emotional regulation/management, academic tutoring, pharmaceutical interventions, and behavioral interventions targeted at treating a range of behaviors. Focus here is intentionally placed on early intervention treatments and behavioral treatments, as they are the first treatments typically recommended after an ASD diagnosis or observation of symptoms due to the evidence supporting their efficacy (Howlin, Magiati, & Charman, 2009; Rogers et al., 2014).

Previous research has documented many significant gains in several developmental domains for children with ASD receiving early intervention (Ben Itzhak, & Zachor, 2007; Eldevik et al., 2009; Lord et al., 2005; Zachor, Ben Itzhak, Rabinovitch, & Lahat, 2007). Studies that have focused on early intensive behavioral intervention have documented significant progress in cognitive and educational functioning (Lovaas, 1987; Eldevik et al., 2009; Smith, McEachin, & Lovaas, 1993). The National Research Council (2001) identified the following characteristics of effective interventions for children with autism: early intervention; intensive instructional programming (defined as five days per week, 25 hours per week, and 12 months per year); the use of systematic instruction; one-to-one and small-group instruction; instructional objectives addressing social, communication, adaptive living, recreation-leisure, cognitive, and academic skills; ongoing monitoring of the effectiveness of interventions; an emphasis on the generalization of skills; and opportunities for supported interaction with typically developing students.

Applied Behavior Analysis Therapy (ABA)

With regard to ASD treatment, ABA is frequently identified as the treatment of choice (Foxy, 2008; Green, 1996; Kearney, 2007). Interventions used in ABA programs are based on evidence-based treatments (empirically validated treatments that have been found to be effective with a certain population in a certain context) (Kazdin & Weisz, 2003). The underlying assumptions of ABA are twofold: behavior is learned, therefore, by teaching new behavior (increasing positive behaviors and reducing negative ones), quality of life can be improved; and a cure for autism is not sought. ABA seeks only to alleviate intrusive, negative symptomology associated with the disorder and increase positive behaviors that support improved daily functioning.

ABA is the application of a scientific discipline called *behavior analysis*, which involves the process of systematically applying interventions based upon empirically validated principles of behavior to improve socially meaningful behaviors and to demonstrate that the interventions used are responsible for the improvement of the behavior (Baer, Wolf, & Risley, 1968; Fisher, Piazza, & Roane, 2011; Miltenberger, 2011). Socially significant target behaviors are identified, an intervention is devised and put into place, and the resulting data show whether or not the intervention was effective (Bailey & Burch, 2002). By simplest definition, ABA is a rule-governed approach to facilitate learning (Saffran, 2007).

The field of applied behavior analysis stresses the study of socially important behavior that can be readily observed, and it uses research designs that demonstrate functional control, usually at the level of the performer. The procedures developed by this field must be replicable, and the extent of the resulting behavior change must have important practical significance for the social community (Bailey & Burch, 2002, p. 17).

Another hallmark of ABA is the use of single-case research designs. Single-case research designs are a family of research and evaluation designs characterized by the systematic repeated measurement of a client's outcome(s) at regular, frequent, pre-designated

intervals under different conditions (baseline and intervention), and the evaluation of outcomes over time and under different conditions in order to monitor client progress, identify intervention effects, and more generally, learn when, why, how, and the extent to which client change occurs (Cooper et al., 2007).

The most important aspects of ABA stem from the concept of operant conditioning, the idea that one can use external reinforcement to increase the likelihood that a particular behavior will occur (Ferster & Skinner, 1957; Matson et al., 2012; Wolf, Risley, and Mees, 1964). Operant conditioning is considered to be a critical concept in the treatment of autistic children because they frequently lack the capacity to learn from their environment and appear to be less motivated to do so. Unlike a typically developing child, a child with autism may not fully grasp that it is in his or her best interest to learn to speak. External rewards function as motivators (or “reinforcers”) and increase the child’s capacity to attend and learn.

Initial evidence of ABA’s effectiveness came in the 1960s with papers by Wolf, Risley, and Lovaas, who used highly structured operant learning paradigms to improve maladaptive behaviors in children with autism (e.g., Baer, Wolf, & Risley, 1968; Lovaas, Berberich, Perloff, & Scheffer, 1966; Lovaas, Freitag, Newson, & Whalen, 1967). Since then, thousands of research articles have been published in peer-reviewed journals documenting the effectiveness of ABA across a variety of populations, interventionists, settings, and behaviors. Moreover, there is an entire peer-reviewed journal dedicated to its efforts, titled the *Journal of Applied Behavior Analysis*.

ABA methods support persons with autism and related developmental disabilities in at least five ways: teach new skills (e.g., systematic instruction and reinforcement procedures to teach functional life skills, communication skills, or social skills); reinforce and maintain previously acquired skills; generalize behavior from one situation to another (e.g., teaching and transferring social skills to natural settings); restrict or narrow conditions under which interfering behaviors occur (e.g., modifying the learning environment), and reduce interfering behaviors by

discontinuing their reinforcement and reinforcing competing replacement behaviors. These methods are incorporated into ABA programs and are comprised of two major components: assessment of behavior in the educational context and intervention based upon the assessment to improve academic, vocational, life, and social behavior (Steege, Mace, Perry, & Longnecker, 2010). The current study will focus on the first of these, teaching communication skills.

ABA research has the following unique focuses:

Applied focus. An applied problem is one that has immediate face validity and social value. It is something that nearly anyone defines as a problem (e.g., crime). Not only must this, but the administration of the intervention to attempt to solve the problem must be doable. “It is not prohibitively complicated or arduous. Implementing behavioral strategies...might best be described as good old-fashioned hard work” (Heward, 2005, p.322).

Behavioral focus. The primary focus of measurement procedures in ABA is observable behavior. Inferred phenomena such as states of mind and feelings are not selected as targets for primary data collection. Rather, the focus of ABA research is on what the person actually *does*, as observed and recorded by someone else. The behavior that is changed as a result of certain procedures must be that of the participant and not the observer (Cooper et al., 2007). A hallmark of ABA is precise and consistent direct measurement of behavior, as opposed to reliance on teacher impressions of change on a standardized checklist (Romanczyk Gillis, White, & Digennaro, 2008). Additionally, behavioral observation is conducted as the behavior is occurring within the natural environment and observations are made repeatedly over time. This allows for the avoidance of recall biases and ensures that observations will have social validity and apply to the real-life environment of the client. Continued observation allows for examination of behavior and conditions influencing behavior over differing periods of time (Orme & Combs-Orme, 2012).

Analytic approach. ABA research must demonstrate believable experimental control over the behavior in question (Baer, Wolf, & Risley, 1968; Siri & Lyons, 2010). There must be a

functional relationship between the intervention and the behavior change. Systematic and orderly research designs and execution of experiments ensures that an intervention was responsible for a specific change in behavior. The criterion of believability is often very difficult to identify and cannot usually be specified in terms of statistics or strict rules. Judgments of the data by colleagues and consumers are necessary to determine if a convincing demonstration has been made (Bailey & Burch, 2002).

Technological approach. The term *technological* refers to the degree of specificity involved in the description of procedures used as independent variables in behavior analysis (Cooper et al., 2007). Procedures must be described with enough accuracy so that they can be replicated by other researchers and practitioners and must also be acceptable to consumers (Gast & Ledford, 2010).

Conceptual systems. The ABA researcher looks for commonalities in procedures that allow for some common conceptual language to emerge and show the consumer "how similar procedures may be derived from basic principles" (Baer, Wolf, & Risley, 1968, p. 96). This includes finding consequences that can be counted on reliably. For example, popcorn may be regarded as a "treat" to get a child to clean up his toys, but consequences must be found that can be counted on to increase behaviors in a reliable fashion. These are labeled *reinforcers*. Traditionally, the most common reinforcers used were food items. The over use of food as reinforcement has been deemed unhealthy, and rewards including affectionate or playful social interaction such as tickling or high-fives and toys such as music or items specific to a child's interests are used more frequently (Tantam, 2011).

Effectiveness. How effective an intervention is refers to the absolute changes in behavior that result from being exposed to the independent variable (Kennedy, 2005). Effectiveness in ABA research is measured not by statistical tests but rather by questioning consumers of the findings in order to determine the social importance of the effects (Baer, Wolf, & Risley, 1968). This is different from the analytic dimension mentioned previously in that

decisions about causality (analytic) are different from those about benefit (effective) (Bailey & Burch, 2002). For example, a researcher may show experimental control and have it recognized by colleagues; however, the consumer may feel that while the procedure produced a change in behavior, it was too small to have any value.

Generality. ABA researchers are usually interested in the generalization of responses acquired in a behavioral framework. A behavior change has generality if it lasts over time, appears in environments other than the one in which the intervention that initially produced it was implemented, and/or spreads to other behaviors not directly treated by the intervention. A behavior change that continues after the original treatment procedures are withdrawn has generality (Cooper et al., 2007). For example, a child may generalize social skills from a therapeutic preschool setting to the playground or at home with siblings. How and why such generalization occurs constitutes an important area of future research.

Applied Behavior Analysis Language Interventions

ABA language interventions often produce substantial gains for children with ASD (Lovaas, 1987; Matson, Benavidez, Compton, Paclawskyj, & Baglio, 1996; Matson, et al., 2012; Smith & Lovaas, 1998). A major trend is more intensive and extensive efforts. Also, these treatments are being applied at very young ages. These trends are intertwined with the focus on early intensive behavioral interventions (Howard, Sparkman, Cohen, Green, & Stanislaw, 2005).

A variety of specific intervention strategies have been described in recent studies. Ingvarsson and Hollobaugh (2011) for example, used constant prompt delays to teach three four-year-old boys with autism to answer questions. Leaf, Sheldon, and Sherman (2010) taught three children with autism to answer questions using simultaneous prompting. Axe and Sainato (2010) used a similar method, named most-to-least prompting, to teach preschoolers with autism to follow directions. Murphy and Barnes-Holmes (2010) used a matching to sample task to teach three autistic teenage boys to request items (mand). Thus, different variations of prompting continue to be effective methods for enhancing communication. This group of

methods continues to be researched and perfected while establishing more potential effective treatment options.

A second method that has gained considerable momentum is the Picture Exchange Communication System (PECS). In one study using these methods, Chaabane, Alber-Morgan, and DeBar (2009) taught the mothers of two boys with autism to implement these methods, using supervision, written instructions, explanation, modeling, practice, and feedback. The mothers were able to effectively implement these treatments.

Some ABA curricula follow a traditional psycholinguistic view of language (Leaf & McEachin, 1999; Lovaas, 2003). The current study uses a form of ABA based on the *verbal behavior model*. Professionals adhering to Skinner's conceptualization of language (verbal behavior model) (Skinner, 1957) refer to their curriculum and intervention programming as *applied verbal behavior*. The applied verbal behavior model views language functionally with each verbal response defined by its unique antecedent and consequences, thus applied verbal behavior model language instruction focuses on the acquisition of functional and distinct verbal operants (e.g., mands) rather than topographies (e.g., words) (LeBlanc, Esch, Sidener, & Firth, 2006).

For children with limited language skills, applied verbal behavior model practitioners often prefer strengthening mand (request) repertoires first based on Skinner's conceptual analysis of language and Michael's (1993) concept of the establishing operation. The establishing operation distinguishes the mand, or request, from other verbal operants in that it evokes a response that specifies a uniquely effective consequence and is the only verbal operant that directly benefits the speaker.

Applied verbal behavior model interventions typically involve manipulation of establishing operations. These may occur too infrequently in the typical environment for a child with autism to develop a mand repertoire. Practitioners arrange the environment such that the learners will mand for preferred items or missing items (Sundberg, Loeb, Hale, & Eigenheer,

2002). Another common feature of the applied verbal behavior approach is pairing of antecedents of strong verbal operants with stimuli that weakly control other verbal operants (i.e., stimulus transfer procedures) to teach new verbal operants. For example, a picture that evokes a tact (label), “cat” will be used to teach the intraverbal “Can you name an animal?” and subsequently faded to transfer control to the verbal antecedent (Drash, High & Tudor, 1999; Finkel, & Williams, 2001; Sundberg, Endicott, & Eigenheer, 2000). Thus, mands, tacts, and intraverbals are incorporated as important outcome variables in the current study. Additionally, tools consistent with Skinner's approach guide assessment and intervention efforts (e.g., VB-MAPP) (Sundberg & Partington, 1998; Sundberg & Michael, 2001).

Computer-Assisted Therapy

Over the past ten years, the scientific and clinical communities have witnessed drastic changes in the way services are conceptualized and delivered. Many of these changes have been facilitated, in part, by new technologically advanced treatments and modalities. Within the area of ASD, computer-assisted therapies were introduced nearly 30 years ago (Panyan, 1984), and continue to be a focus for cutting-edge research. Not only can computer programs hold an inattentive child's interest because of their interactivity, computer programs and applications may also appeal to the autistic child's need for constant stimulation and visual acuity (Caron, Moltron, Rainville, & Chouinard, 2004). In addition, the use of visual tools (rather than auditory prompts) may be superior because echoic prompts leave some children with ASD dependent on such prompts (Vedora, Meunier, & Mackay, 2009).

Computer-assisted therapies designed for individuals with ASD have been used to assist with social interaction instruction (Bernard-Opitz, Sriram, & Nakhoda-Sapuan, 2001; Grynszpan, Martin, & Nadel, 2005; Silver & Oakes, 2001); communication and language enhancement (Bosseler & Massaro, 2003; Heimann, Nelson, Tjus, & Gillberg, 1995; Tjus, Heimann, & Lundälv, 2003); and reading skills (Heimann et al., 1995; Tjus, Heimann, & Lundälv, 2003; Williams, Wright, Callaghan, & Coughlan, 2002). Several studies also indicate the effectiveness

of computer assisted therapies such as video modeling to enhance initiation of communication (e.g., Buggey, 2012; Cihak, Smith, Cornett, & Coleman, 2012) and responding (e.g., Hart & Whalon). Moreover, Moore and Calvert (2000) found that computer instruction was more successful than teacher instruction for children with ASD in acquiring vocabulary.

With the advent of the iPad® (and other smart tablets) and smart phones, have come *apps*, or applications designed for a specific purpose such as playing an interactive game, watching a film, or browsing the Internet. Some of these apps, which have the same interactive benefits as their computer-based predecessors but are far more portable and inexpensive, have been designed for use with individuals with ASD. Examples of "Apps for Autism" include: ABA Therapy Images, All About Me, augie AAC, ChoiceBoard Maker, Communicating Basic Needs App, and Proloquo2Go™ (see Brady, 2011, www.SNapps4kids.com, and www.a4cwsn.com for a more complete list).

Anecdotally, teachers, parents, and therapists describe the profound differences that apps have made in helping autistic children develop skills. Some provide a means of communicating for children with autism who cannot speak or who have language delays. Other apps help children learn to handle social situations that can be stressful, such as crowds. Still other apps promote functions like writing or fine motor skills. Mobile technologies offer a number of potential benefits for the enhancement of communication including increased awareness and social acceptance of augmentative and alternative communication, greater consumer empowerment in accessing augmentative and alternative communication solutions, increased adoption of augmentative and alternative communication technologies, greater functionality and interconnectivity, and greater diffusion of augmentative and alternative communication research and development (McNaughton & Light, 2013).

Preliminary evidence suggests the usefulness of apps to teach new skills to children and adults with ASD (Carpenter, 2012; Gosnell, Costello, & Shane, 2011; Hyatt, 2011; McLeod, 2011; Sennott & Bowker, 2009). Individuals with ASD who have been trained to use Apple iPod

Touch PDAs as vocational supports in the workplace have improved functional performance and reduced behavioral challenges (Gentry, Lau, Molinelli, Fallen, & Kriner, 2012). iPod Touch can additionally be used to help achieve Individual Education Plan goals for young children with developmental disabilities (Marks & Milne, 2008). Adolescents with autism can successfully learn to use an iPod Touch to independently perform multi-step requesting sequences (Tunney & Ryan, 2012).

Some of the strongest initial evidence is in favor of using an app called Proloquo2Go™. Proloquo2Go™ is a multilingual augmentative and alternative communication solution to be used on the iPad or iPhone designed to assist people who have difficulty speaking or cannot speak at all. Proloquo2Go™ can be adapted to suit the needs of a wide range of users with varying literacy levels. Featuring natural-sounding voices, speech can be generated by tapping buttons with symbols or typing using the on-screen keyboard with word prediction (www.assistivesoftware.com/product/proloquo2go).

Several preliminary studies indicate the effectiveness of using Proloquo2Go™ with children and adolescents on the autism spectrum to enhance communication. Sennott and Bowker (2009) found that Proloquo2Go™ can be used with children with ASD to meet fully daily communication needs, and additionally identified Proloquo2Go™ in their “best practices” category for its use of symbols, visual supports, voice output, and ability to support inclusion. In a thesis, King (2011) found that Proloquo2Go™ enhanced the mand (request) repertoire for three children ages three to five with autism as compared to the Picture Exchange Communication System (PECS). In another thesis, Wilkins (2013) evaluated the results reported in ten studies that used the iPad/iPod® with children or adults in need of augmentative communication. The results suggested that iPad/iPod® usage most often employed the Proloquo2Go™ application. In addition, those children with a diagnosis of autism were most likely to show positive results from the use of these devices. Of the 31 subjects in the ten studies, 74% showed improvement. Eighteen of the 20 children diagnosed with autism were

reported to have improved through the use of the iPad/iPod®. In yet another thesis, Valenzuela (2013) evaluated the effects of a high-tech (Proloquo2Go™) and low-tech ACC device on reducing echolalia in a verbal eleven-year-old child with autism during conversational speech using a single-case alternating treatment research design. The results supported the use of Proloquo2Go™ in reducing echolalic utterances. Additionally, Duncan and Tan (2012) found evidence to support the use of Proloquo2Go™ as a visual task manager for students with autism, Roth (2013) found evidence to support the use of Proloquo2Go™ to enhance communication and performance in physical education classes, and van der Meer, Sutherland, O'Reilly, Lancioni, & Sigafos (2012) demonstrated the effectiveness of Proloquo2Go™ in helping autistic students to communicate in a classroom setting.

Augmentative and Alternative Communication

"Communication is the ability to relay information and thoughts using a reliable method of expression that produces a mutually understood message intentionally exchanged between two or more people" (Spears & Turner, 2011, p.19). For children with ASD, the ability to communicate is often significantly impaired. In fact, a portion of children with ASD may never develop functional communication (Pickett, Pullara, O'Grady, & Gordon, 2009).

The fact that language development can be positively affected by early treatment has tremendous potential significance, because the emergence of spoken language is one of the most important variables predicting better outcomes in later childhood and adulthood (Gillberg & Steffenburg, 1987; Howlin et al., 2004; Venter, Lord, & Schopler, 1992). Thus, given the role of language acquisition in shaping long-term outcomes, it has become important to identify the most successful strategies for facilitating language acquisition in young children with ASD, who demonstrate significant delays in at least some aspects of language and communicative development (Tager-Flusberg, Paul, & Lord, 2005).

Previous studies have identified differences in both structural and functional aspects of brain organization that can impact language in individuals with ASD (e.g., Barnea-Goraly et al.

2004; Sparks et al. 2002). Studies have reported that speech perception and perception of socially relevant sounds are impaired in autism (Surian, 2012). Unlike typically developing children, those with autism fail to spontaneously orient to speech and to sounds of social origins, such as hand clapping (Dawson, Meltzoff, Osterling, Rinaldi, & Brown, 1998, Dawson, et al., 2004) and display a lack of preference for their mother's voice in naturalistic settings (Klin, 1991). Such differences have implications for the ways in which information is processed and how learning occurs in individuals with ASD. At a behavioral level, deficits in attention, language, and social interaction skills may impact the child's ability to use skills in one domain to support the development of skills in a different domain. Thus, abilities influence the quality of children's earliest interactional experiences, which exert a significant and cumulative influence on subsequent development, especially in the area of spoken language acquisition (Hart & Risley, 1992). Early language abilities and language learning opportunities are especially important given that the development of verbally fluent spoken language during the preschool years is a strong prognostic indicator of long-term outcomes in children with ASD (e.g., Howlin, 2003).

For children with ASD who struggle to develop functional communication, augmentative and alternative communication systems are frequently used. These include: speech generating devices, the Picture Exchange Communication System (PECS), and symbolic language systems (e.g., sign language).

Speech-generating devices are being used increasingly as augmentative and alternative communication options for individuals with developmental disabilities who have limited or no spoken language (Lancioni et al., 2007; Schlosser & Blischak, 2001; Sigafoos, Didden, & O'Reilly, 2003, Sigafoos, et al., 2009; van der Meer et al., 2012). Speech generating devices typically consist of a computer-based processing unit with a visual display. The visual display holds a number of vocabulary items (e.g., photographs, line drawings, or printed words). The devices are programmed to produce digitized (i.e., recorded) or synthesized speech output

corresponding to each vocabulary item. For example, touching the line drawing of an apple from the visual display might produce corresponding speech output such as, “I would like an apple, please.”

Two recent reviews, summarizing a total of 58 studies, provide empirical support for the use of speech generating devices in communication interventions for individuals with developmental disabilities (Rispoli, Franco, van der Meer, Lang, & Camargo, 2010; van der Meer & Rispoli, 2010). Specifically, van der Meer and Rispoli (2010) reviewed 23 studies that collectively provided SGD intervention to 51 children (3 to 16 years of age) with ASD. The majority of these studies (78%) provided conclusive evidence that children with ASD can be taught to use various types of speech generating devices to request preferred objects. Similarly, Rispoli et al. (2010) reviewed 35 studies that focused on teaching SGD use to a total of 86 participants (1–42 years of age) with other types of developmental disabilities (e.g., intellectual disability, cerebral palsy, and multiple disabilities). These reviewers also found conclusive evidence that such individuals can learn to use a range of speech generating devices for functional communication. Based on these two systematic reviews, there is empirical support for the use of speech generating devices within communication interventions for individuals with developmental disabilities.

American Sign Language (ASL)

“American Sign Language (ASL) is a complete, complex language that employs signs made by moving the hands combined with facial expressions and postures of the body” (National Institute on Deafness and Other Communication Disorders, 2014). In spoken language, words are produced by using the mouth and voice to make sounds. For people who use ASL, vision is the most useful tool for communication. ASL users employ their hands and facial expressions to communicate (NIDCD, 2014).

Many children with ASD fail to develop speech or have limited or unintelligible speech (Matson, Mahan, Kozlowski, & Shoemaker, 2010). Using a form of alternative communication

such as ASL is often a more effective means of communication than verbal speech for these children. A recent systematic review found that ASL could enhance communication for children with autism (Wendt, 2009). In several studies, ASL is compared with speech generating devices. In many of these studies, the researchers found that the children were able to learn to request items using speech generating devices, picture exchange systems, and ASL. However, the children often learned to request at differing rates and to differing degrees of proficiency among the three modes (van der Meer et al., 2012). In another 2012 study, van der Meer, et al. compared three augmentative and alternative communication modes, specifically a speech generating device, picture exchange communication system, and manual signing (ASL). This study involved four new children with developmental disabilities aged six to 13 years. The children were taught to make a general request for preferred snacks or toys using a speech generating device, picture exchange, and ASL. While all four children reached the acquisition criteria with picture exchange and the speech generating device, only two also achieved the acquisition criterion during ASL instruction.

While some proponents of teaching ASL have claimed that individuals with disabilities may prefer to use an augmentative and assistive communication device and may not be motivated to learn to use speech to communicate (Glennen & DeCoste, 1997), others argue that augmentative and assistive communication facilitates speech for individuals with disabilities who have speech impairments (Ronski & Sevcik, 1996). The author of the current study argues that augmentative and alternative communication devices benefit speech production because they reduce pressure on the individual for speech production, thereby reducing stress and facilitating speech. Additionally, the motor and cognitive demands of speech and/or ASL are bypassed using augmentative and alternative communication, allowing focus on the goal of communication. Acquiring basic communication skills, the individual may be better able to then allocate more cognitive resources to improving speech production. Moreover, in our current society wherein mobile technology has become accepted and almost required, an individual

oftentimes may appear more “normal” in public situations using a mobile assistive device to communicate.

Because ASL accesses the part of the brain involved in speech production (Braun, Guillemin, Hosey, & Varga, 2001; MacSweeney, Capek, Campbell, & Woll, 2008), the agency where the current study was conducted used ASL with all of their students in the interest of encouraging higher order thinking and verbal speech. For these reasons, ASL was baseline in the current study.

Summary and Introduction of Current Study

The current study examines the effectiveness of a speech generating device (Proloquo2Go™ delivered via iPad®) in enhancing communication for nonverbal children with ASD. Prior to the introduction of the Proloquo2Go™ intervention, baseline data were collected using a symbolic language system, American Sign Language (ASL). ASL is the most commonly used communication intervention for children at the center where the study was conducted. The center relies heavily on ASL because it requires higher-order thinking and encourages emotional expression among children with autism who may struggle to produce appropriate facial expressions (Kane, Connell, & Pellecchia, 2010).

Individuals with severe expressive communication disorders benefit most from the use of speech generating devices. These include individuals who use gesture, speech, and/or written communication methods that do not adequately address their expressive communication attempts or needs (Spears & Turner, 2011). Even children with ASD who have some ability to use ASL may benefit from the use of speech generating devices. Once equipped with multiple options for expressive communication, the learner can pair the most effective and efficient method with the communication situation. This allows for faster and easier communication exchanges, more communication opportunities, and more learning (Downey et al., 2004). Additionally, ASL cannot always be used in community or even family settings where other

individuals are not fluent. In these instances, the use of speech generating devices can be used to enhance community participation and promote empowerment and self-determination.

The current study will build upon previous research by providing more evidence as to how, when, and where mobile augmentative communication devices such as Proloquo2Go™ can be useful for children with ASD. For example, the current study takes place within the context of the applied behavior analysis treatment setting, which is unique to studies examining the effectiveness of Proloquo2Go™ for enhancing communication for children with autism. This is of utmost importance since the applied behavior analysis treatment setting is vitally important for the growth and development of the young learner with ASD. Additionally, the current study uses a multiple baseline across behaviors single-case design, favored by researchers interested in studying communication interventions for children with ASD. In a recent systematic review to identify research studies that used high-tech devices (e.g., smartphone and iPad® technology) to teach functional requesting skills to individuals under the age of 16 with ASD, multiple baseline designs were the most commonly used among 16 identified studies. Moreover, the researchers concluded that interventions were largely positive, suggesting high-tech devices can be successfully implemented as alternative communication devices for individuals with ASD. Further research was suggested for evaluating claims made about facilitating requesting skills in children with ASD, highlighting the importance of the emphasis on manding (requesting) in the current study (Still, Rehfeldt, Whelan, May, & Dymond, 2014).

CHAPTER 3: MATERIALS AND METHODS

Introduction and Research Question

The current study uses a multiple baseline across behaviors single-case research design with five children on the autism spectrum to ask the question, "Does the utilization of the app Proloquo2Go™ delivered via iPad® enhance communication skills for children with ASD and complex communication needs during ABA therapy?" The objective of the study is to determine the effectiveness of using Proloquo2Go™ in teaching tacting (labeling), manding (requesting), and verbal completion (fill-in-the-blank) tasks during Applied Behavior Analysis (ABA) therapy to children with ASD. Additionally, each of the five participants was classified as having either "low" or "mid-range" scores on three standardized measures in order to examine possible prerequisite skills of children who would be responsive or nonresponsive to the intervention.

Participants

The sample of individuals in this study consisted of five children diagnosed with ASD with complex communication needs between the ages of three and five years old who were receiving ABA therapy from a Board Certified Behavior Analyst (BCBA) or ABA therapist. Children were being studied in this research project because of the need for research concerning evidence-based practices for early intervention. Preschool-aged children diagnosed with ASD are the primary targets of early intervention, and previous methodologically sound studies investigating similar interventions have specifically focused on this age range (see Warren et al., 2011 for a systematic review). Moreover, if children with ASD learn verbal skills by around age five, they tend to become happier and higher-functioning adults than do their nonverbal peers (Billstedt, Gillberg, & Gillberg, 2005).

Children were recruited from one agency providing ABA therapy in East Tennessee by personal invitation from the principal investigator. Their parents/guardians were presented with a written description of the study and its potential risks and benefits. Services at the agency are

provided by a BCBA and three employees trained in ABA therapy. Each participant received the therapeutic intervention from his or her primary therapist in addition to the other therapists employed at the agency. Written consent was given for the proposed project to take place at the agency (Appendix 1).

To be included in the study participants had to be diagnosed with ASD and require complex communication intervention (Level One or Two on the VB-MAPP assessment, as described in more detail in Appendices 4 and 5), and be between the ages of three and five years old. Parents of participants signed a consent form (Appendix 2) and agreed to release documentation of an ASD diagnosis from a physician or psychologist and prior behavioral assessments, including the VB-MAPP. All documentation was kept in a locked file cabinet and computer on the University of Tennessee campus.

Setting

The agency where the study took place provided ABA therapy to approximately 15 children on the autism spectrum. The center employed one BCBA and three bachelors-to-Ph.D.-level ABA therapists who worked under the supervision of the BCBA. The center had a private office with a secure file cabinet, a spacious waiting room with toys, a full kitchen, a handicap accessible bathroom with a changing table, and three therapy rooms approximately 12' x 15' in dimension. Each therapy room was equipped with a table and chairs, storage area, therapy equipment, and children's toys. Each room was also equipped with a video camera that was used during therapy sessions. All parents or guardians with children receiving therapy at the center signed a release form for ABA therapy sessions to be video-taped for training and research purposes. Parents/guardians were additionally asked on consent forms if they would or would not like video-taping to occur during the proposed study and had the option to decline video-taping with no penalty. No parents/guardians declined video-taping.

Incentive

The agency received three iPads® (valued at approximately \$400 each) and the Proloquo2Go™ app (valued at approximately \$219). The rationale behind providing this incentive was to allow the agency and its clientele to continue to enjoy the therapeutic benefits of the Proloquo2Go™ app after the conclusion of the study. ABA therapists also received \$25 gift cards to a local retail store for their time in training.

Materials

Materials used for this study included three iPads®, the Proloquo2Go™ app, data collection sheets (see Appendix 3 for example of data collection sheets), three video cameras, a computer with Microsoft Excel® and Word®, and the VB-MAPP, MIS, and CSBS assessments (each described in more detail in Appendix 4 and 5) for each participant. The CSBS was used in the current study prior to the implementation of the intervention phase. It was used to assess communication and symbolic abilities of the participants, and target behaviors were selected based on the VB-MAPP assessment. The purpose of the evaluation using the CSBS was to determine delays in social communication and expressive speech/language. The MIS was used in the current study prior to implementation of the intervention phase. It was used to assess a child's ability to imitate single-step motor imitation tasks. The VB-MAPP was conducted prior to the study. The initial assessment was done by a therapist at the center where current study data were gathered. It was intended to assess the verbal capabilities of each participant.

Instrumentation

Three different instruments were used during the current study: the VB-MAPP, MIS, and CSBS. Each instrument was administered prior to the start of the study, with the VB-MAPP assessment occurring prior to the current research project, at the time of the participant's arrival to the agency. The VB-MAPP was administered by a BCBA at the agency where data were collected, and the MIS and CSBS were administered by the principal investigator. The purpose of each instrument was to assess each participant's level of expressive speech, ability to

imitate, and symbolic behavior. Specifically, the MIS and CSBS, in combination with the VB-MAPP, allowed the principal investigator to determine whether or not each participant was a good candidate for the intervention (e.g., participants did not score “high” on measures of communicative ability). Additionally, if the agency where the current research study was conducted decided to continue use of the Proloquo2Go™ app with the five participants, the therapists could use the CSBS and MIS as outcome measures (in addition to the VB-MAPP) to assess whether or not the participants were continuing to make progress in the area of communication. Moreover, each of the five participants was classified as having either “low” or “mid-range” scores on each of these measures in order to examine possible prerequisite skills of children who would be responsive or nonresponsive to the intervention. For example, Yoder and Stone (2006) noted that children with low object exploration befitted more for RPMT than PECS methods in the development of spoken communication skills (frequency of non-imitative spoken communication acts and number of different non-imitative words spoken). Conversely, children with high object exploration befitted more for PECS than RPMT methods. Therefore, this research asks the question, what, if any, prerequisite are required to learn tacting, manding and verbal completion using Proloquo2Go™?

Target Behaviors

Target behaviors were selected based on the VB-MAPP assessment. Target behaviors were: tacting (labeling), manding (requesting), and verbal completion (e.g., ready, set, ____). Therapists chose appropriate objects and terms for tacting, manding, and verbal completion depending on the repertoire of each individual participant and based on a preference assessment. A paired choice preference assessment (Fisher et al., 1992) was completed by each participant’s therapist. As part of this assessment, the participants were asked to make choices from various items presented in a pair. The result of this assessment indicated highly preferred items and least preferred items. Once these items were identified, they were used to develop a repertoire of items to be offered at various study phases of the research. This method

of identifying preference ensured that the participants' preferred items for the manding portion of the study and for reinforcers were incorporated. All participants were challenged with tacting, manding, and intra-verbal targets for which they had not before been tested.

Research Design

This study used a single-case research design, which is the method of choice to examine the effectiveness of treatment approaches utilizing ABA for individuals with ASD (Bailey & Burch, 2002; Cooper et al., 2007; Kazdin, 2011). ASD is a field that relies heavily on single-case designs, to personalize and customize interventions for individual needs. Single-case design research's use of each participant as his/her own control subject provides an understanding of individual differences, rather than the difference of the average between groups. For this reason, single-case design research is often considered the best research design when measuring behavioral change.

The National Center for Technology Innovation acknowledges the important role single-case design research plays in identifying and documenting interventions for individuals with disabilities. The field of autism research needs much more evidence on what works for whom, under what conditions, and for which tasks. Although individuals with disabilities often experience unique needs, solutions may be adaptable in different environments, and knowledge-sharing can inform others working on assistive solutions (NCTI, 2012).

Single-case designs have two main components: a focus on the individual and a design in which each individual is used as his or her own control. The focus on the individual differs from other research designs, such as experimental and quasi-experimental group designs, which look at the average effect of an intervention within or between groups of people. Like an experimental design, a single-case design research study can demonstrate causal-relation or functional-relation. In single-case design research, researchers often use more than one individual to examine generalizability, but results are examined by using each individual as his

or her own control, rather than averaging results of different groups. Comparisons are made on the behavior of one individual to that same individual at a different point in time.

Single-case designs are a family of research and evaluation designs characterized by the systematic repeated measurement of a client's outcome(s) at regular, frequent, pre-designated intervals under different conditions (baseline and intervention), and the evaluation of outcomes over time and under different conditions in order to monitor client progress, identify intervention effects and, more generally, learn when, why, how, and the extent to which client change occurs (Orme & Combs-Orme, 2012). These designs are also known as "single-subject designs," "single-system designs," "N = 1 designs," or sometimes "time series" or "interrupted time series" designs.

Specifically, this study used a Multiple Baseline across Behaviors (MBAB) design. A MBAB design is a single-case design that begins with a baseline during which two or more behaviors are measured at the same time for a single client in a particular setting. Baseline is followed by the application of the intervention to one behavior with baseline conditions remaining in effect for other problems, and then the intervention is applied sequentially to the remaining behaviors to see whether intervention effects are replicated across different problems (Orme & Combs-Orme, 2012). In MBAB designs, effects are demonstrated by introducing the intervention to different baselines (e.g., behaviors) at different points in time. If each baseline changes when the intervention is introduced, the effects can be attributed to the intervention rather than to other extraneous events. Once the intervention is implemented to alter a particular behavior, it need not be withdrawn, so there is no need to return behavior to baseline levels, making the MBAB an excellent choice when observing learning and also to negate any practical or ethical concerns that may arise by temporarily withdrawing the intervention (as in an ABAB design) (Kazdin, 2011).

Data were collected for all three outcome variables (tacting, manding, and verbal completion) from all participants in an initial baseline phase. In this study, during baseline,

therapists implemented treatment as usual, which was ASL. Next, the intervention (Proloquo2Go™) was implemented for the first dependent variable (e.g., tacting) while maintaining baseline conditions for the other two dependent variables (e.g., manding, and intra-verbal). After a period of three weeks, or at least five data points, the treatment was introduced for the second dependent variable (tacting), and three weeks or five data points later for the third dependent variable, verbal completion.

The rationale for the order in which behaviors were targeted is based on the applied verbal behavior model. For children with weak language skills, applied verbal behavior model practitioners often prefer strengthening mand repertoires first based on Skinner's conceptual analysis of language and Michael's (1993) concept of the establishing operation. The establishing operation distinguishes the mand from other verbal operants in that it evokes a response that specifies a uniquely effective consequence and is the only verbal operant that directly benefits the speaker.

Data Collection

ABA therapists signed consent forms (Appendix 6) and agreed and were responsible for collecting individual data for each participant using a standardized data sheet (Appendix 3). Training on the correct use of data sheets and correct implementation of the intervention was provided to the behavioral therapists by the principal investigator. In-depth training, bi-weekly visits to the agency, and a clearly defined intervention protocol (Appendix 7) ensured treatment fidelity and adherence to the data collection protocol.

For each mand, tact, or verbal request target, the ABA therapist recorded whether the child required a physical, model, verbal, or gestural prompt to complete the task correctly, or completed the task correctly independently (i.e., without a prompt). The degree of independence in providing a correct response was coded as (1) physical; (2) model; (3) verbal; (4) gestural; (5) independent. Higher values indicated greater independence. When graphed,

data were represented as percent independent (not prompted at all). The prompting level data were recorded to remain consistent with typical data collection at the agency.

Prior to baseline, an instructional phase in which the therapist taught the participant basic use of the iPad® took place. This included an introductory, age and skill-level appropriate lesson on how to use the Proloquo2Go™ app. Baseline data were first obtained for each participant during October of 2012 after IRB approval. All data collection ceased by the end of January, 2013.

Procedures

Baseline. Baseline data were collected for three weeks or until a stable or slightly decelerating baseline was achieved. Baseline included at least five stable or slightly decelerating data points across opportunities. Number of therapeutic sessions and length of therapeutic sessions varied by individual due to insurance constraints and families' financial ability, therefore, data were collected by opportunity. An opportunity in the current study was defined as one therapeutic session. This is labeled on the graphs below as "session" and data were graphed as a percentage of independent answers per session. During baseline, therapists used treatment as usual, and participants were prompted to use American Sign Language (ASL) to communicate each target behavior (tacting, manding, or verbal completion). Baseline stability was achieved for each target behavior before introducing the Proloquo2Go™ app.

Intervention. To ensure proper adherence to the intervention and fidelity to treatment, an intervention protocol was designed and implemented (See Appendix 7). The intervention tested in the current study used the app Proloquo2Go™ delivered via iPad®. Proloquo2Go™ is a multilingual Augmentative and Alternative Communication (AAC) solution designed to assist people who have difficulty speaking or cannot speak at all. Proloquo2Go™ can be adapted to suit the needs of a wide range of users with varying literacy levels. Featuring natural-sounding voices, speech can be generated by tapping buttons with symbols or typing using the on-screen keyboard with word prediction.

Users of Proloquo2Go™ touch the screen of the iPad® with their fingertips to select an icon of choice. The device then reads aloud the item in a voice that can be customized. The Proloquo2Go™ app also has several formatting options, allowing users to customize placement of icons, number of icons on the screen, and how to display an item (e.g., picture only, text only, or both.) In the current study, icons including both picture and text were used. The communication board grid had three items available on the screen. Sizes of the icons were customized for each child.

After the instructional phase, wherein the therapist demonstrated to the participant that by tapping the icon on the screen, a voice could be heard, the ABA therapist cued the participant's individualized Proloquo2Go™ screen with her or his desirable items. The ABA therapist then gave the discriminative stimulus, or cue, to the participant. For example, s/he said, "What is this?" in the case of a tact (label). For manding (requesting), the ABA therapist displayed the desired item, blocking access to the item in order to encourage a mand (request). In the case of verbal completion, the ABA therapist said, for example, "Ready, Set," and then paused (for three seconds) to wait for the participant to choose "Go" on his or her Proloquo2Go™ screen. Gestural, verbal, model, and physical prompts were implemented to achieve errorless learning. For a response to be considered independent, the participant needed to select the appropriate icon completely independent of prompts within three seconds. Consistent with the principles of ABA and operant learning, participants were reinforced for independent answers. Reinforcers varied from participant to participant based on a preferences assessment, and each child's ABA therapist was in control of reinforcement. Examples of reinforcers included: chips, hugs, and verbal praise.

ABA therapists were trained by the principal investigator in the use of Proloquo2Go™. Training included how to use an iPad® during ABA therapy, how to tailor the app Proloquo2Go™ to an individual child by selecting icons that are appropriate for each child, and how to record data using the standardized data collection form.

Interobserver agreement and procedural fidelity. Interobserver agreement (IOA) data were collected for 20% of baseline and 20% of the intervention phase. IOA data were calculated by dividing the number of agreements by the number of agreements plus disagreements $\times 100$. IOA during baseline and intervention phases was between 90-100%. An undergraduate student research assistant viewed 20% of baseline and 20% of intervention video tapes. The student then coded what she viewed and her scores were compared against the scores collected by the individual therapists. A procedural fidelity checklist (Kaderavek & Justice, 2010) was used to ensure that the procedures were completed as outlined. Procedural fidelity data were collected throughout the study (random checks by principal investigator) and indicated that procedures were followed at 100% fidelity across baseline and intervention phases of the study (Appendix 8).

Limitations

In single-case design research, several aspects of the data can interfere with drawing valid inferences, or threats to data-evaluation validity. These include: excessive variability in the data, unreliability of the measures, trends in the data, insufficient data, and mixed data patterns. Additionally, special issues that should be considered with regard to comparison studies (studies comparing two interventions) are multi-treatment interference, non-reversibility of effects, and separation of treatments (Gast, 2010; Kazdin, 2011; Orme & Combs-Orme, 2012). These are discussed in further detail with relation to the current study in Chapter 5: Discussion. As with any type of analysis, visual analysis has limitations, namely that different observers under differing circumstances may draw different conclusions from the same data (Kahng et al., 2010; Orme & Combs-Orme, 2012; Ximenes, Manolov, Solanas, & Quera, 2009). Power is determined by replication of treatment effectiveness across baseline/intervention phases. Within multiple baseline across behaviors single-case design research, three phase repetitions (as in the current study) are required, but adding phase repetitions increases the power of the

statistical test, similar to adding participants in a traditional group design (Horner, Swaminathan, Sugai, & Smolkowski, 2011).

Protection of Human Subjects

Discomfort and Potential Risks

Federal regulations require researchers to classify research involving children into one of four categories and to document their discussions of the potential risks and benefits of the proposed research study. This study poses a minimal risk to participants. Children may feel some discomfort or stress when asked to learn to use a new device like an iPad®. Likewise, children may experience discomfort or stress when the iPad® is removed. Each child's therapist was instructed to stop immediately if a child experienced moderate or severe stress as evidenced by anxious behaviors, crying, hitting, etc. There was a slight risk that the intervention may not have been as effective as treatment as usual or may have been detrimental; however previous research indicated that Proloquo2Go™ was effective at enhancing communication skills for children with autism in a variety of environments (Carpenter, 2012; Grossnell, Costello, & Shane, 2011; Hyatt, 2011; McLeod, 2011; Sennott & Bowker, 2009). If it was observed in bi-weekly data checks that a participant was losing ground or the findings showed the intervention was harmful, the intervention was to be withdrawn. This did not occur.

Confidentiality

The final potential risk for involvement in this study was a breach of confidentiality. All information and therapeutic progress was kept confidential. Access to this information was given only to the child's therapist, the principal investigator, and a research assistant.

Each child's information was protected in a number of different ways:

1. All data collected from the study were kept in a locked filing cabinet. Access to this cabinet was provided only to the principal investigator and the child's therapist. When identifying information was input into a computer, it was destroyed immediately.

2. All data were transported on a laptop computer and USB drive that were both password-protected. The only individual with access to the password was the principal investigator.
3. All videos were stored on a computer that is password-protected. The only individual with access to the password was the principal investigator. When the videos were no longer needed for data collection, they were destroyed.
4. The research assistant who viewed videos to record data signed a letter of confidentiality and was trained in the University of Tennessee Responsible Conduct of Research and the Collaborative Institutional Training Initiative (CITI) Social and Behavioral Research Training.
5. Both the principal investigator and the dissertation advisor were trained in the University of Tennessee Responsible Conduct of Research and the Collaborative Institutional Training Initiative (CITI) Social and Behavioral Research Training.
6. In reports or publications from this study, anything that can identify participants will not be reported.

Potential Benefits

Previous research has indicated that using computer assisted therapy and apps for autism such as Proloquo2Go™ can be useful in enhancing skills for children with autism (Carpenter, 2012; Grossnell, Costello, & Shane, 2011; Hyatt, 2011; McLeod, 2011; Sennott & Bowker, 2009). This research helps determine if the app Proloquo2Go™ is useful during applied behavior analysis therapy in enhancing communication for young children with autism who have not developed age-appropriate language.

CHAPTER 4: RESULTS

Introduction

This chapter includes a description of the sample of research participants, research question, and analysis of data. Data were analyzed using visual analysis, and results were graphed below for each participant, with a narrative description of each participant included.

Description of Sample

The sample of individuals in this study consisted of five children diagnosed with ASD with complex communication needs between the ages of three and four years old who were receiving ABA therapy from a Board Certified Behavior Analyst (BCBA) or ABA therapist.

Children were recruited from one agency providing ABA therapy in East Tennessee by personal invitation from the principal investigator. Their parents/guardians were presented with a written description of the study and its potential risks and benefits. Services at the agency were provided by a BCBA and three employees trained in ABA therapy. Written consent was given for the proposed project to take place at the agency (see Appendix 1).

Study participants had to be diagnosed with ASD and have significant communication concerns from parents and therapists (scoring Level 1 or 2 on the VB-MAPP), and be between the ages of three and five years old to be considered for participation.

Prior to the study, each participant was administered the CSBS and MIS by the principal investigator. Three participants scored “low” on these measures (i.e., 2, 7, and 8 on the MIS and 1 on the CSBS) and two participants scored “mid-range” (i.e., 18 and 20 on the MIS and 3 on the CSBS). Scores on the CSBS indicate delays in social communication and expressive speech/language. Scores on the MIS indicate a child’s ability to imitate single-step motor imitation tasks.

Research Question

The current study uses a multiple baseline across behaviors single-case research design with five children on the autism spectrum to ask the question, "Does the use of the app

Proloquo2Go™ delivered via iPad® enhance communication skills for children with ASD and complex communication needs during ABA therapy?" The objective of the study is to determine the effectiveness of using Proloquo2Go™ in teaching tacting (labeling), manding (requesting), and verbal completion (fill-in-the-blank) tasks during ABA therapy to children with ASD. Additionally, each of the five participants was classified as having either "low" or "mid-range" scores on three standardized measures in order to examine possible prerequisite skills of children who would be responsive or nonresponsive to the intervention.

Data Analysis

All participants' results are graphed below and discussed using pseudonyms so as to maintain confidentiality. Graphed data were analyzed for changes in level, trend, variability, immediacy, and overlap using visual inspection. In the graphs below, the x axis represents "Session Number" and the y axis represents "Percent of Independent Responses." An independent response was a response that required no prompting. Prompting was to occur after three seconds of the presentation of the stimulus or in the event of an incorrect response. During baseline, this meant that a participant correctly used sign language to mand, tact, or complete the phrase within three seconds of the therapist presenting the stimulus. During intervention, this meant that a participant correctly used Proloquo2Go™ to mand, tact, or complete the phrase within three seconds of the therapist presenting the stimulus. Visual inspection criteria, rather than statistical tests, were the primary means of evaluating data.

Visual inspection refers to reaching a judgment about the reliability and consistency of intervention effects by visually examining the graphed data (Kazdin, 2011). In traditional between-group research, the experimental criterion is met primarily by comparing performance between or among groups and examining the differences statistically. Groups receive different conditions and statistical tests are used to evaluate whether performance after treatment is sufficiently different to attain conventional levels of statistical significance (e.g., $p \leq .05$). In single-case research, the experimental criterion is met by examining the effects of the

intervention at a minimum of three different points so that a judgment can be made based on the overall pattern of data (Kazdin, 2011). Both statistical evaluation and visual inspection are methods to avoid committing Type I error (concluding the intervention produced an effect when results could be due to chance) or Type II error (concluding the intervention did not produce an effect when, in fact, it did) (Kazdin, 2011; Orme & Combs-Orme, 2012).

Unlike an experimental group design, in which a researcher is often comparing two groups (one receiving treatment and one not receiving treatment) and using statistical analyses to compare the treatments post-study among the two groups, single-case designs, such as MBAB, typically use visual inspection for evaluation. Graphing and visual inspection, rather than statistical tests are the primary means of evaluating single-case data (Cooper et al., 2007). Visual analysis is a systematic process for interpreting results of single-case design data that involves visually examining graphed data within and between different conditions, for example between baseline and intervention (Orme & Combs-Orme, 2012). While there are some statistical tests that are occasionally used, these are not regarded as the primary criteria and are used in the minority of cases of single-case research. It is argued that visual analysis provides the means for determining whether interventions make real-world differences to clients in ways that are superior to statistical analysis (Kazdin, 2011; Orme & Combs-Orme, 2012).

Traditionally, research methodology is comprised of assessment, experimental design, and data evaluation, with each of these being tightly intertwined. The broadening of single-case designs to multiple disciplines and fields (e.g., education, clinical psychology, rehabilitation, recreational therapy, internal medicine, psychiatry, and social work), combined with the publication of single-case design research in multiple peer-reviewed journals (e.g., *Analysis of Verbal Behavior*; *Behavior Modification*; *Journal of Applied Behavior Analysis*) has led to the expansion of the methodology (Kazdin, 2011). The current study uses visual inspection data analysis only for the purposes of evaluation.

When visually inspecting data, it is important to take into consideration several questions:

- 1. Is change occurring?*
- 2. If change is occurring, is it change for the better—or are the client's problems getting better or worse?*
- 3. If change is occurring, and it is change for the better, is the pace of change sufficient—is change happening rapidly enough, based on previous research, theory, experience, or other considerations?*
- 4. If change is occurring and it is in the desired direction, is the change large enough—is the change meaningful and sufficient to the client?* (Orme & Combs-Orme, 2012, p. 88).

Moreover, change can occur within a phase or between conditions (e.g., baseline and intervention), and consideration of how behavior is changing within phases is crucial to interpreting change between conditions (Orme & Combs-Orme, 2012). There are five important patterns to inspect visually in single-case design graphs: level, trend, variability, immediacy and overlap (Cooper et al., 2007; Gast & Spriggs, 2010; Johnston & Pennypacker, 2009; Kazdin, 2011; Orme & Combs-Orme, Riley-Tillman & Burns, 2009).

Level. Level is the value on the vertical axis around which a series of outcome data converge (Cooper et al., 2007). There are two basic aspects of level that are important: level stability and level change. Level stability is the amount of variability, or range in data-point values, in a data series. When the range of values is small (low variability), data are said to be stable. Generally speaking, this means that 80% of the data points of a condition fall within a 20% range of the median level of all data point values of a condition (Gast, 2010). It is recommended that the last 3-5 data points in a series be analyzed for level stability before deciding whether to move to the next condition (Gast, 2010). Sometimes it can be useful to characterize the overall level of a phase by citing the mean or median. However, at times, this can be misleading (Orme & Combs-Orme, 2012). Often, the last two or three data points in a

phase are very telling. For example, if the last two data points are detectably higher than the rest of the points, this indicates that significant change in level has occurred within the phase.

Trend. Trend is the overall direction of a data path within a phase. There are three types of trend: 1. no trend, 2. negative trend (descending), and 3. positive trend (ascending) (Orme & Combs-Orme, 2012). In addition to determining trend direction, it is also important to consider trend stability. This can be evaluated by determining the number of data points that fall on or within a predetermined range along the condition trend line (Gast, 2010).

Variability. Variability is the degree to which data points deviate from the overall trend. It is the extent to which data fall within a relatively narrow range around the overall trend (Orme & Combs-Orme, 2012). In single-case design research, having a stable baseline is important because without stability it is difficult to predict when to introduce the intervention or to determine if the intervention had the desired effect. A stable baseline occurs when data exhibit little variability over time and little or no trend during baseline. With a more stable baseline, it is easier to tell change from one condition to the next. Conversely, a variable baseline (not desirable) occurs when data are scattered around a relatively larger range of values around a horizontal line. While a stable baseline is ideal, most baselines show improving or deteriorating trends to some degree (Parker, Cryer, and Byrns, 2006).

Immediacy. Immediacy refers to the amount of time it takes for a change in level, trend, or variability to occur after a change in condition (e.g., from baseline to intervention). Ideally, immediately after the intervention is implemented, there will be an observable change for the better in level and trend (Kazdin, 2011; Orme & Combs-Orme, 2012). When change is delayed, this is referred to as a lagged effect, and it might be possible that the intervention did not cause the change. Instead, something may have occurred between the implementation of the intervention and the change that caused the change. To determine immediacy of change, the last data point at the end of baseline is compared to the first data point in intervention. Then, the smaller value is subtracted from the larger one (Cooper et al., 2007; Orme & Combs-Orme,

2012). In the case of certain interventions (e.g., certain medications or a learned skill), immediate change would not be expected. In the current study, where participants were expected to learn a new skill, some delay in the effect of the intervention was expected.

Overlap. Overlap is the degree to which data in adjacent conditions share similar quantitative values. Less overlap makes for more convincing evidence that there is a change from one condition to the next (e.g., baseline to intervention). Sometimes, trend can override the importance of overlap when determining change during intervention (Orme & Combs-Orme, 2012). For example, if an outcome is deteriorating during baseline, then starts improving upon intervention, there will be considerable overlap.

Findings

There was considerable variability in results within the current study. Overall, for participants in Group 1 (Low pre-verbal skills), the Proloquo2Go™ intervention had positive results in enhancing manding, tacting, and verbal completion repertoires during ABA therapy. For Robert and Thomas, the intervention had a clinically significant impact. Robert achieved 80% criterion across three sessions for mastery on all targets across all behaviors, and Thomas achieved this for manding and verbal completion in two of three cases, but not for tacting. For Chad, the intervention had a positive impact, and while Chad was unable to meet the 80% criterion for mastery in most sessions, he did meet the 80% criterion for manding across all behaviors. In the three Group 1 cases, there was an improvement in level for manding, tacting, and verbal completion across all targets and the criterion was achieved for manding across all targets. In one case, the criterion for tacting was achieved across all three targets. In the remaining two cases, with the exception of one target, there was notable improvement in the level of tacting and verbal completion, but the 80% criterion was not achieved.

There was an improvement in level for manding in one target for Lauren and all targets for Gregory and there was an improvement in level for verbal completion for one target for Lauren; in each of these cases the criterion was achieved. However, Lauren and Gregory (with

the exception of one target) achieved the criterion for tacting and verbal completion across all targets by the end of baseline, and therefore, there was very little room for improvement in these skills upon implementation of the Proloquo2Go intervention. Both Lauren and Gregory (Group 2) demonstrated reduced variability in their manding, tacting, and verbal completion skills during the intervention phase.

All five children were able to quickly learn to use the Proloquo2Go™ application on the iPad® and were able to use the device to learn three new manding, tacting, and verbal completion targets during ABA therapy. For the two children who showed communication gains using American Sign Language during baseline, the use of Proloquo2Go™ may be an additional communication tool that they can transfer to a public environment where few people use sign language (e.g., ordering food at a restaurant.)

Robert. Robert was a three-year old male diagnosed with ASD. He had been receiving ABA therapy for six months. Prior to the current study, Robert scored Level 1 on the VB-MAPP, 1 on the CSBS, and 2 on the MIS, and he was placed into Group 1 based on these scores. Robert's communicative ability was described by his mother and therapists as "very low." Robert, additionally, made no eye contact, making teaching sign language very difficult for his therapists. His preferred method of requesting (manding) was to stare at the desired item and whine. Robert's mother and therapists stated that Robert did not have a repertoire of any spoken words, and was just beginning to use a few signs sporadically, such as "more", "all done", and "drink." Robert's mother additionally stated that improving communication was a "very high priority" because Robert had no spoken language, often ignored other people, and frequently cried. Examples of words that Robert could identify receptively were: daddy, mommy, dog, cat, mailbox, pancake, sandwich, hands, feet, eat, and drink.

Level. Robert's graph below shows a clear change in level from ASL to intervention, and the change was in the therapeutic direction.

Trend. In all three graphs below, there was no trend observed during the baseline phase. In Figure 1, during the intervention phase, all targets had a positive trend. In Figure 2, during the intervention phase, targets “tools” (manding) and “sandwich” (tacting) had a positive trend, and target “bed” (verbal completion) had no trend. In Figure 3, during the intervention phase, all targets had a positive trend.

Variability. Virtually no variation occurred during baseline in any targets and with few minor exceptions the percentage of independent responses remained at zero. Data points varied more with all manding targets (as opposed to tacting and verbal completion targets) during intervention.

Immediacy. An important consideration in multiple baseline single-case designs is whether or not the change in behavior occurred only after implementation of the intervention. Immediacy of change was calculated by comparing the last data point at the end of the baseline phase with the first data point at the beginning of the intervention phase. Robert had an immediate change with the first session within the intervention phase for each target, and it was evident that for most targets a distinct change for the better occurred after intervention.

Overlap. There was little overlap between baseline and intervention data in the graphs below. However, in the case of this study, trend is likely a better indicator of change during intervention.

Criterion Achievement. Robert achieved the 80% criterion for mastery across three sessions for all manding, tacting, and verbal completion targets.

Summary. Based on Robert’s data during baseline, ASL was not an effective way to teach manding, tacting, or verbal completion. Therefore, the Proloquo2Go™ intervention was warranted and was found to be useful. The intervention had a huge, positive, clinically significant effect for Robert across all three domains and all target behaviors. Both Robert’s caregivers and therapists were very pleased with his progress and are hopeful to continue the use of Proloquo2Go™ for communication during ABA therapy.

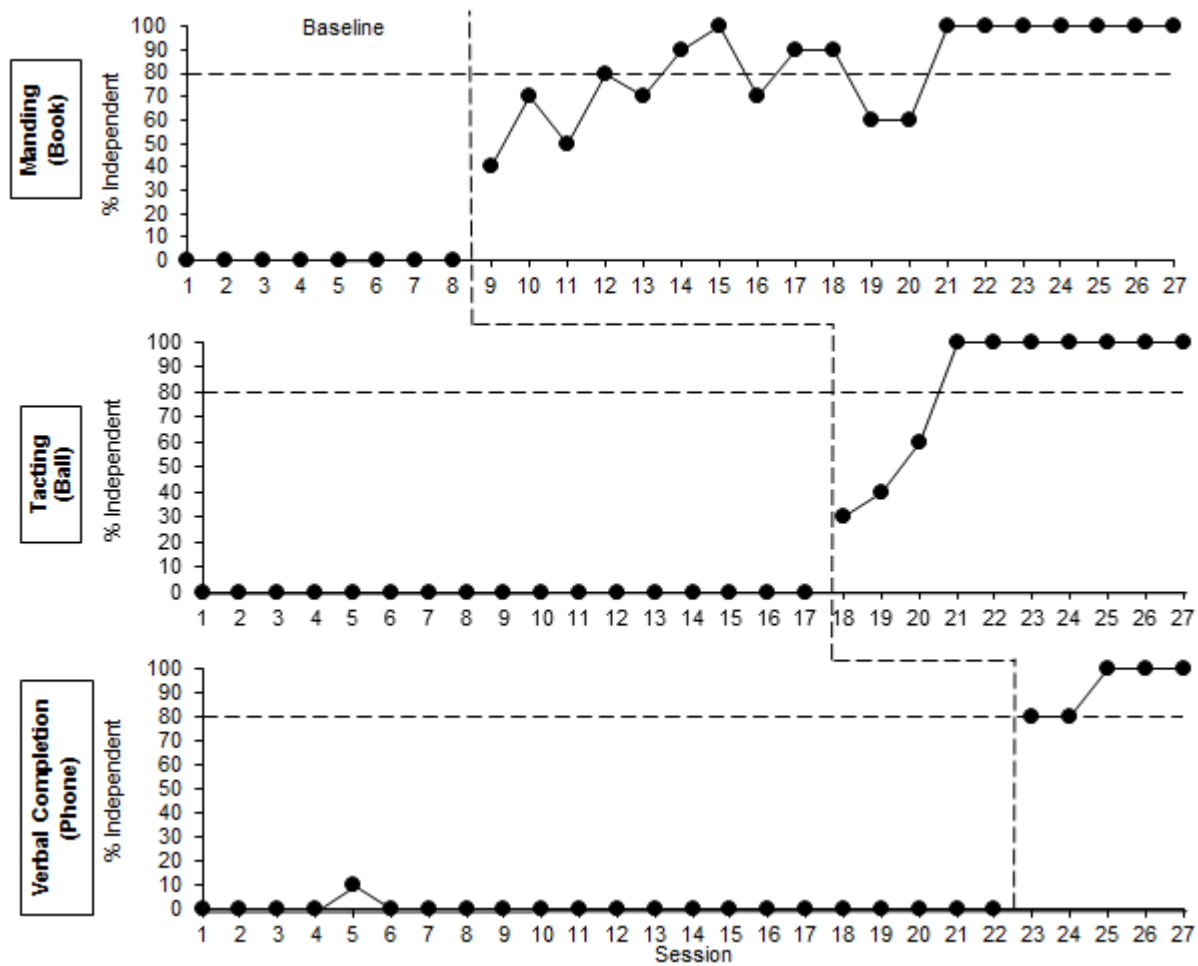


Figure 1. Separated data for Robert (Group 1—Low). Multiple baseline across three behaviors (Book, Ball, and Phone) with percent independent during baseline and intervention.

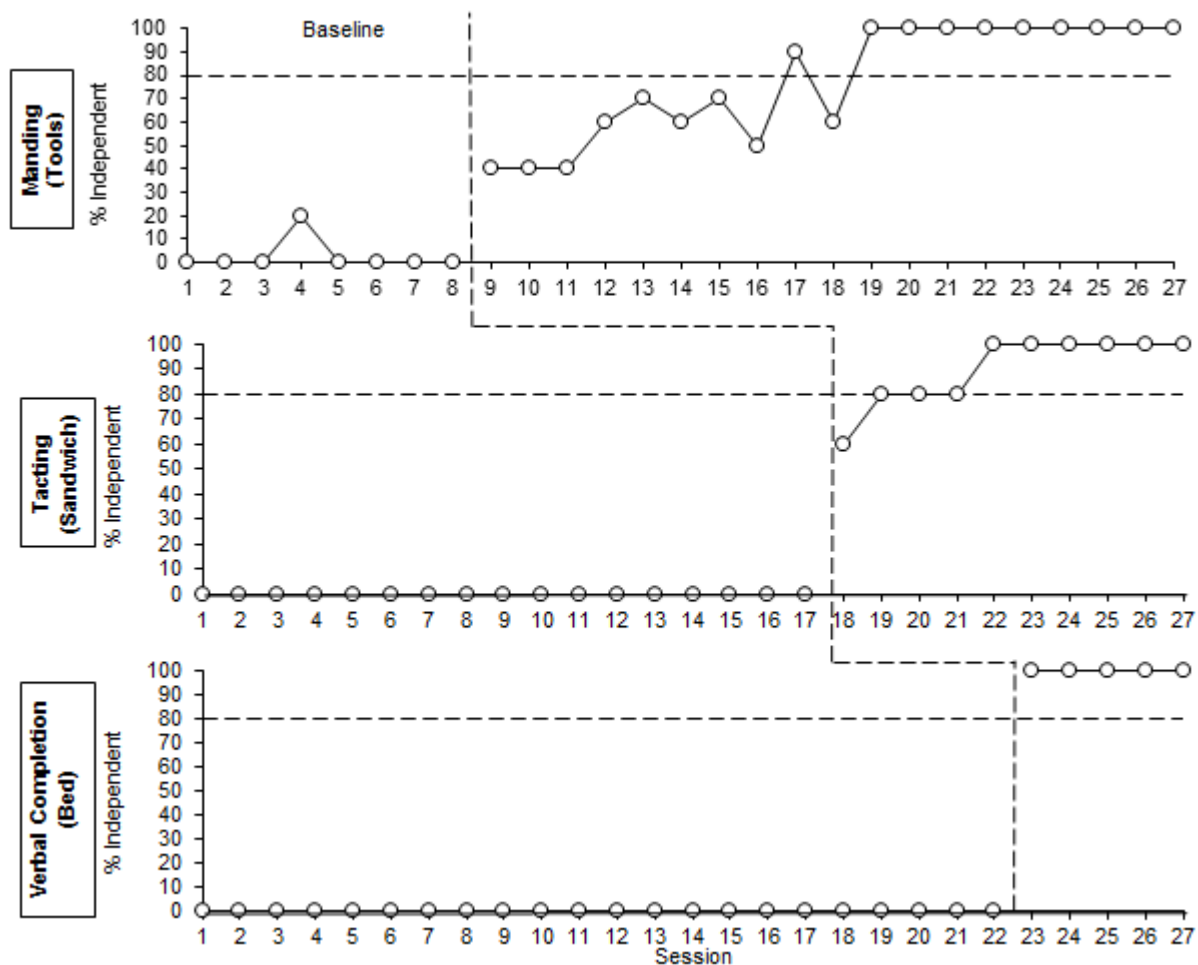


Figure 2. Separated data for Robert (Group 1—Low). Multiple baseline across three behaviors (Tools, Sandwich, and Bed) with percent independent during baseline and intervention.

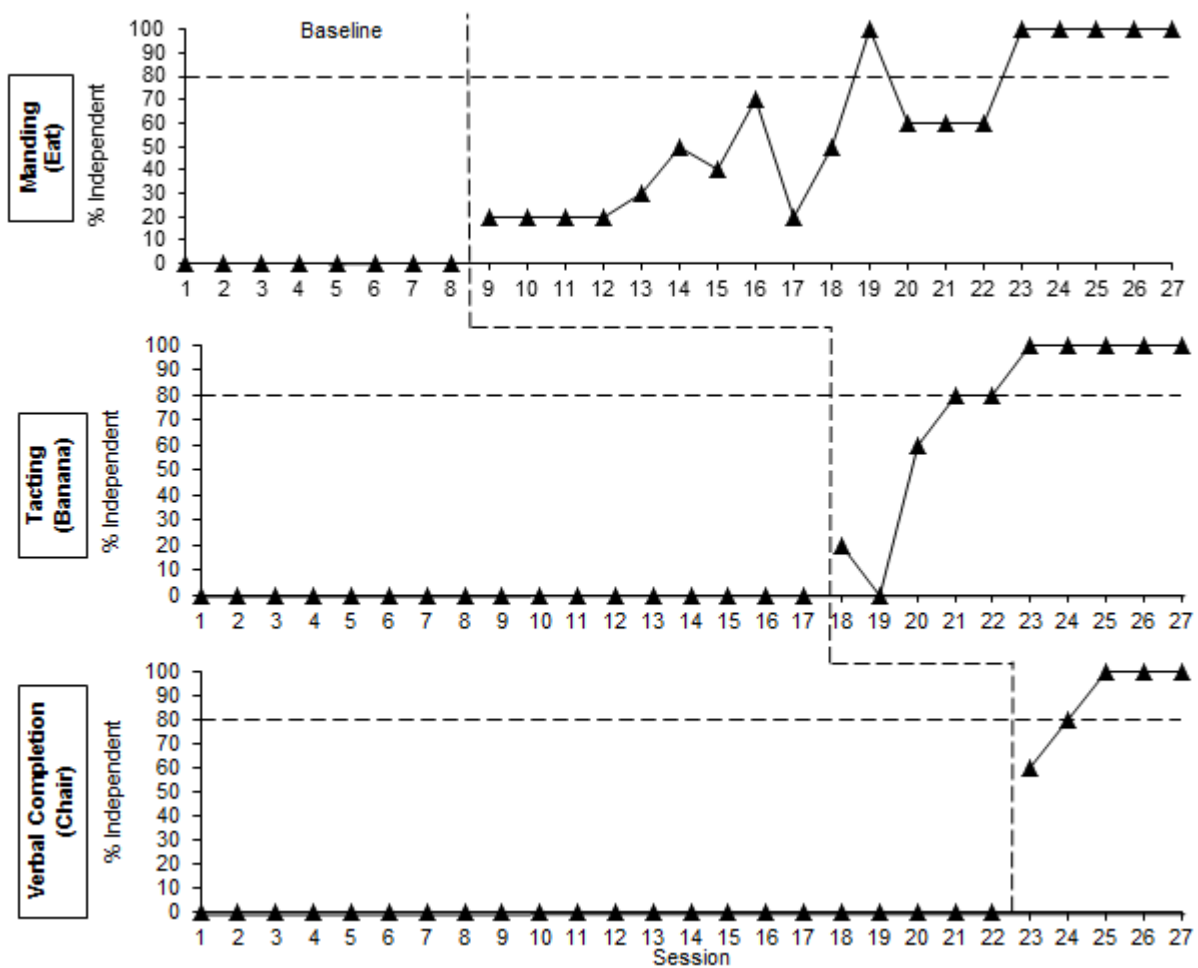


Figure 3. Separated data for Robert (Group 1—Low). Multiple baseline across three behaviors (Eat, Banana, and Chair) with percent independent during baseline and intervention.

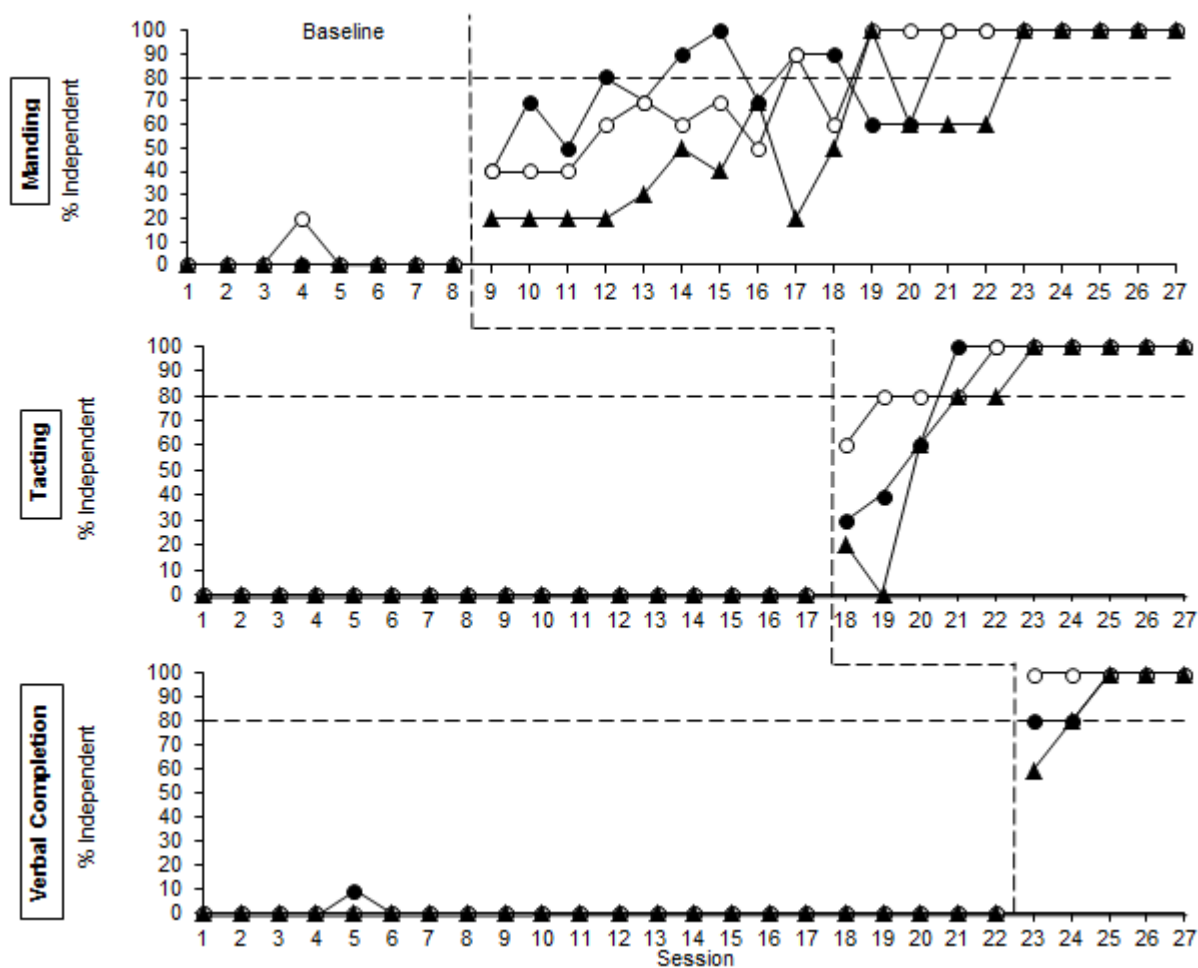


Figure 4. Combined data for Robert (Group 1—Low). Multiple baseline across three behaviors with percent independent during baseline and intervention.

Thomas. Thomas was a four-year old male diagnosed with ASD. He had been receiving ABA therapy for one year. Prior to the current study, Thomas scored Level 1 on the VB-MAPP, 1 on the CSBS, and 7 on the MIS. He was placed into Group 1 based on these scores. Thomas's communicative ability was described by his mother and therapists as "low." His preferred method of requesting (manding) was to make utterances such as grunting noises, bringing the desired item to the caregiver, and pushing the hand of the caregiver towards the desired item. Thomas's mother and therapists stated that Thomas had a vocabulary of 3 single words, and did not show a preference for sign language or verbal speech. Thomas's mother additionally stated that improving communication was a "very high priority" because Thomas had an extremely limited vocabulary of spoken words (e.g., momma, bee-bee (brother), and no) and appeared to have tantrums frequently (including hitting, kicking, and biting) associated with the inability to communicate. Examples of words that Thomas could identify receptively were: momma, mawmaw, Peanut (dog), drink, go, no, all done, bite, and bye.

Level. Thomas's graph below shows a clear change in level from ASL to intervention, and the change was in the therapeutic direction.

Trend. In all three graphs below, there was no trend observed during the baseline phase. In Figure 5, during the intervention phase, all targets had a positive trend. In Figure 6, during the intervention phase all targets had a positive trend. In Figure 7, during the intervention phase, targets "cat" (tacting) and "chair" (verbal completion) had a positive trend and target "spin" (manding) had no trend.

Variability. There was no variation during baseline in any targets and the percentage of independent responses remained at zero during baseline. Tacting and manding targets had slight variability and two of the three manding targets had considerable variability.

Immediacy. Immediacy of change was calculated by comparing the last data point at the end of the baseline phase with the first data point at the beginning of the intervention phase. Although there was no dramatic change with the first session within the intervention phase for

each target, it was evident that for most targets, the intervention had a positive effect within 2-3 sessions.

Overlap. There was little overlap between baseline and intervention data in the graphs below.

Criterion Achievement. Thomas achieved the 80% criterion for mastery for all manding targets, and two of the three verbal completion targets. He did not achieve the 80% criterion for mastery for any tacting targets.

Summary. Based on his scores on the VB-MAPP, CSBS, and MIS, Thomas was placed into Group1—Low. Based on Thomas' data during baseline, ASL was not an effective way to teach manding, tacting, and verbal completion targets. Therefore, the Proloquo2Go™ intervention was warranted and was found to be useful. The intervention had a huge, positive, clinically significant effect for Robert across all three domains and all target behaviors. Although Robert did not achieve the goal of 80% for mastery of a skill across all target behaviors, both Robert's caregivers and therapists were very pleased with his progress and are hopeful to continue the use of Proloquo2Go™ for communication during ABA therapy.

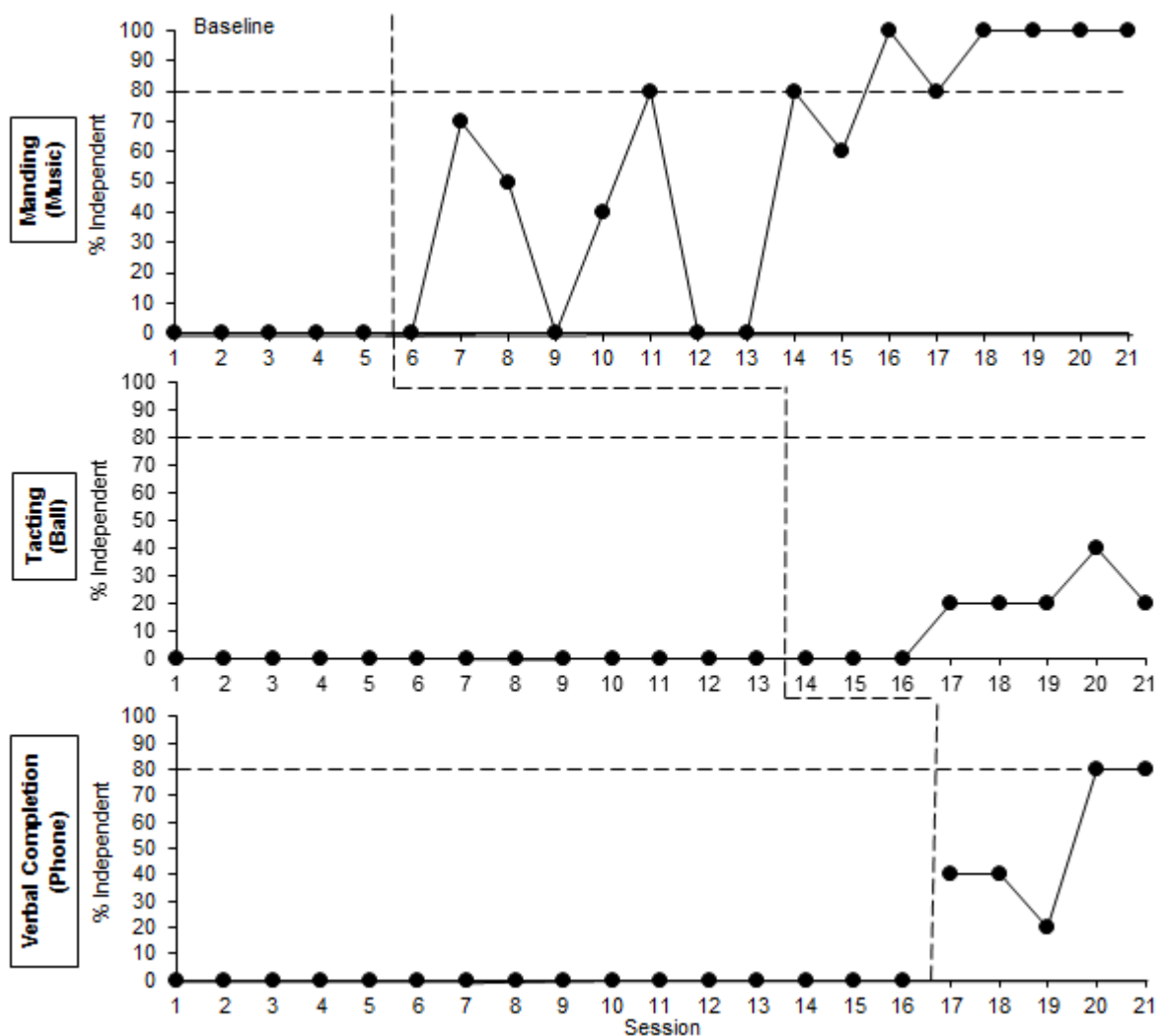


Figure 5. Separated data for Thomas (Group 1—Low). Multiple baseline across three behaviors (Music, Ball, and Phone) with percent independent during baseline and intervention.

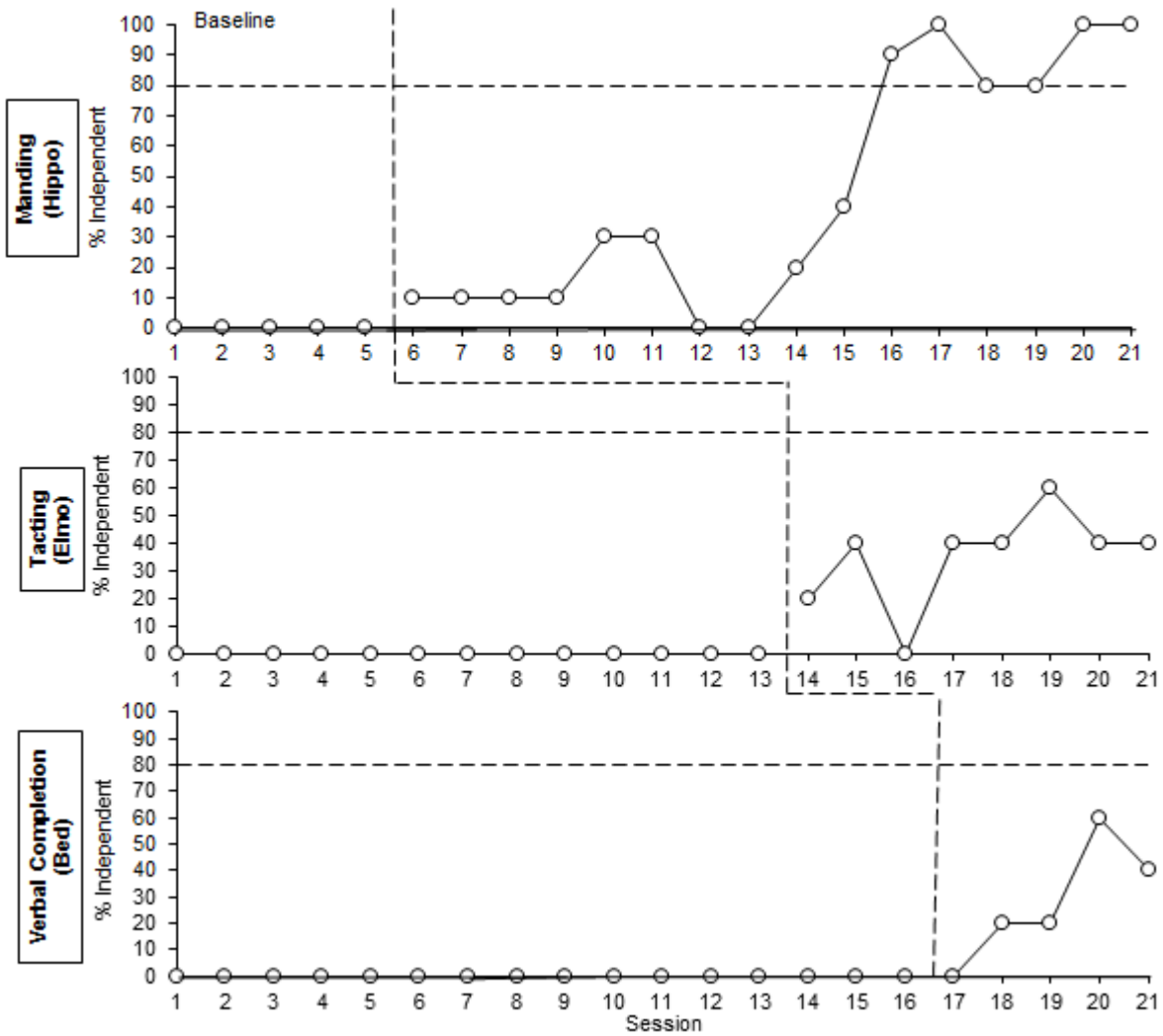


Figure 6. Separated data for Thomas (Group 1—Low). Multiple baseline across three behaviors (Hippo, Elmo, and Bed) with percent independent during baseline and intervention.

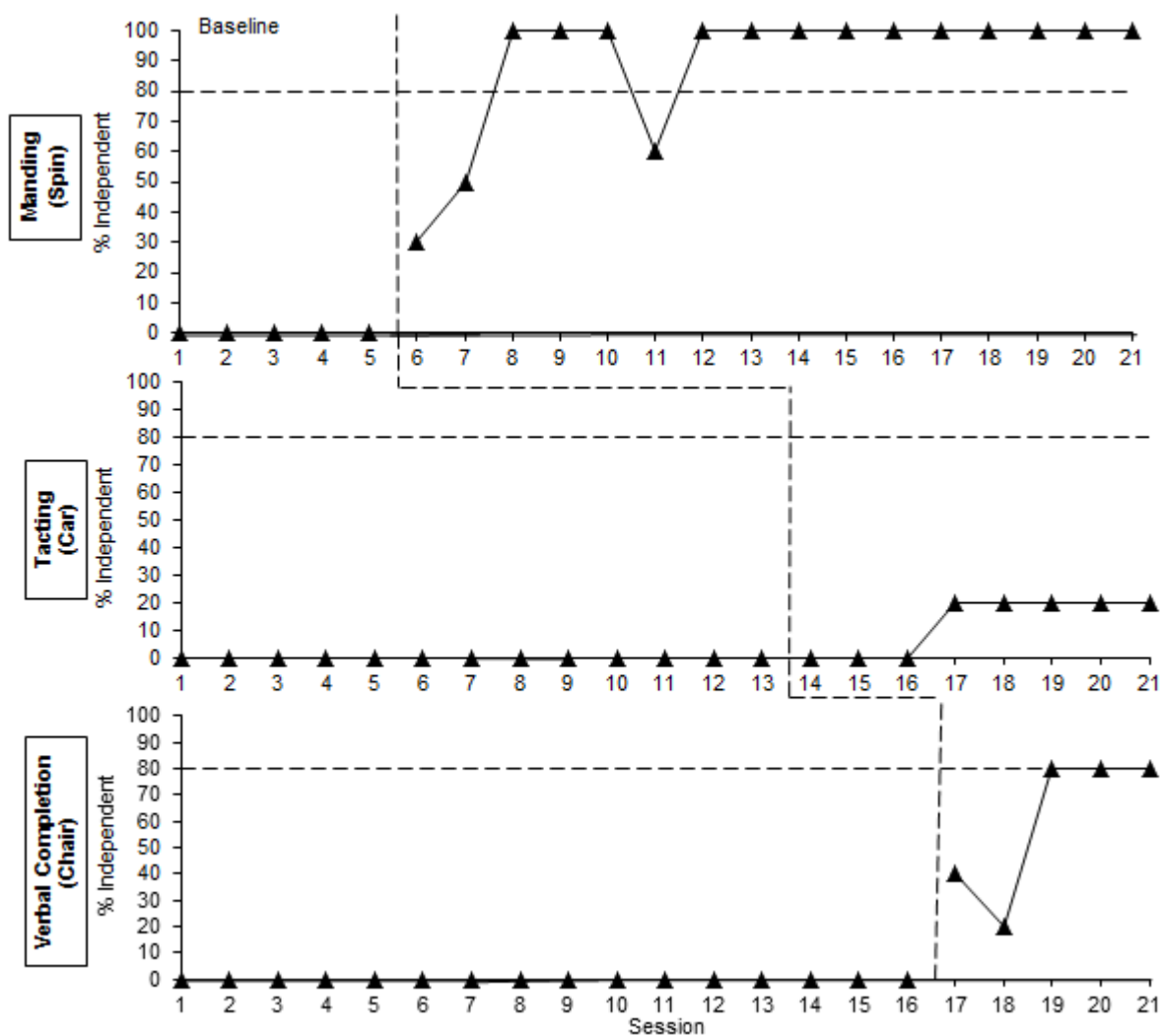


Figure 7. Separated data for Thomas (Group 1—Low). Multiple baseline across three behaviors (Spin, Car, and Chair) with percent independent during baseline and intervention.

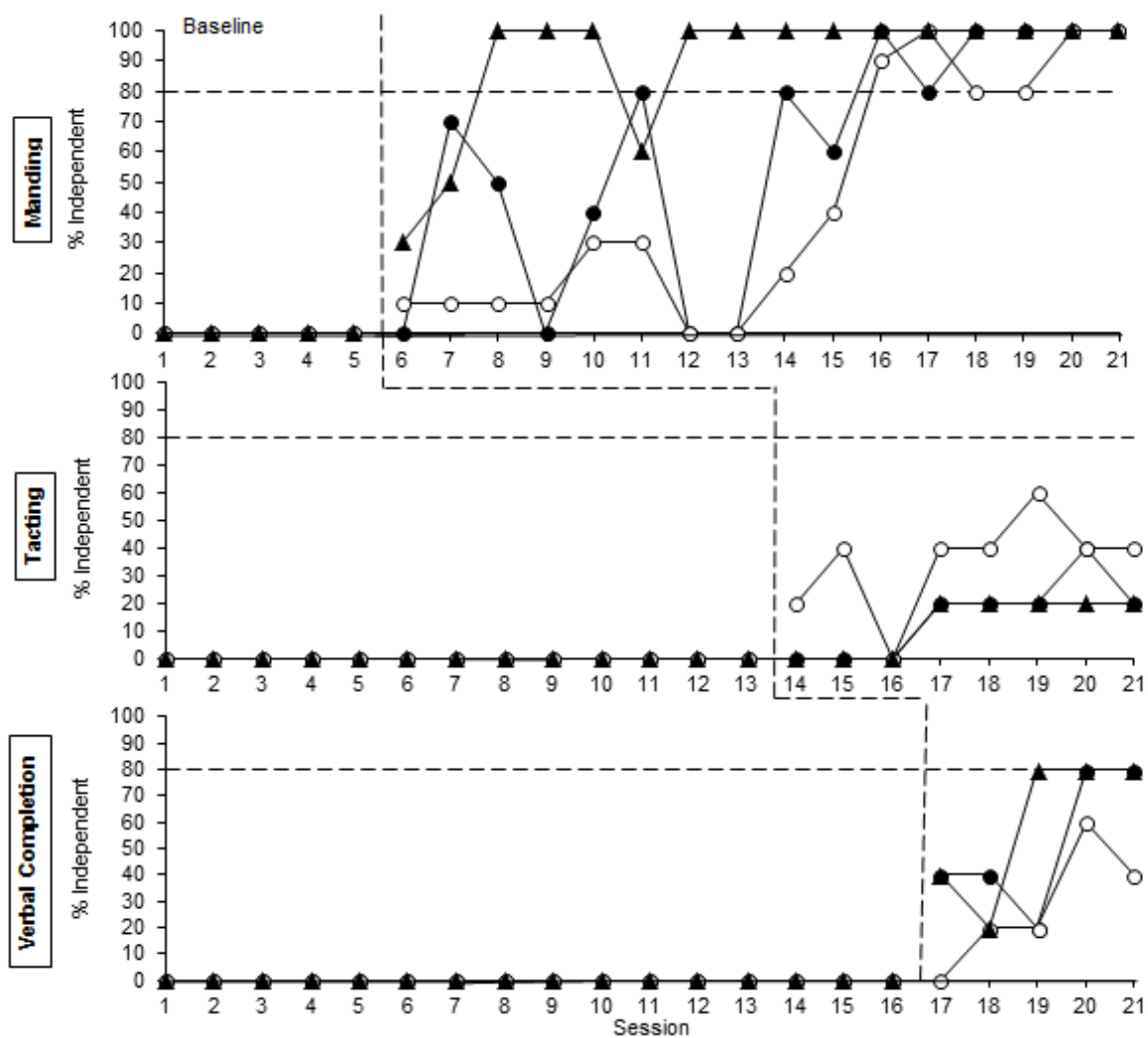


Figure 8. Combined data for Thomas (Group 1—Low). Multiple baseline across three behaviors with percent independent during baseline and intervention.

Chad. Chad was a three-year old male diagnosed with ASD. He had been receiving ABA therapy for six months. Prior to the current study, Chad scored Level 1 on the VB-MAPP, 1 on the CSBS, and 8 on the MIS. He was placed into Group 1 based on these scores. Chad's communicative ability was described by his mother and therapists as "low." His preferred method of requesting (manding) was to make utterances such as grunting noises, gestures, and pushing the hand of the caregiver towards the desired item. Chad's mother and therapists stated that Chad had a vocabulary of around 20 single words, and Chad mainly preferred sign language to verbal speech. Chad's mother additionally stated that improving communication was a "high priority" because Chad tended to become upset when she could not figure out what he was asking for. Examples of words that Chad could identify receptively were: mom, dad, nana, puzzle, blanket, book, cup, chips, nose, go, and stop.

Chad only had three data points during the verbal completion phase of the study because he became ill and had to stop therapy for several weeks.

Level. Chad's graph below shows a clear change in level from ASL to intervention, with one exception (tacting for one target), and the change was in the therapeutic direction.

Trend. In all three graphs below, there was no trend observed during the baseline phase. In Figure 9, during the intervention phase, targets "chip" (manding) and "bed" (verbal completion) had positive trends and target "dog" (tacting) had no trend. In Figure 10, during the intervention phase, targets "frog" (tacting) and "phone" (verbal completion) had no trend, and target "spin" (manding) had a positive trend. In Figure 11, during the intervention phase, targets "puzzle" (manding), "pop tart" (tacting), and "chair" (verbal completion) had no trend.

Variability. Virtually no variation occurred during baseline in any targets and with few minor exceptions the percentage of independent responses remained at zero. Data points varied more with all manding targets (as opposed to tacting and verbal completion targets) during intervention.

Immediacy. Although there was no dramatic change with the first session within the intervention phase for each target, it was evident that for most targets, within the first 2-3 sessions, a distinct change for the better occurred after intervention.

Overlap. There was little overlap between baseline and intervention data in the graphs below, except for the tacting target, “frog”, where all data during baseline and intervention remained at zero.

Criterion Achievement. Chad achieved the 80% criterion for mastery for all manding targets, but not for any tacting or verbal completion targets.

Summary. As shown below in Figures 9-12, a positive change occurred for Chad with regard to manding, tacting, and verbal completion targets during use of the Proloquo2Go™ intervention. Although the pace and amount of change for Chad was slow and mainly below the 80% mark that is typically used to define mastery of a skill in ABA therapy, Chad’s therapists and caregivers were overall pleased with his progress. Prior to the study, Chad made very little effort to communicate and had very few successes during ABA therapy. After this study, his caregivers and therapists discovered that he could use the Proloquo2Go™ app to communicate more effectively during therapy, and they are hopeful that this is a tool that can be continue to be used to improve Chad’s therapeutic experience and perhaps generalized to other settings. To be noted as a possible reason for Chad’s slow and low gain was the fact that he became ill towards the end of the study. It is, therefore, possible that Chad was not feeling well for some time prior, and being unable to communicate his feelings, was not diagnosed with illness until quite later. His feeling of illness prior to diagnosis may have led to his slow gain.

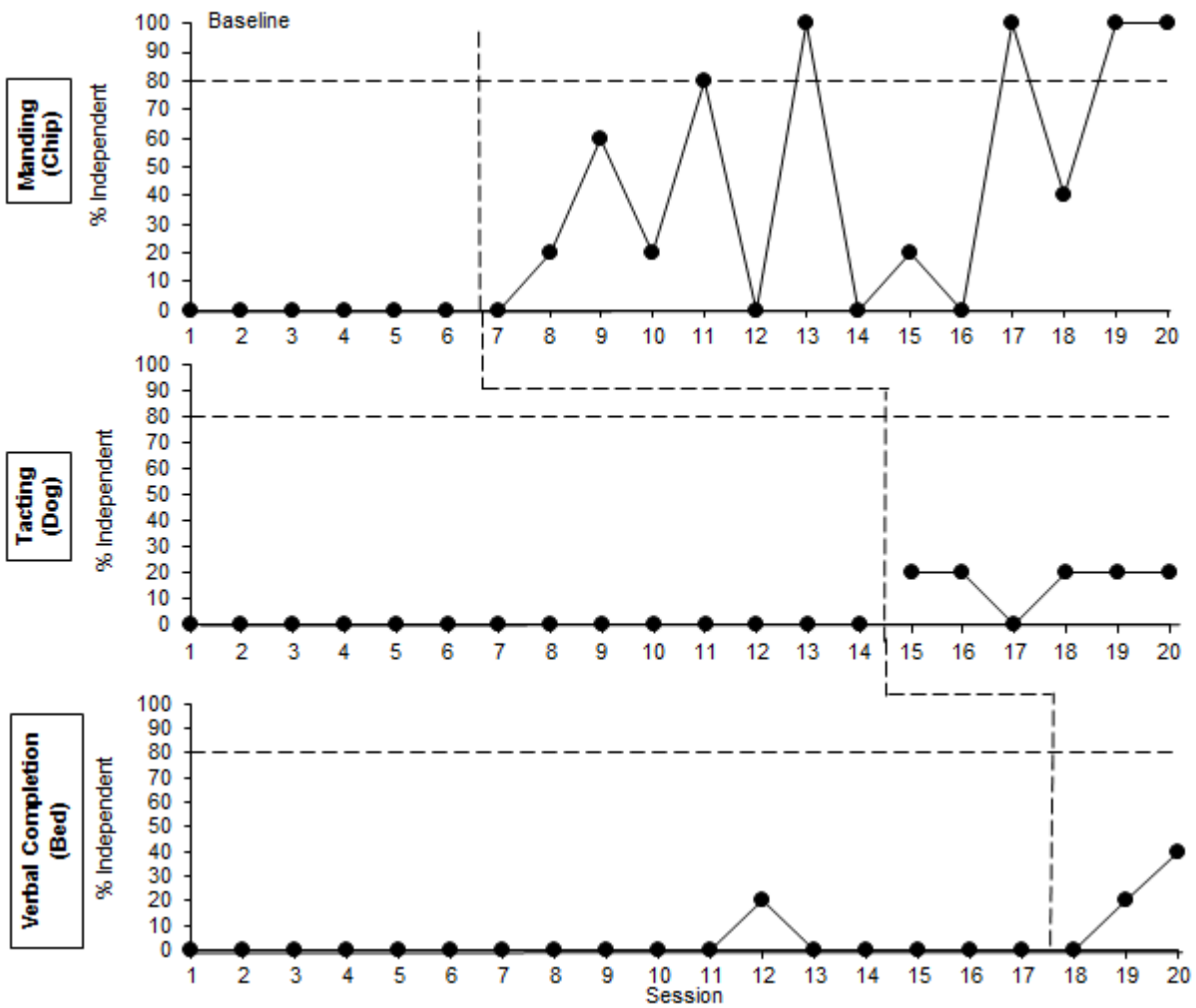


Figure 9. Separated data for Chad (Group 1—Low). Multiple baseline across three behaviors (Chip, Dog, and Bed) with percent independent during baseline and intervention.

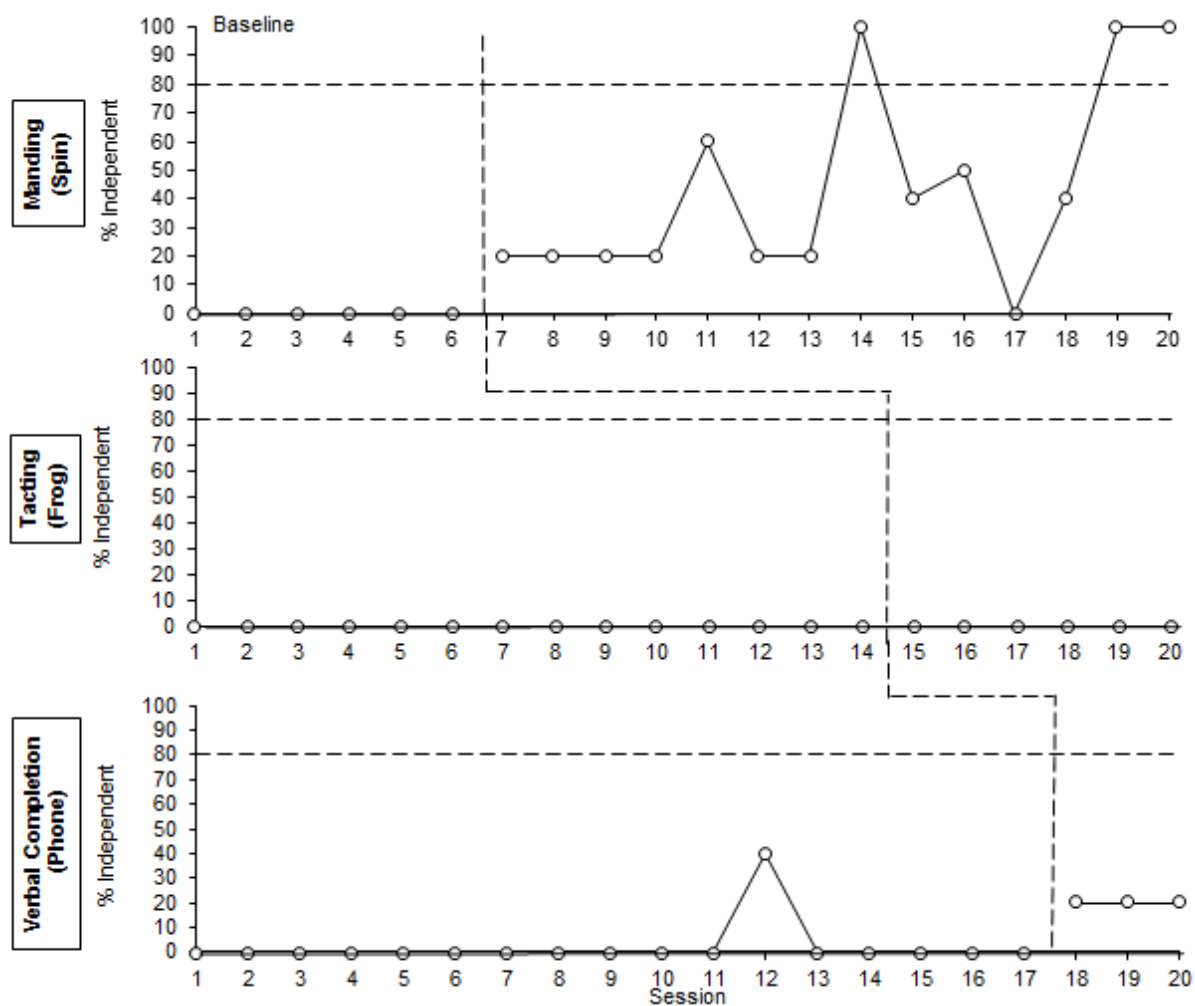


Figure 10. Separated data for Chad (Group 1—Low). Multiple baseline across three behaviors (Spin, Frog, and Phone) with percent independent during baseline and intervention.

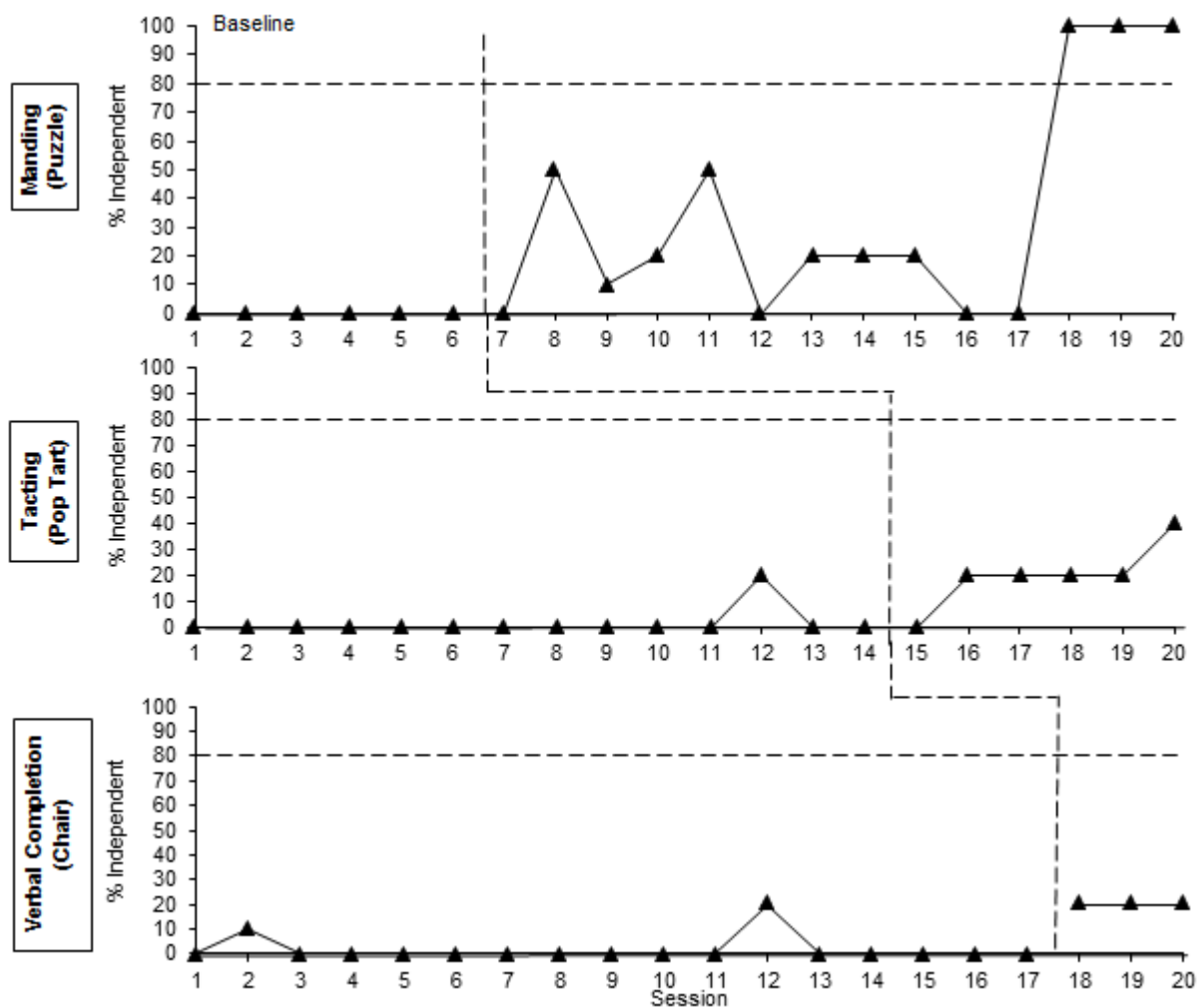


Figure 11. Separated data for Chad (Group 1—Low). Multiple baseline across three behaviors (Puzzle, Pop Tart, and Chair) with percent independent during baseline and intervention.

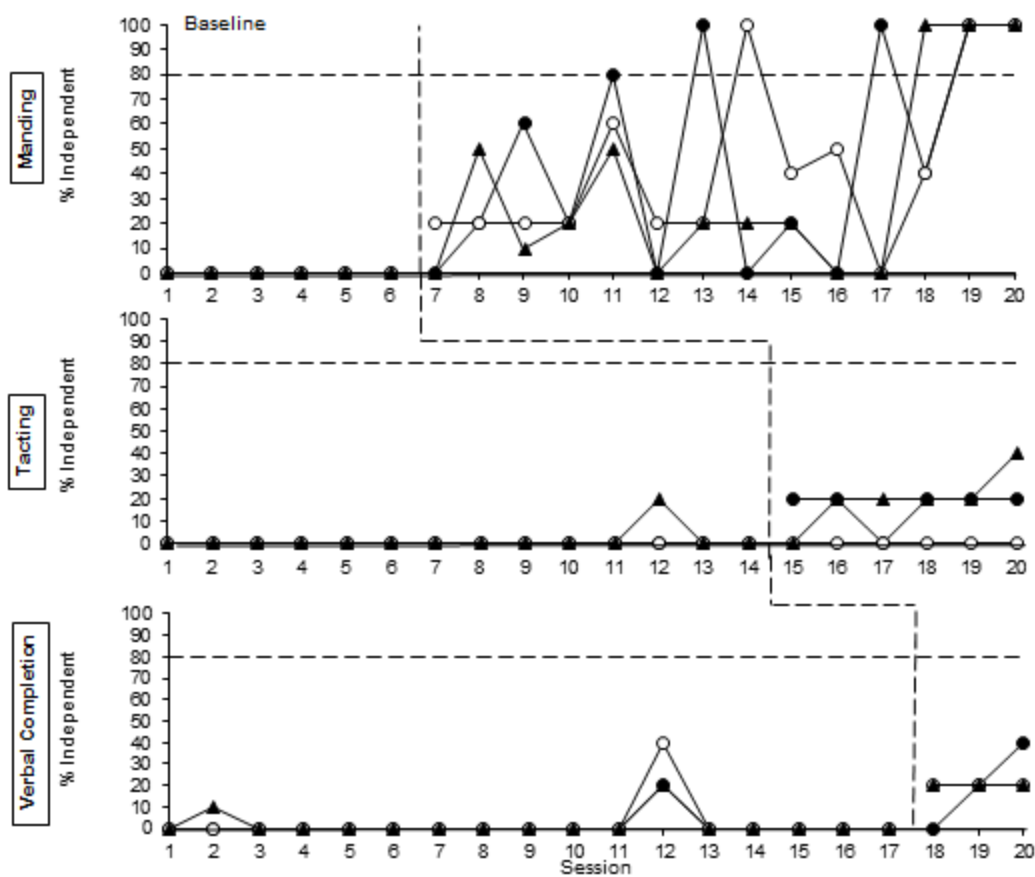


Figure 12. Combined data for Chad (Group 1—Low). Multiple baseline across three behaviors with percent independent during baseline and intervention.

Lauren. Lauren was a four-year old female diagnosed with ASD. She had been receiving ABA therapy for over a year. Prior to the current study, Lauren scored Level 2 on the VB-MAPP, 3 on the CSBS, and 20 on the MIS. She was placed into Group 2 based on these scores. Lauren's communicative ability was described by her mother and therapists as "moderate." Her preferred methods of requesting (manding) were to use sign language, verbal speech, gestures, and pointing. Lauren's mother and therapists stated that Lauren had a vocabulary of around 15 single words, and Lauren mainly preferred sign language to verbal speech. Lauren's mother additionally stated that improving communication was a "high priority" because Lauren had a limited capacity for communication outside of using sign language. This was prohibitive in public settings where most people did not use sign language for communication. Examples of words that Lauren could identify receptively were: daddy, mommy, grandma, brother, puzzle, music, chicken nuggets, ice cream, head, knees, run, and stop.

Level. In Lauren's graph below, there was little change in level between baseline and intervention except for manding for one target. Variability also decreased during intervention.

Trend. In Figure 13, during the baseline phase, targets "necklace" (manding) and "cat" (tacting) had no trend and target "trash can" (verbal completion) had a positive trend. In Figure 14, during the baseline phase, all targets had a positive trend. In Figure 15, during the baseline phase, all targets had a positive trend, and targets "doll" (manding) and "airplane" (verbal completion) had a positive trend.

Target "necklace" (manding) additionally had a positive trend during the intervention phase, while targets "cat" (tacting) and "trash can" (verbal completion) had no trend during the intervention phase. During the intervention phase, only target "cups" (manding) had a positive trend. Targets "flower" (tacting) and "phone" (verbal completion) had no trend during the intervention phase. trend.

All interpretations of trend for Lauren's data are somewhat ambiguous because she achieved most of her goals during baseline (except for "necklace").

Variability. The variability of both baseline and intervention data was observed in the graphs below. Of importance was the decrease in variability that occurred during the intervention phase for all targets. Data were highly variable during the baseline phase and considerably less variable during the intervention phase. However, for some targets such as manding targets, "necklace" and "doll", there was more variability during the intervention phase.

Immediacy. Immediacy of change was calculated by comparing the last data point at the end of the baseline phase with the first data point at the beginning of the intervention phase. Lauren did not have a clinically significant change between baseline and intervention phases. Since Lauren did not have a clinically significant change between baseline and intervention phases, and she, additionally, mastered all targets during baseline, interpreting immediacy in her case is not necessary.

Overlap. There was considerable overlap between baseline and intervention data in the graphs below.

Criterion Achievement. Lauren achieved the 80% criterion for mastery for all targets in baseline and intervention phases, except for the manding target, "necklace" during baseline.

Summary. In Lauren's case, ASL was working for communication during ABA therapy. She was consistently achieving the goal of 80% for mastery of a skill for all targets within manding, tacting, and verbal completion behaviors. There was very little room for improvement with the new intervention. However, Lauren's caregivers wanted her to learn to use the Proloquo2Go™ app during ABA therapy as another communication tool. They are hopeful that Lauren can generalize the skill learned in ABA therapy, and use Proloquo2Go™ in public settings where communicating with ASL is difficult because few people use sign language to communicate, and Lauren can be frustrated when others do not understand her. Additionally, within ABA therapy, there are certain objects for which there are no signs (e.g., whirly ball), or

signs that are beyond Lauren's level of fine motor skills, so Lauren has no way to request them. Using Proloquo2Go™, an icon could be created within the app to solve this issue.

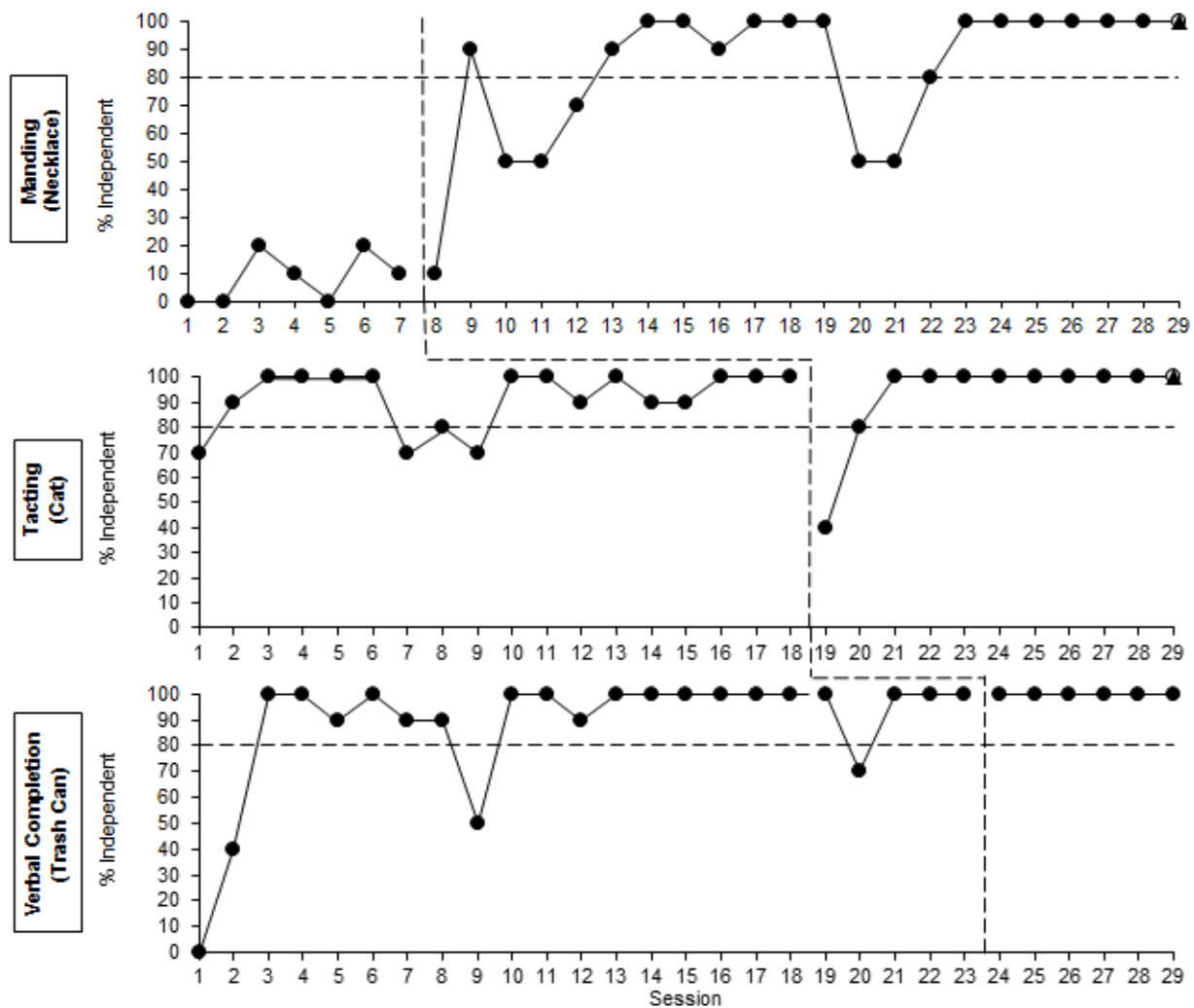


Figure 13. Separated data for Lauren (Group 2—Mid-range). Multiple baseline across three behaviors (Necklace, Cat, and Trash Can) with percent independent during baseline and intervention.

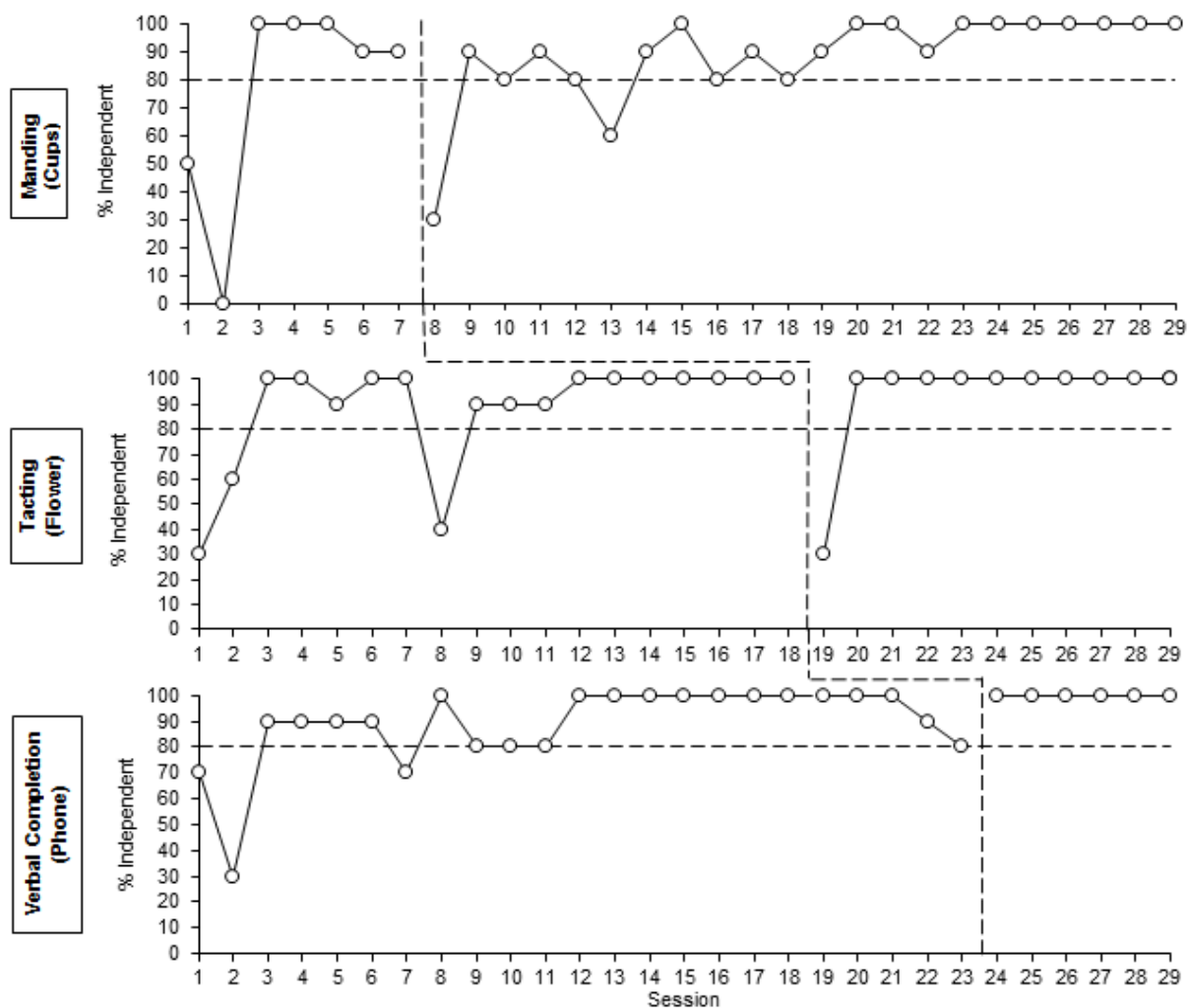


Figure 14. Separated data for Lauren (Group 2—Mid-range). Multiple baseline across three behaviors (Cups, Flower, and Phone) with percent independent during baseline and intervention.

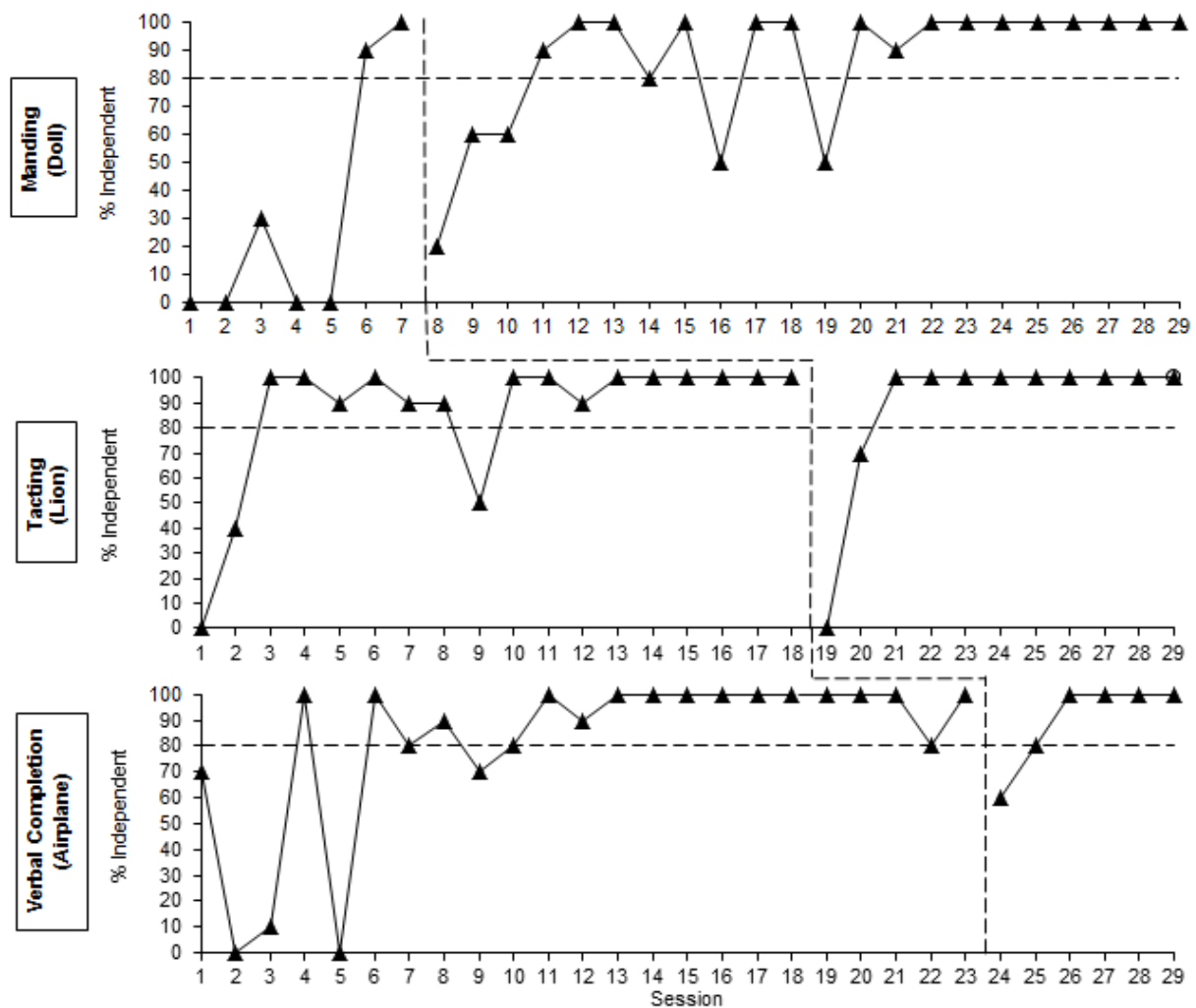


Figure 15. Separated data for Lauren (Group 2—Mid-range). Multiple baseline across three behaviors (Doll, Lion, and Airplane) with percent independent during baseline and intervention.

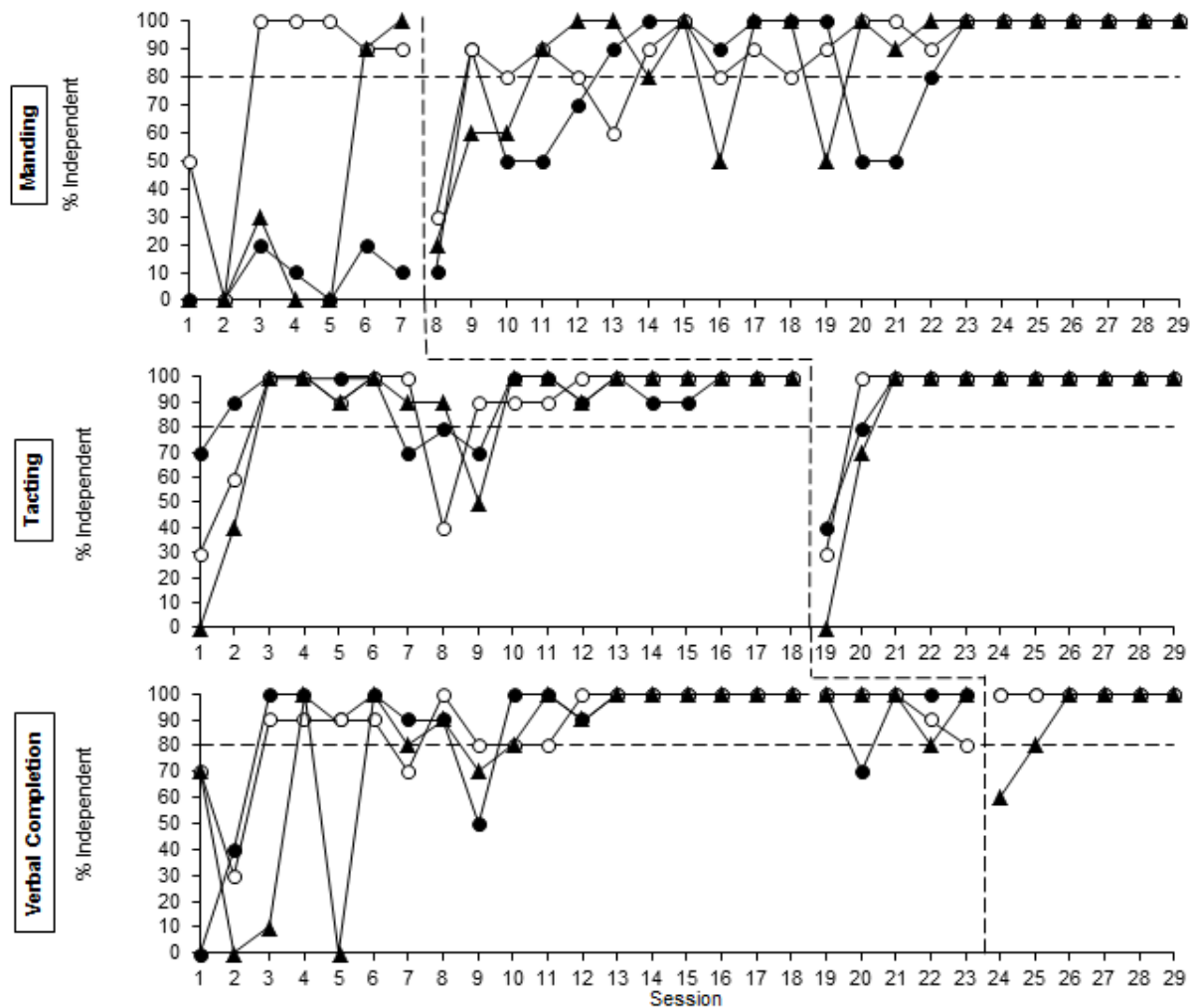


Figure 16. Combined data for Lauren (Group 2—Mid-range). Multiple baseline across three behaviors with percent independent during baseline and intervention.

Gregory. Gregory was a three-and-a-half year old male diagnosed with ASD. He had been receiving ABA therapy for nine months. Prior to the current study, Gregory scored Level 2 on the VB-MAPP, 3 on the CSBS, and 18 on the MIS. He was placed into Group 2 based on these scores. Gregory's communicative ability was described by his mother and therapists as "moderate." His preferred method of requesting (manding) was to make utterances such as whining, gesturing, and pointing to the desired item. Gregory's mother and therapists stated that Gregory had a vocabulary of over 50 single words and two-word phrases, and Gregory used sign language and verbal speech to communicate. Gregory's mother additionally stated that improving communication was "very important" because Gregory tended to become aggressive and "melt down" when trying to express himself. Examples of words that Gregory could identify receptively were: Jake (cat), daddy, mommy, sissi, mamaw, ball, milk, spaghetti, arm, leg, eye, run, walk, sleep, eat, and play.

Level. In Gregory's graph below, overall there was a small change in level between baseline and intervention. Gregory did have an improvement in level for manding across all three targets. Variability decreased slightly during intervention during verbal completion and remained the same between baseline and intervention except for two of three tacting targets and two of three manding targets.

Trend. In Figure 17, during the baseline phase, targets "race track" (manding) and "phone" (verbal completion) had positive trends and target "hula hoop" (tacting) had no trend. In Figure 18, during the baseline phase, target "gear toy" (manding) had no trend; target "chicken nugget" (tacting) had a positive trend; and target "swing" (verbal completion) had a negative trend. In Figure 17, during the baseline phase, targets "wrestle" (tacting) and "trash can" (manding) had a positive trend, and target "fire truck" (manding) had no trend.

Target "phone" (verbal completion) had a positive trend during the intervention phase, while targets "race track" (manding) and "hula hoop" (tacting) had no trend during the intervention phase. During the intervention phase each of these targets had no trend. During the

intervention phase, targets “fire truck” (manding) and “trash can” (verbal completion) had no trend, and target “wrestle” (tacting) had a positive trend.

All interpretations of trend for Gregory’s data are somewhat ambiguous because he achieved most of his goals during baseline, except for manding targets.

Variability. The variability of both baseline and intervention data was observed in the graphs below. Of importance was the decrease in variability that occurred during the intervention phase for all targets. Data were highly variable during the baseline phase and considerably less variable during the intervention phase.

Immediacy. Immediacy of change was calculated by comparing the last data point at the end of the baseline phase with the first data point at the beginning of the intervention phase. Gregory did not have a clinically significant difference between baseline and intervention during tacting and verbal completion because he met most of his goals during baseline. However, there was a notable change between baseline and intervention for all manding targets, and the change was immediate.

Overlap. There was considerable overlap between baseline and intervention data in the graphs below for tacting and verbal completion, however, there was virtually no overlap for manding.

Criterion Achievement. Gregory achieved the 80% criterion for mastery for all tacting and verbal completion targets in baseline and intervention phases. Gregory did not achieve the 80% criterion during baseline for any manding targets during baseline, but did achieve 80% criterion for manding targets during intervention.

Summary. As shown below in Figures 17-20, ASL had a positive but variable effect. For tacting targets, Proloquo2Go™ reduced this variability. The 80% goal for mastery of a skill within ABA therapy was not going to be achieved for manding with ASL, so a new intervention was warranted for manding, and the Proloquo2Go™ intervention had a positive, large, and clinically significant effect on manding across all three behaviors. Due to extreme variability, the

effect of the intervention on verbal completion is ambiguous, at best, for two of the three behaviors. However, for the target, “trash can” (verbal completion), Gregory showed considerably less variability during the intervention phase. Gregory’s therapists and caregivers were pleased with the overall decrease in variability during the intervention phase, and are hopeful that Proloquo2Go™ can become another communication tool for use in ABA therapy in order to decrease the number of “melt-downs” and temper tantrums that take away from productive therapeutic time. Additionally, Gregory’s caregivers are interested in generalizing this skill to public settings where Gregory is less able to be understood by others because of his unclear speech, whining, and others’ inability to understand sign language.

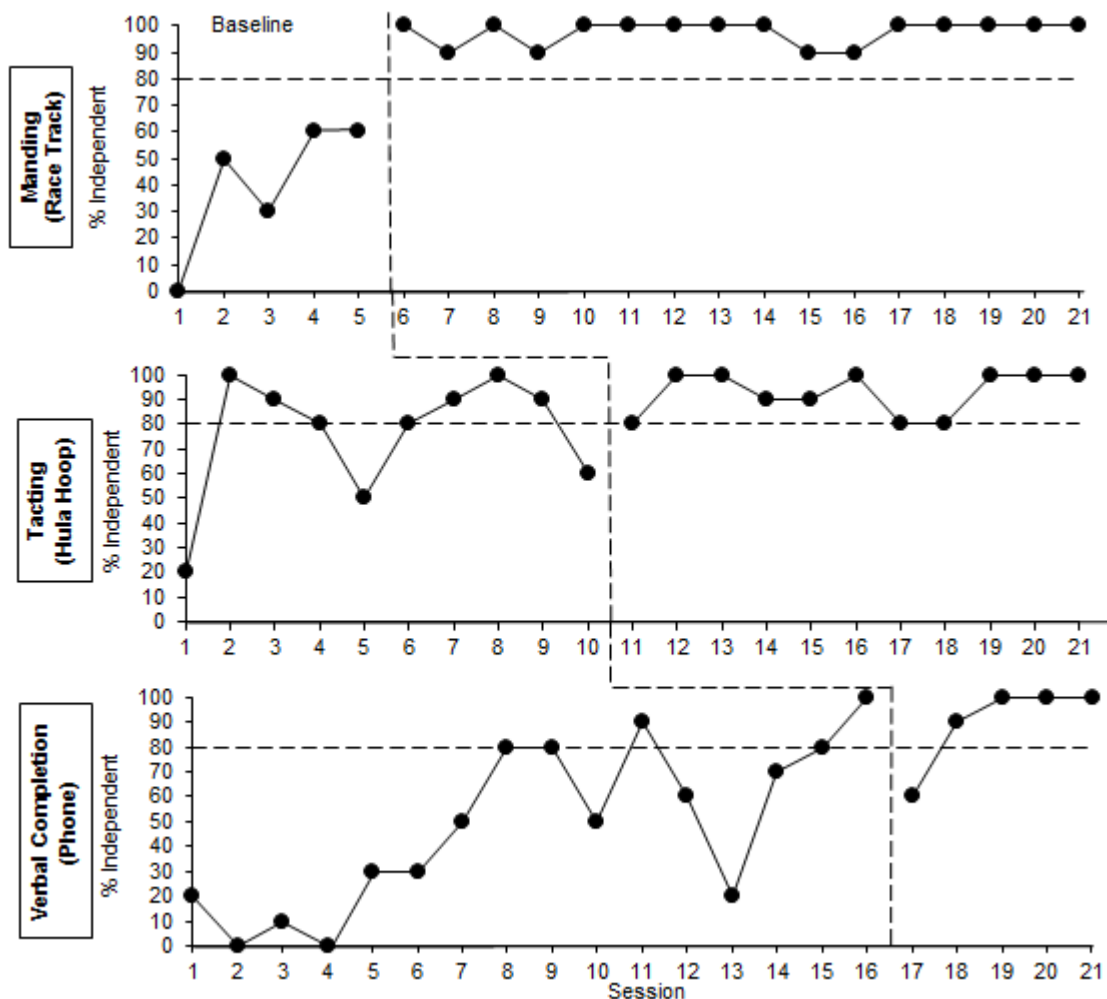


Figure 17. Separated data for Gregory (Group 2—Mid-range). Multiple baseline across three behaviors (Race Track, Hula Hoop, and Phone) with percent independent during baseline and intervention.

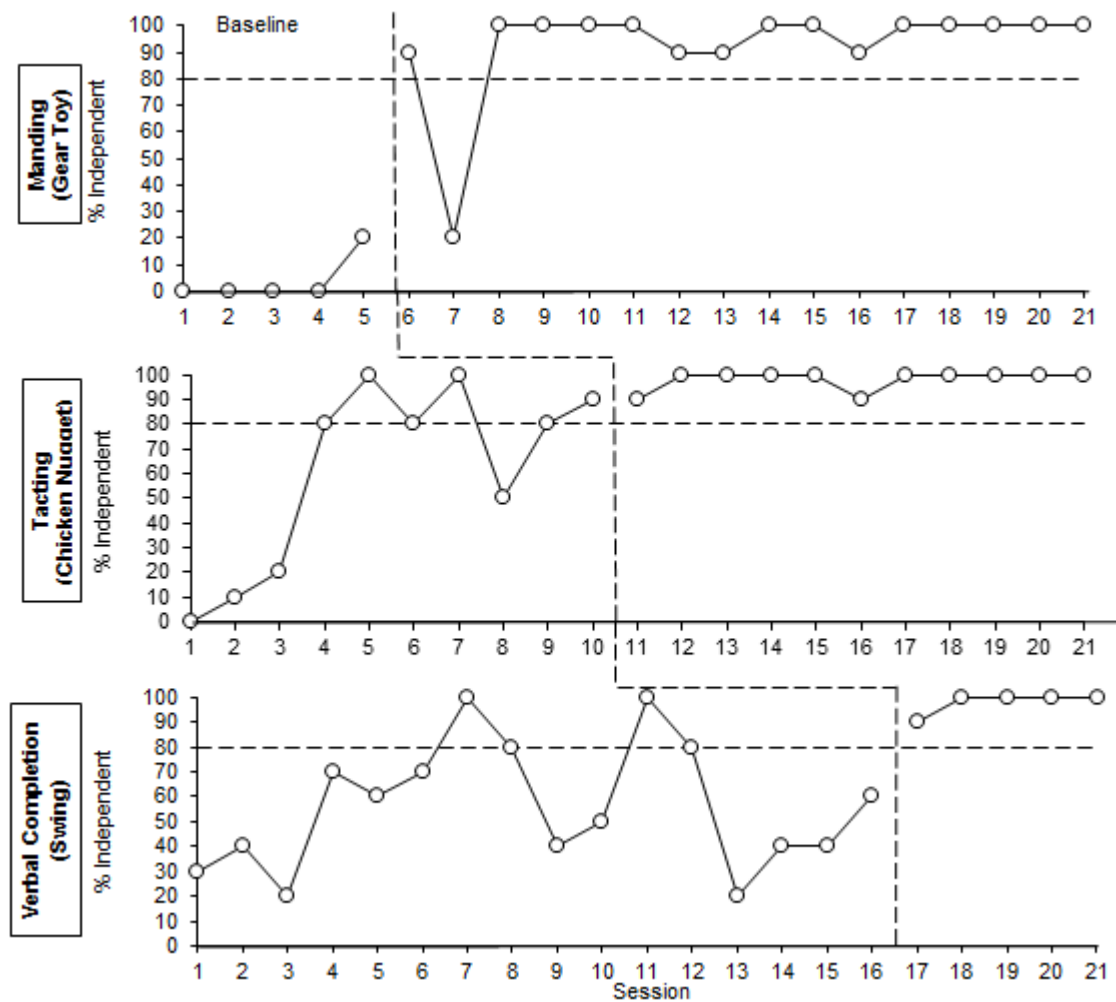


Figure 18. Separated data for Gregory (Group 2—Mid-range). Multiple baseline across three behaviors (Gear Toy, Chicken Nugget, and Swing) with percent independent during baseline and intervention.

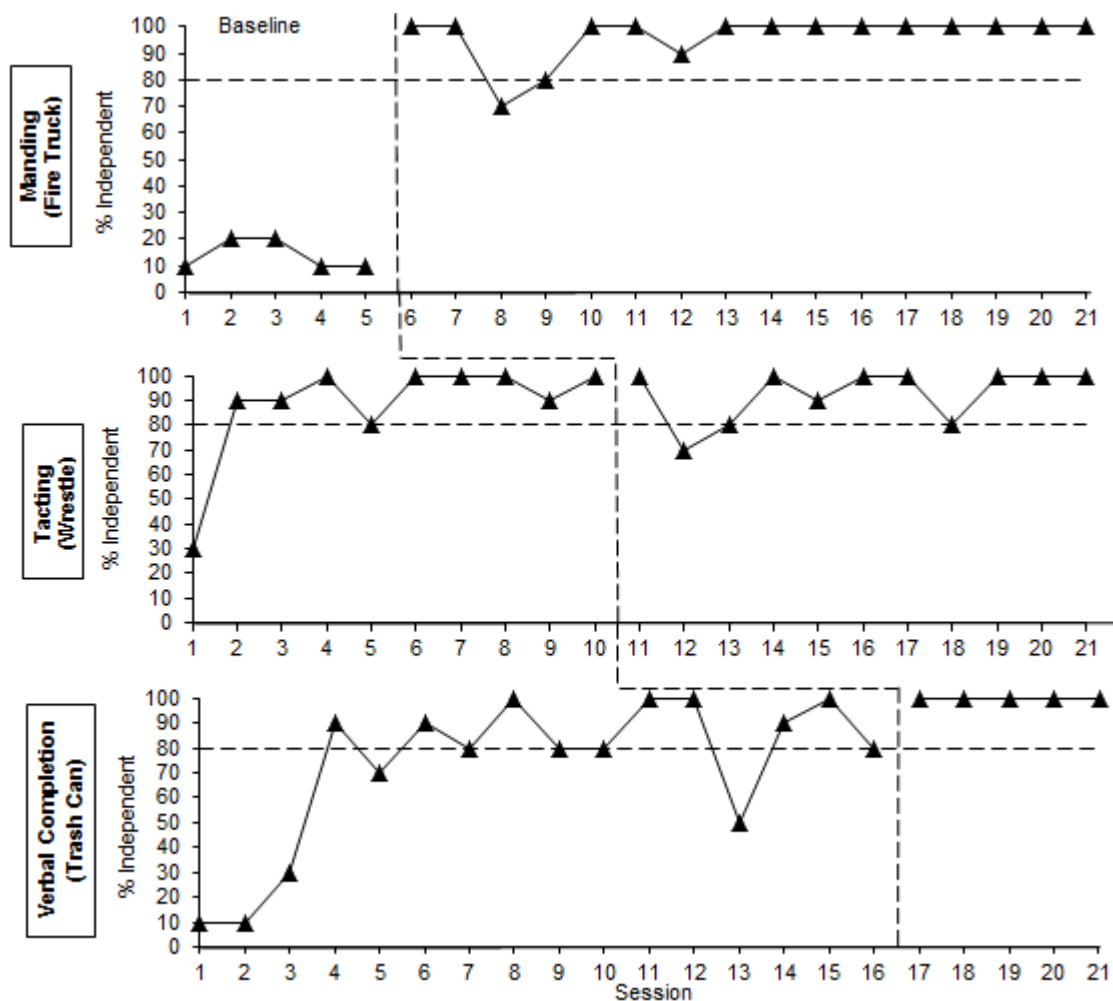


Figure 19. Separated data for Gregory (Group 2—Mid-range). Multiple baseline across three behaviors (Fire Truck, Wrestle, and Trash Can) with percent independent during baseline and intervention.

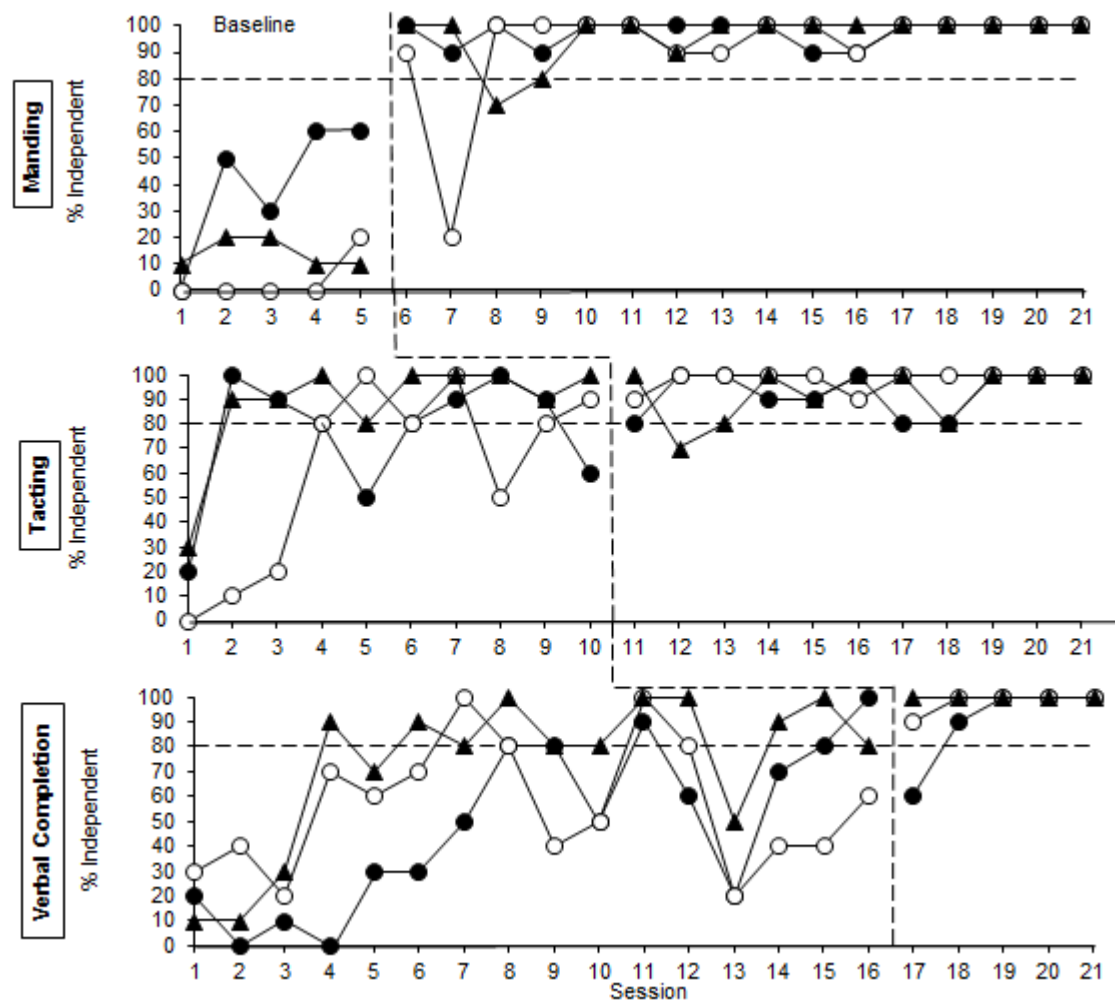


Figure 20. Combined data for Gregory (Group 2—Mid-range). Multiple baseline across three behaviors with percent independent during baseline and intervention.

CHAPTER 5: DISCUSSION

Introduction

In the current study, a multiple baseline across behaviors single-case research design was employed to assess the effectiveness of Proloquo2Go™ in enhancing manding, tacting, and verbal completion during Applied Behavior Analysis (ABA) therapeutic sessions for five children ages three to four years old with ASD and complex communication needs. Results of this study provide insight into the usefulness of Proloquo2Go™ in enhancing communication skills for children with ASD and complex communication needs during ABA therapy. Specifically, this study provides evidence that using Proloquo2Go™ with some children with ASD who are in early preverbal stages may be useful in enhancing tacting, manding, and verbal completion skills during ABA therapy. Additionally, using Proloquo2Go™ with some children who are in later preverbal stages may be useful as an accessible form of communication in addition to ASL. This chapter will provide a summary of the current study, discussion of the results, discussion of the limitations of the methodology and results, and implications for future research.

Summary of Current Study

Of the five participants in the current study, three had communication skills quantified as “low” (Group 1) and two had communication skills quantified as “mid-range” (Group 2) based on three standardized scales (VB-MAPP, CSBS, and MIS). Overall, Group 1 demonstrated a real need for intervention as evidenced by baseline data, and showed a clinically significant improvement in manding, tacting, and verbal completion skills during the intervention phase of the study. In contrast, Group 2 did not show as much of a need for the intervention as Group 1, and while the Proloquo2Go™ app tended to decrease variability in the data, participants were, overall, just as likely to master manding, tacting, and verbal completion skills (using 80% criteria) during baseline (ASL) as they were during intervention (Proloquo2Go™). For Group 2, there was not much room for improvement, except in manding, given that the 80% criterion was achieved during baseline with ASL. Participants in Group 2 readily learned how to use

Proloquo2Go™ indicating that this could be a device for use in other contexts where they could be understood by more people. In both groups, caregivers and therapists reported that the intervention was warranted and useful.

Strengths of the Current Study

The National Secondary Transition Technical Assistance Center (NSTTAC) is a national technical assistance and dissemination center funded by the U.S. Department of Education's Office of Special Education Programs from January 1, 2012 – December 31, 2014 (www.nsttac.org.) It is directed and staffed by the Special Education Program at the University of North Carolina at Charlotte, in partnership with the Special Education Program at Western Michigan University. NSTTAC provides technical assistance and disseminates information to State Education Agencies, Local Education Authorities, schools, and other stakeholders to (a) implement and scale up evidence-based practices leading to improved academic and functional achievement for students with disabilities, preparing them for college or other postsecondary education and training and the workforce; (b) implement policies, procedures, and practices to facilitate and increase participation of students with disabilities in programs and initiatives designed to ensure college- and career-readiness; and (c) achieve 100% compliance with the Individuals with Disabilities Education Act. The NSTTAC lists 20 "Decision Rules for the Presence of Single-Subject Quality Indicators." The current study sought to include these quality indicators, listed below:

- 1. Age, disability, gender reported and the description provided allows for possible replication of the study. Participants were operationally described.*
- 2. The process by which students were selected for participation is replicable. Participant selection was operationally described.*
- 3. Operational descriptions of the setting were provided.*
- 4. What is being measured in the study was operationally defined. Each dependent variable is described for valid consistent assessment of the variable.*

5. *Measure of the dependent variable is quantifiable (e.g., frequency, time) or observable.*
6. *The assessment process for each dependent variable can be replicated, based on the description of the measurement provided.*
7. *The dependent variable is measured repeatedly to allow for observation of patterns prior to intervention and comparison of performance across conditions or phases.*
8. *Interobserver reliability data were collected repeatedly throughout various phases of the study (e.g., not only in baseline).*
9. *The independent variable was operationally defined to allow both valid interpretation of the results and accurate replication of the procedures.*
10. *The independent variable was systematically manipulated by the researcher (not a naturally occurring event). The researcher determined when and how the independent variable would change.*
11. *Documentation of procedural fidelity measures was provided, either through a continuous direct measure of the independent variable's implementation or some other measure that was reported.*
12. *The dependent variable was observed until a pattern of responding is consistent to allow for prediction to future responses (5 or more are recommended, fewer are acceptable if pattern established).*
13. *Baseline conditions/procedures described with replicable procedures.*
14. *At least three demonstrations of effect of the intervention were demonstrated at three different points in time with one participant, or across at least three different participants.*
15. *Experimental control demonstrated through (a) introduction and withdrawal of the independent variable, (b) staggered introduction of the independent variable, or (c) manipulation of levels of the independent across observation periods.*

16. *Within one study external validity is enhanced through replicable descriptions of (a) participants, (b) study context, and (c) factors influencing behavior prior to intervention. Also enhanced through use of multiple participants or settings and multiple measures of the dependent variable in one study. Weakened by selection and attrition bias.*
17. *The dependent variable selected was important for the individual(s) included in the study.*
18. *The amount of change in performance (dependent variable) has social significance, according to the author's analysis of the social validity measure.*
19. *Costs reported and the procedures associated with the independent variable were determined by the author (or stakeholders) to be practical and cost efficient.*
20. *Typical intervention agents reported the procedures to be acceptable, feasible, effective, and choose to continue the intervention after the study (NSTTAC, 2014).*

Limitations

In addition to the above mentioned quality criteria, within single-case design research, several aspects of the data can interfere with drawing valid inferences, or threats to data-evaluation validity. These include: excessive variability in the data, unreliability of the measures, trends in the data, insufficient data, and mixed data patterns. Additionally, special issues that should be considered with regard to comparison studies (studies comparing two interventions) are multi-treatment interference, non-reversibility of effects, and separation of treatments (Gast, 2010; Kazdin, 2011; Orme & Combs-Orme, 2012). These are discussed in further detail with relation to the current study below.

Additionally, as with any type of analysis, visual analysis has limitations, namely that different observers under differing circumstances may draw different conclusions from the same data (Kahng et al., 2010; Orme & Combs-Orme, 2012; Ximenes, Manolov, Solanas, & Quera, 2009).

Within multiple baseline across behaviors single-case design research, three phase repetitions (as in the current study) are required, but adding phase repetitions increases the power of the statistical test, similar to adding participants in a traditional group design (Horner, Swaminathan, Sugai, & Smolkowski, 2011).

Moreover, this study did not include a generalization phase, which would demonstrate that a participant could expand a newly learned skill such as manding for a sandwich to a new environment (e.g., a restaurant).

Threats to Data Evaluation Validity

Excessive variability in the data. Excessive variability in the data can make it difficult to tell if the intervention had the intended impact. Variability can come from many sources, such as: uncontrolled influences in the setting that change widely each day; error in measurement; inconsistent implementation of the intervention; genuinely high variability in performance; differences among subjects if more than one was used; cycles/abrupt changes with the individual (e.g., on/off medicine; illness) or the environment (e.g., changes in who is present during the intervention; changes in classroom activity/routine) (Kazdin, 2011).

Variability in the data was an issue of concern in the current study, primarily for participants in Group 2. Participants in Group 2 tended to have a great deal of variability in data during the baseline phase, making it sometimes unclear as to when or whether the intervention should be introduced. Additionally, observed variability in data with children on the autism spectrum is relatively common due to changes in environment, routine, and/or medication (Tustin, 2013). For example, children with ASD tend to have negative behaviors that can interfere with data collection or stability of data during times of transition such as a new therapist, changes in the weather, or moving furniture in the room where the research project is taking place. To attempt to counteract some of these potential challenges, parents and caregivers were asked to refrain from drastic medication changes during the course of the study (e.g., stopping or starting a new medication). If a drastic medication change was needed,

parents and caregivers were asked to report the change to the researcher so that it could be noted. No drastic changes in medication occurred. Also, therapists were asked to keep their usual daily routines and keep the physical environment of the therapy room the same each day. Variability for Group 2 may have been heightened because the participants in that group were more advanced than Group 1, so they may have become bored after mastering a skill.

Variability among the targets within each behavior was also an area of concern for external validity. For Chad, for example, there was considerable variation among targets during manding and tacting. Because Chad became ill during the research study, it is possible that some of his variation was due to his illness. However, it is also possible for Chad and other participants experiencing variability among targets within the same behavior, that there was some inherent difference among the targets that made some easier or harder to learn than others. This concern would relate back to the choosing of targets for each child, which was done using a preference assessment completed by each child's therapist.

Unreliability of the measures. Reliability is a general term for the consistency of measurements, and unreliability means inconsistency caused by random measurement errors. Interobserver reliability, more specifically, is the degree of consistency in ratings or observations across raters, observers, or judges. Variability in obtained results will occur in the measurement daily due to different influences such as mood of the individual being studied or mood of the individual collecting data, as well as many other influences. Even when measurements are perfectly reliable, variability will still occur because performance is multiply determined, and the measure is only one contributing factor (Kazdin, 2011). Unreliability of the measure imposes yet another source of variation. Even when measures are checklists, rating scales, or self-report measures that are standardized, these measures, too, have reliability that can vary as a function of use, sample, and conditions of administration. Reliability, therefore, is not a property of a scale alone, but also a function of its use and conditions of administration (Kazdin, 2011).

The current study sought to address the issue of reliability by ensuring a training for therapists collecting data, a standardized data collection form, an intervention protocol, and random checks of data collection and adherence to the intervention by the principle investigator. Additionally, an undergraduate student assistant helped obtain inter-observer reliability data by viewing and coding 20% of baseline and intervention data.

Trends in the data. Trend refers to the slope or pattern of change over time based on multiple observations (Kazdin, 2011). A trend in the data is the overall direction of a data path within a phase or across phases of a single-case design line graph. Examples include: no trend, negative trend (also referred to as a descending or decelerating trend because values are decreasing over time), and positive trend (also referred to as ascending or accelerating trend because values are increasing over time) (Orme & Combs-Orme, 2012). Single-case designs depend on seeing changes in trends over time. Sometimes, during baseline observation, a trend is identified in the therapeutic direction. In this case, improvement is occurring without introduction of the intervention. Or, in other cases, during the intervention phase, behavior may improve quickly and then rapidly deteriorate over the course of treatment. Both of these situations can make drawing inferences difficult.

During the current study, there were several instances wherein the baseline data showed a positive trend in the therapeutic direction. While a positive trend in data during baseline is relatively common (Gast & Ledford, 2014), it did make it difficult to assess when to implement the intervention phase (or if it should be implemented) of the study and to wholly determine the cause of positive change if it occurred. There were no instances in the current study wherein a participant improved during the intervention phase of the study and then began to show a decline. The only instance where this was a potential issue was for Gregory during verbal completion.

Insufficient data. Evaluation in single-case designs relies on looking at multiple single-case design characteristics of the data within and across phases to see if change has occurred.

A validity threat can occur if the data are insufficient to characterize performance and/or provide information required to project performance in the future. Determining the number of data points required for “sufficient data” can be difficult and subjective. More data points are invariably better, but generally speaking, at least three data points are considered useful (Kazdin, 2011).

In the current study, five data points were considered the minimum for a phase. There was one instance where this did not occur (see Figure 1). In this instance, the participant achieved three data points during the verbal completion phase of the intervention and was unable to continue due to illness.

Mixed data patterns. Consistency in data is important for drawing inferences in research, so mixed data patterns within and across phases can interfere with evaluation of the data. A threat to data-evaluation validity occurs if the data pattern is mixed and interferes with drawing inferences about the intervention. Excessive variability, trend, and insufficient data at one or more places in the design could be the basis for a mixed data pattern (Kazdin, 2011).

In the current study, variability was an issue of concern primarily for Group 2, and while there was not insufficient data for Chad (as seen in Figure 1), he was unable to meet the five data point standard for verbal completion during the intervention.

In addition to data-evaluation validity, internal, external, construct, and social validity should also be considered.

Multi-treatment interference. Multi-treatment interference is the influence one experimental condition has on performance under another experimental condition. Carryover effects are the influence of one experimental condition on performance under another condition due to the nature of the initial condition. Sequence effects are the influence of one condition on another due to the ordering of experimental conditions (Gast, 2010). When a subject or subjects receives more than one treatment, the results may be internally valid, that is, threats to internal validity are ruled out. However, the possibility still exists that the particular sequence of order in which the interventions were given may have contributed to the results (Kazdin, 2011). In the

case of the current study, the second intervention (Proloquo2Go™) appeared to be more effective, generally speaking, for Group 1. However, these results may be due to the fact that the Proloquo2Go™ intervention was second and followed by ASL. A different ordering of the treatments may have produced different results. Hence, the conclusions drawn are restricted to the special way in which the multiple treatments were presented (Kazdin, 2011).

Non-reversibility of effects. In some comparative research studies, one intervention is used for several observations and later a second intervention is used for several observations. When this occurs, the problem of non-reversibility of effects may arise. If the behavior is not readily reversible (to baseline levels), then the first intervention may cause the behavior to occur at the ceiling or floor levels of the measurement system (Gast, 2010). This is more of a concern for alternating treatments designs. The current study used a multiple baseline across behaviors design in order to avoid this concern, and additionally, to avoid the concern of the inability to reverse effects because the desired outcome behaviors were learned behaviors.

Separation of treatments. Like most comparative studies, the current study sought to evaluate the superiority of one intervention over another and to make recommendations regarding which intervention to use. “However, when two or more interventions are applied to the same behavior, the ultimate levels of the behavior cannot be attributed to only one intervention” (Gast, 2010, p. 334). This inability to attribute the ultimate behavior change to one and *only* one intervention is known as the separation of treatments issue (Holcombe, Wolery, & Gast, 1994). This is an issue of concern when interpreting the results of the current study, and additionally, when making generalizations and recommendations.

Internal Validity

The internal validity of an experiment refers to the extent to which the experiment rules out plausible alternative explanations of the results (Kazdin, 2011), or in the case of the current experiment, the extent to which client change is attributable to the intervention. A number of things can cause threats to internal validity. These include history effect (some other event

occurred at the same time as the intervention); instrumentation effect (change in how the outcome was measured); maturation effect (naturally occurring changes in client over time); testing effect (deterioration in outcome caused by repeated measurement or improvement in outcome due to repeated measurement); and regression effect (tendency for higher or lower scores to regress to the mean) (Orme & Combs-Orme, 2012).

In the current study, all efforts were made to ensure that no other new events (e.g., medication changes, changes in therapist, etc.) occurred at the same time as the intervention. There were no changes in how the outcome variables were measured, and this was ensured through random checks by the principle investigator. The issue of maturation effect could have been an issue in the current study because participants were learning a new skill, and with any learned skill, there is a tendency to do better over time. Testing effect may have also been an issue of concern, as some deterioration in outcome may have occurred over time, especially for participants in Group 2. These participants may have become bored with a skill that they had already mastered but were still required to complete while learning other new skills for other phases of the study. Regression to the mean did not seem to be an issue of concern in the current study, as participants who achieved 80% and above tended to stay at that goal.

Upon introduction of the independent variable (e.g., Proloquo2Go™) for the first behavior (e.g., manding), there was an immediate change in the dependent variable in most cases in the therapeutic direction, while data for other behaviors (e.g., tacting and verbal completion) remained relatively stable and unchanged. In this way, in the current study, using a multiple baseline across behaviors single case design, controlled for threats to validity by staggering the introduction of the independent variable across behaviors. By identifying behaviors that were functionally independent from one another (the introduction of the intervention did not bring about changes across other behaviors in the design), and behaviors which were functionally similar (when the intervention was introduced for one behavior, the effect of the intervention was replicated across behaviors), the current study was able to

maintain experimental control. It was demonstrated that behavioral co-variation did not occur, and there was no ambiguous demonstration of effect (wherein it was obvious that change in behavior occurred but not that the change was due to the intervention) (Gast, 2010).

External Validity

External validity is the extent to which the results of an experiment can be generalized beyond the conditions of the original experiment. Threats to external validity include generality across subjects, responses, settings, time, and behavior-change agents; reactivity of experimental arrangements and the assessment procedures; and multiple-treatment interference (Kazdin, 2011).

In the current study, the intervention was only delivered in a certain treatment context/environment and was not tested outside of that therapeutic environment, thus it would not be possible to generalize the conclusions for each participant beyond the scope of the ABA therapeutic environment. However, it is the hope of the investigator, caregivers, and therapists that participants could learn to generalize the skills learned in the study to other environments.

Because of the nature of single-case design research, is not possible to generalize the conclusions drawn for each participant to other children. However, the Proloquo2Go™ intervention seemed to be effective with three of the five participants. These participants (Group 1) had lower scores on the CSBS, MIS, and VB-MAPP, meaning that they scored low on symbolic play, motor imitation, and other pre-verbal skills. It could be that for young children with ASD who score low on measures of pre-verbal skills, Proloquo2Go™ would be a more effective means of communication (as opposed to ASL) during ABA therapy or perhaps the participants in Group 2 were not in need of the Proloquo2Go™ intervention within the ABA context, and, therefore, it would be better tested in other environments/contexts. Children in Group 1, and perhaps other children with ASD who score low on the VB-MAPP, CSBS, and MIS, may have trouble with the fine motor skills necessary to use sign language or may not have the skills to imitate motor actions needed to learn basic signs. Using an app like Proloquo2Go™ may not

only make ABA therapy more effective by allowing for better communication between therapist and student, but may also encourage verbal speech wherein the child would hear the word on the selected Proloquo2Go™ icon. Additionally, more initial success which would likely result in more reinforcement with desired items, further encouraging communicative attempts.

The Proloquo2Go™ intervention was not equally effective for tacting, manding and verbal completion. As speculated by the Applied Verbal Behavior model, greater success occurred with enhancing manding repertoires. Applied Verbal Behavior model practitioners would posit that this is due to the inherent reinforcement occurring with the mand. Based on previous research, it is plausible that the results of the current study have some generality across responses. For example, Valenzuela (2013) found that using a speech generating device reduced rates of echolalia in children with ASD and Lorah et al. (2013) found that the majority of students in their study preferred the speech generating device and overall, independent manding was enhanced. Further research is needed in this area. Because of its ease of use and low cost, generality across behavior-change agents for the intervention, Proloquo2Go™, is likely high. It would be very simple for a different therapist, mom, dad, family member, or care giver to help a young learner with ASD to use Proloquo2Go™.

One area of potential concern in the current study is multiple-treatment interference. Sometimes this is referred to as “sequence effects.” Sequence effects occur when there is influence from one condition on another due to the ordering of experimental conditions (Gast, 2010). Because the current study employed both ASL and Proloquo2Go™ and there was no non-intervention baseline, the conclusions reached from this study are restricted. Specifically, the results from the current study may only apply to individuals who have experienced both treatments in the same way and the same order (i.e., ASL and then Proloquo2Go™).

Construct Validity

Construct validity refers to the accuracy of conclusions based on evidence and reasoning about the degree to which cause and effect variables as operationalized in a study

represent the constructs of interest (e.g., does an intervention as implemented or an outcome as measured contain all of the relevant features and exclude irrelevant features). Once threats to internal validity (confounds) are ruled out, one can ask, "What is the intervention and why did it produce the effect" (Kazdin, 2011, p. 36)?

Additionally, construct validity refers to the degree to which scores on a measure can be interpreted to represent a given construct. For example, one would expect that measures of anxiety correlate with other measures in certain ways: depression (positively) and happiness (negatively) (Orme & Combs-Orme, 2012). Convergent validity (degree to which scores derived from a measure are correlated in the predicted way with other measures of the same construct) and discriminant validity (degree to which scores from a measure are uncorrelated with theoretically dissimilar constructs or other variables) evidence are especially important for establishing construct validity (Orme & Combs-Orme, 2012). The reliability and validity of each measure used in the study are discussed in Appendix 4.

The most important aspects of construct validity in the current study were the outcome measures (independent responses) and the intervention (Proloquo2Go™). Kazdin (2011) additionally asks, "Given that the intervention was responsible for change, what specific aspect of the intervention was the mechanism, process, or causal agent? What is the conceptual basis (construct) underlying the effect" (p. 29)? Failure to properly conceptualize this may also be referred to as "invalidity of the measurements." In the current study, it was assumed that the intervention, Proloquo2Go™, was the impetus for change in the participants' behaviors. However, it may also be plausible that another augmentative and alternative communication application employed during ABA therapy could have the same (or better) results. Or, perhaps it was the use of the iPad® in general, with its interactive features, that captivated the attention of the participants and led to changes in their communicative behavior? Would the intervention have been or less successful if implemented using an iPhone® or other mobile device?

Moreover, had the intervention been employed differently (e.g., grid on the screen been set up with more or fewer icons), perhaps there would have been different results?

Assuming that the Proloquo2Go™ intervention as implemented was the causal change agent, previous research outlined in Chapter 2 would indicate that it is the highly interactive and vocal features of the app that give it the ability to enhance communication for young learners with ASD and complex communication needs. These learners tend to be drawn to interactive devices such as iPads®, iPhones®, and iPods®, and additionally, may benefit from having a device which gives them voice output. The voice output feature, may, in and of itself, be inherently reinforcing, promoting further communicative attempts. What sets the Proloquo2Go™ intervention apart from other apps with voice output is its accessibility—ease of use, availability in Spanish language, inexpensive cost, and availability on multiple devices, as well as its success demonstrated in previous studies.

In addition to the validity of scores on measures used, it is important to consider the validity of the intervention, for example, was the intervention adhered to uniformly across all participants and across all sessions? Was it the intervention employed or the intervention in combination with some other element from baseline or the environment that caused the changes in behavior? To ensure fidelity to the intervention, an intervention protocol was used and the principle investigator performed random checks of fidelity by viewing video tapes of therapeutic sessions.

Moreover the validity of the targets themselves is an important consideration. For example, consider the question, Are the targets used in the current study representative of a broader population of possible targets? In the case of the current study, targets were selected by each participant's primary therapist based on three criteria: 1. Was the target introduced previously? 2. Does the child prefer the target over other targets (based on preferences assessment)? and 3. Is the target indicated as a developmentally appropriate target based on the child's scores on the VB-MAPP assessment? The validity of the behaviors themselves (e.g.,

manding, tacting, and verbal completion) is supported by the Applied Verbal Behavior Model, through which strengthening manding repertoires first is deemed most important, and then based on Skinner's conceptualization of language, tacting and verbal completion repertoires are then enhanced.

Social Validity

Social validity refers to the extent to which target behaviors are appropriate, intervention procedures are acceptable, and important and significant changes in target and collateral behaviors are produced (Cooper et al., 2007). Since the inception of ABA, the consideration of social validity has been principal. Baer et al. (1968), when writing of the domain of ABA, stated the importance of, "behaviors that are socially important, rather than convenient for study" (p. 92). In a sense, this places importance on the subjectivity of ABA. Whether a therapy goal or educational objective, treatment program or instructional strategy, or educational gains or therapy outcomes have social significance should be left up to "significant others," those who have a direct interest in the study participant, including study participants themselves, parents, guardians, teachers, therapists, employers, etc. (Gast & Ledford, 2010).

In the current study, social validity was determined by therapists and parents/guardians of participants. Prior to the study, therapists reviewed the intervention procedures and determined appropriate target behaviors that would be relevant for each child. A limitation of the current study was that there was no standardized measure of social validity outcomes. Instead, a semi-structured interview was conducted using questions from the qualitative portion of the CSBS. Parents/guardians were asked about their children's current forms of communication (e.g., how many words they could speak or sign), preferred method of communication, receptive language skills, and future goals for communication.

Parents/guardians reviewed participants' progress throughout the study and were given the option to stop the intervention if they deemed it not useful to their child's progress in therapy. At the conclusion of the current study, parents/guardians were asked for their opinions of their

children's progress and how the intervention could be improved to better meet their children's needs. All parents/guardians found the intervention useful and successful. However, for the participants in Group 2, since the intervention did not significantly enhance communication beyond that of baseline (ASL), parents/guardians were interested in further investigation using Proloquo2Go™ in other environments.

In the cases of the participants in Group 2, arguably, the 80% criterion for mastery was less useful in determining Proloquo2Go™'s ability to enhance communication, as parents/guardians were additionally interested in communication in public settings and being able to have more "conversational" communication at home with their children. It is notable that Group 2 participants did not do worse during intervention than during baseline, except for several instances within the first couple of sessions. (This may have had more to do with the adjustment to learning a new communicative device.) In other words, for Group 2 participants, Proloquo2Go™ might be useful in a broader range of circumstances.

Conclusions

Overall, for participants in Group 1 (Low), the Proloquo2Go™ intervention had positive results in enhancing manding, tacting, and verbal completion repertoires during ABA therapy. For Robert and Thomas, the intervention had a clinically significant impact. For Chad, the intervention had a positive impact, and while Chad was unable to meet the 80% criterion for mastery in most sessions, he did meet the 80% criterion for manding across all behaviors, and tacting and verbal completion were deemed successful by both his caregivers and therapists.

Within Group 2 (Mid-range), there was an improvement in level for manding in one target for Lauren and all targets for Gregory and there was an improvement in level for verbal completion for one target for Lauren; in each of these cases the criterion was achieved. However, Lauren and Gregory (with the exception of one target) achieved the criterion for tacting and verbal completion across all targets by the end of baseline, and therefore, there was very little room for improvement in these skills upon implementation of the Proloquo2Go

intervention. Both Lauren and Gregory had some reduced variability in their manding, tacting, and verbal completion skills during the intervention phase.

All five children were able to quickly learn to use the Proloquo2Go™ application on the iPad® and were able to use the device to learn three new manding, tacting, and verbal completion targets during ABA therapy. For the two children who showed communication gains using American Sign Language during baseline, the use of Proloquo2Go™ may be an additional communication tool that they can transfer to a public environment (e.g., ordering food at a restaurant), home environment (communicating with a grandparent who does not use sign language), or in cases where the participant does not know the appropriate sign (or there is no ASL sign) to ask for a desired item.

The current study may have reached different conclusions had it incorporated a non-intervention baseline. If a non-intervention baseline is established in a stable condition, it can act as a control condition (Hammond, Malec, Nick, & Buschbacher, 2014). However, it would have been difficult to gain access to a sample of children with autism and limited communication skills who were not receiving some form of intervention to assist with communication. Had a non-intervention baseline been employed in the current study, results would have likely looked different, especially for Group 2. Participants in Group 2 tended to be able to mand, tact, and fill in the blank during verbal completion using ASL effectively; however, if Group 2 participants did not know ASL and were expected to produce verbal speech during baseline, it is likely that neither Lauren nor Gregory would have met the 80% criterion across three sessions for mastery. This elucidates another strength of the current intervention, in that, Proloquo2Go™ gives users actual voice output, making it potentially more usable across a broader range of contexts (outside of ABA therapy) and more accessible to children who are in earlier pre-verbal stages. Additionally, if a different app with higher cognitive demands such as SoundingBoard or Verbally had been used (especially with Group 2), the study may have reached different conclusions. It is likely that participants in Group 2 would not have mastered targets during

baseline while using an app such as Verbally, which has a higher cognitive demand and can entail skills such as typing a word instead of tapping a picture icon as with Proloquo2Go™.

Chad

American Sign Language was not working to help Chad learning to mand, tact, and complete a phrase, so the Proloquo2Go™ intervention was implemented. There was clear, relatively large improvement in manding and the goal of 80% was achieved for most targets after some time. Chad appeared to need more practice than other participants in Group1 to learn a new skill. This was potentially because of his illness. There was a clear but modest improvement in tacting across the three behaviors, and the change didn't occur until implementation of the intervention. While there was no immediate change (e.g., first data point in intervention), Chad, again, appeared to simply need some practice before change occurred.

Gregory

American Sign Language was having a positive but variable effect for Gregory. The Proloquo2Go™ intervention reduced this variability for two of the three behaviors. The 80% goal was not going to be achieved for manding with ASL, so the Proloquo2Go™ intervention was warranted for manding, and the intervention had a positive, large, and clinically significant effect on manding across all three behaviors. The effect of the Proloquo2Go™ intervention on verbal completion was ambiguous.

Lauren

American Sign Language was mainly working for Lauren for manding, tacting, and verbal completion tasks during ABA therapy. The goal of 80% was achieved during baseline (except for manding in Figure 9). Lauren did experience less variability in data during the intervention phase, and while little improvement was made, her caregivers and therapists remain hopeful that Proloquo2Go™ is a communication tool that Lauren can generalize to other environments where ASL is not prevalent.

Robert

American Sign Language was not working to teach Robert manding, tacting, and verbal completion skills during ABA therapy, and therefore, a new intervention (Proloquo2Go™) was warranted. The intervention had a huge, positive, clinically significant effect across all three domains and all target behaviors.

Thomas

American Sign Language was not working to teach Thomas manding, tacting, and verbal completion skills during ABA therapy, and therefore, the Proloquo2Go™ intervention was warranted. Ultimately, the intervention had a large, positive, clinically significant effect on manding, although, generally it took a bit of time to see this change. A positive and modest effect on tacting was observed for Thomas.

Implications for Future Research

Several previous studies have indicated the effectiveness of using Proloquo2Go™ with children and adolescents on the autism spectrum to enhance communication. In a thesis, Wilkins (2013) evaluated the results reported in ten studies that used the iPad/iPod® with children or adults in need of augmentative communication. The results suggested that iPad/iPod® usage most often employed the Proloquo2Go™ application. In addition, those children with a diagnosis of autism were most likely to show positive results from the use of these devices. Of the 31 subjects in the ten studies, 74% showed improvement. Eighteen of the 20 children diagnosed with autism were reported to have improved through the use of the iPad/iPod®. In another thesis, King (2011) found that Proloquo2Go™ enhanced the mand repertoire for three children aged three to five with autism as compared to the Picture Exchange Communication System (PECS). In yet another thesis, Valenzuela (2013) evaluated the effects of a high-tech (Proloquo2Go™) and low-tech ACC device on reducing echolalia in a verbal eleven-year-old child with autism during conversational speech using a single-case alternating treatment research design. The results supported the use of Proloquo2Go™ in reducing

echolalic utterances. Sennott and Bowker (2009) found that Proloquo2Go™ can be used with children with ASD to meet fully daily communication needs, and additionally identified Proloquo2Go™ in their “best practices” category for its use of symbols, visual supports, voice output, and ability to support inclusion. Additionally, Duncan and Tan (2012) found evidence to support the use of Proloquo2Go™ as a visual task manager for students with autism, Roth (2013) found evidence to support the use of Proloquo2Go™ to enhance communication and performance in physical education classes, and van der Meer, Sutherland, O'Reilly, Lancioni, & Sigafoos (2012) demonstrated the effectiveness of Proloquo2Go™ in helping autistic students to communicate in a classroom setting.

The findings of the current study are consistent with previous research indicating that Proloquo2Go™ may be an effective tool for enhancing communication for some children with ASD and complex communication needs. Results are consistent with previous research showing that acquisition of alternative and communication modalities varies across children with autism, and supports the use of assessment to determine modality preference (e.g., Lorah, et al., 2013). Specifically, with relation to the King (2011) thesis, the current study additionally incorporated tacting and verbal completion outcomes with demonstrated effectiveness for participants in Group 1. The current study also examined ASL at baseline, as opposed to the Picture Exchange Communication System (PECS) used in the King (2011) study, demonstrating that Proloquo2Go™ is effective when compared to both ASL and PECS.

In both the current study and the King (2011) study, Proloquo2Go™ was found to be effective at increasing manding repertoires. This finding was consistent with the assumptions of the applied verbal behavior model. For children with weak language skills, applied verbal behavior model practitioners often prefer strengthening mand (request) repertoires first based on Skinner's conceptual analysis of language and Michael's (1993) concept of the establishing operation. The establishing operation distinguishes the mand, or request, from other verbal

operants in that it evokes a response that specifies a uniquely effective consequence and is the only verbal operant that directly benefits the speaker.

Overall, participants in the current study tended to have more significant outcomes during the manding phase, possibly because, as the verbal behavior model indicates, the mand directly benefits the speaker in that the individual receives the item that he or she was requesting instead of a pre-determined reinforcer item. Thus, manding in and of itself, is inherently reinforcing. Because participants using Proloquo2Go™ in the current study demonstrated the ability to mand effectively for desired items, this may further reinforce their use of the Proloquo2Go™ app, and they may be more inclined to try using it for other forms of communication. Future research should continue to investigate for which types of communication Proloquo2Go™ may be most effective.

A recent review of published interventions using high-technology communication aid devices found that, while the use of high-technology alternative and augmentative communication devices has led to improvements in the communicative ability of people with communication difficulties, there is a great deal of variation in the outcomes of published research and a need for more high-quality research in this area (Baxter, Enderby, Evans, & Judge, 2012). This is most likely due to variation in diagnosis and severity of communication impairment. They suggest that much greater attention to individual characteristics is needed in order to make decisions about who will benefit most and which type of device may be best suited to individual needs. The current study responds to this need by incorporating measures of preverbal skills (e.g., VB-MAPP, CSBS, and MIS) in order to determine which prerequisite preverbal skills are necessary for successfully using Proloquo2Go™ for communication.

The current study builds upon past research by indicating the effectiveness of Proloquo2Go™ in expanding the manding, tacting, and verbal completion repertoires of young children with ASD, and broadens it to include the ABA therapy setting. Future research should continue to build upon this knowledge by using a larger sample of participants and including a

generalization phase into the single-case design. A generalization phase demonstrates that a participant can expand a newly learned skill to a new environment or with a new individual. No studies employed Proloquo2Go™ outside of the classroom or therapeutic environment.

Generalizing communication skills to a new environment would demonstrate that a participant could have more independence in a public setting (e.g., ordering food in a restaurant, communicating needs in a grocery store, or asking to use the bathroom). Additionally, a study using a multiple baseline across settings design may also be useful.

Moreover, and perhaps most importantly, future studies may incorporate a non-intervention baseline phase, other verbal tasks, and other types of participants (e.g., younger or older aged participants or participants with other disabilities). Without a non-intervention baseline, it is difficult to determine whether the effects of the current study are due to the intervention or some combination of the baseline and intervention phases. Future research should also carefully describe how the Proloquo2Go™ app intervention is implemented (e.g., on a tablet; number of icons on the screen, etc.) and provide evidence that the skills acquired can be maintained after the conclusion of the research study. Using a different device to deliver the app may be another important area for generalization, especially in public settings where a smaller, more portable device may be more useful.

Both caregivers and therapists in the current study indicated that they were eager to determine how participants might be able to use Proloquo2Go™ in other environments. It is difficult to posit how the results of the current study might generalize to other contexts (e.g., public settings such as restaurants and stores, school settings, etc). However, given that overall participants in Group 1 showed clinically significant effects and participants in Group 2 showed a decrease in variability, the overall positive results indicate that participants may be able to generalize their use of Proloquo2Go™ effectively. One potential setback may lie in the portability of the mobile device used in a public setting. For example, an iPhone® or mini-tablet would be lighter and easier to carry in public, but would require higher level fine motor skills

because the screen would be smaller than the regular sized iPads® used in the current study. In fact, the limiting of fine motor demands in the use of Proloquo2Go™ versus American Sign Language may be part of the reason for its success in the current study. Additional research might use smaller tablets or smartphones and/or incorporate a standardized measure of fine motor skills needed to use these items so as to determine which children would be better suited for which devices.

As previously highlighted, American Sign Language is often advocated as a front line communication intervention for children with ASD because of its ability to activate areas of the brain that are involved with speech production. However, there is no research examining which areas of the brain are activated by using a device like an iPad® with the Proloquo2Go™ app for communication. Thus, it is plausible that Proloquo2Go™ may also activate areas of the brain involved in speech production and may have the potential to encourage higher-order thinking and/or additional communicative functions given consistent repeated use. Research has not indicated the limits of how far a child with ASD can progress using augmentative and assistive communication via an app like Proloquo2Go™, so future research is imperative to explore the untapped potential.

Summary

Autism is a bio-neurological developmental disorder presenting in early childhood that has a profound effect on an individual's ability to communicate. The iPad® with the Proloquo2Go™ app is a multilingual Augmentative and Alternative Communication (AAC) solution designed to assist people who have difficulty speaking or cannot speak at all.

Proloquo2Go™ can be adapted to suit the needs of a wide range of users with varying literacy levels. Featuring natural-sounding voices, speech can be generated by tapping buttons with symbols or typing using the on-screen keyboard with word prediction (www.assistivesoftware.com/product/proloquo2go). Several preliminary studies indicated the effectiveness of using Proloquo2Go™ with children and adolescents with ASD to enhance

communication within the therapeutic and school environments (Duncan & Tan, 2012; King, 2011; Roth, 2013; Sennott & Bowker, 2009; Valenzuela, 2013; van der Meer et al., 2011; Wilkins, 2013). The current study built upon past research and examined the effectiveness of the Proloquo2Go™ app delivered via iPad® in enhance the tacting, manding, and verbal completion repertoires for children with autism during ABA therapy. Participants included five children between the ages of three and four years old diagnosed with ASD and complex communication needs. Prior to the study, participants were assessed using the Verbal Behavior Milestones Assessment and Placement Program (VB-MAPP), the Communication and Symbolic Behavior Scales (CSBS) Joint Attention and Constructive Play subscales, and the Motor Imitation Scale (MIS). Three participants (Group 1) scored low (2, 7, and 8 on the MIS; 1 on the CSBS; and Level 1 on the VB-MAPP), and two participants (Group 2) scored mid-range (18 and 20 on the MIS; 3 on the CSBS; and Level 2 on the VB-MAPP) on assessments of joint attention, constructive play, and motor imitation.

A multiple baseline across behaviors design was used to assess the effectiveness of Proloquo2Go™ in enhancing tacting, manding, and verbal completion skills during ABA therapy sessions for both groups. The Proloquo2Go™ intervention was compared to American Sign Language at baseline. Results indicated that Proloquo2Go™ was useful for enhancing communication skills for some children with ASD during ABA therapy. Specifically, this study provided evidence that the use of Proloquo2Go™ with children with ASD and complex communication needs who were in early preverbal stages could enhance tacting, manding, and verbal completion skills during ABA therapy, and using Proloquo2Go™ with children who are in later preverbal stages could be useful as a more accessible form of communication in addition to American Sign Language. This is of utmost importance because the ABA treatment setting is vitally important for the growth and development of the young learner with ASD and early language abilities and language learning opportunities are especially important given that the

development of language during the preschool years is a strong prognostic indicator of long-term outcomes in children with ASD (Howlin, 2003).

Future research will continue to find novel and innovative interventions to enhance communication, education, and daily living skills for individuals with autism. As mobile devices such as iPhones®, iPods®, iPads®, and other tablets become smaller, more light-weight, and more durable/portable, new research will continue to find ways to use these to enhance and enrich the lives of people with disabilities and their families.

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Appendices

Appendix 1

July 15, 2012

Sara Gilbert, B.C.B.A.
Executive Director
Knoxville Center for Autism
9051 Executive Park Drive Suite 600
Knoxville, TN 37923

Taylor E. Krcek, M.S.W.
College of Social Work
University of Tennessee
1618 Cumberland Avenue
Knoxville, TN 37996

Dear Ms. Krcek,

Knoxville Center for Autism is happy to provide full support for your dissertation research project by referring to you ABA therapists and nonverbal children with autism between the ages of three and seven years of age. I understand the procedures involved with the project including the donation of three iPads® for use during your study, the recruiting and training of therapists to implement the intervention, and the recruiting of six to eight nonverbal children with autism between the ages of three and seven. I understand the purpose of this study is to examine the effectiveness of using Proloquo2Go™ in enhancing communication skills for nonverbal children with autism.

I have a short script and study description to invite parents and children to be a part of the study. I understand that only after informed consent documents have been signed for both therapists and participants, and only after participants have been read an assent form, will this research take place. I also understand that all information and data will be kept completely confidential, and I agree to give you access to a locked filing cabinet in my office. Other confidential information will be kept on your personal password protected computer and will only be transported to your office at UT via password protected USB drive. Clients at my agency have already signed an agreement for their children to be videotaped for training and research purposes, and I understand that they will have the option to opt in or out of videotaping for the purposes of this study.

ABA therapists who agree to participate will receive a short script of how to confirm assent with each child participant and will receive trainings and bi-weekly support from you. In the event that a child participant becomes overly stressed as evidenced by anxious behaviors such as crying, hitting, or yelling, the therapist will be instructed to stop the intervention. If a therapist, parent, or child participant chooses to withdraw from the study at any time, they may do so with no penalty and all confidential information will be destroyed within 24 hours. All participants will be given your contact information as well as the contact information of your dissertation advisor and the IRB compliance officer.

I understand that all information will be kept confidential by both you and your research assistant who will assist with taking data from video footage. Your research assistant will sign a letter of confidentiality, as will anyone at my agency who is involved with your dissertation study in any way.

Sincerely,

Sara Gilbert, B.C.B.A.

Appendix 2

INFORMED CONSENT STATEMENT

Effectiveness of Proloquo2Go™ in Enhancing Communication Skills for Children with Autism during ABA Therapy

INTRODUCTION

Your child is invited to participate in a dissertation research study at the University of Tennessee examining the effectiveness of Proloquo2Go™ in helping children with autism communicate. The proposed study asks the question, "Does the the app Proloquo2Go™ on an iPad® promote communication in children with autism?" The objective of the study is to determine the effectiveness of Proloquo2Go™ to teach labeling, requesting, and verbal completions like "Ready, Set, ___!" during Applied Behavior Analysis (ABA) therapy.

INFORMATION ABOUT PARTICIPANTS' INVOLVEMENT IN THE STUDY

This study will last approximately three months. Over this time frame, your child will be given the opportunity to use an iPad® with the application Proloquo2Go™ during his or her regularly scheduled Applied Behavior Analysis (ABA) therapy time. The investigator for this study understands that schedule of treatment sessions will vary depending on your insurance. Proloquo2Go™ is a communication app which may help children with autism who have difficulty communicating. This study is specifically interested your child's ability to label objects, request objects, and complete phrases like "Ready, Set, ___!") Your ABA therapist will continue to complete communication objectives outlined in your child's therapy program with the use of Proloquo2Go™. Your ABA therapist will also continue to collect data and video tape therapy sessions as usual. You have the option to decline use of videotaping for the purposes of this study with no penalty. You may choose to remove your child from the study at any time with no penalty and with no consequence to your child's therapy. Although it is unlikely that a child will be unable to complete his or her portion of the study, in this event (e.g., a major illness or insurance issue that inhibits a child from attending regular treatment), the child will be dropped from the study and his or her data will be destroyed within 24 hours. Participants will only be dropped from the study for this reason if they cannot attend 50% of treatment sessions over a three week period.

RISKS

Federal regulations require researchers to classify research involving children into one of four categories and to document their discussions of the risks and benefits of the proposed research study. This study poses a minimal risk to participants. Your child may feel some discomfort or stress when asked to learn a new device like an iPad®. Likewise, your child may experience discomfort or stress when the iPad® is removed. Your child's therapist is instructed to stop immediately if your child experiences moderate to severe stress as evidenced by anxious behaviors, crying, hitting, etc.

The final risk for involvement in this study is a breach of confidentiality. All of your child's information and therapeutic progress will be kept confidential. Access to this information will be given only to your child's therapist, Sara Gilbert, B.C.B.A., Taylor E. Krcek, M.S.W., the principal investigator, and a research assistant who will watch video of your child's therapy and take data.

We are very careful to protect your child's information and will do so in a number of different ways:

1. We will keep all data collected from the study in a locked filing cabinet. Access to this cabinet is provided only to the principal investigator, Taylor E. Krcek, M.S.W., Sara Gilbert, B.C.B.A. and your child's therapist. When data is input into a computer, all identifying information will be destroyed.
2. We will input and transport data on a laptop computer and USB drive which are password protected. The only individuals with access to the password are the principal investigator and Sara Gilbert, B.C.B.A.
3. We will store all video on a computer which is password protected. The only individuals with access to the password are the principal investigator and Sara Gilbert, B.C.B.A. When the video is no longer needed for data collection, it will be destroyed.
4. The research assistant who will view your child's video to record data will sign a letter of confidentiality and will be trained in the University of Tennessee Responsible Conduct of Research and the University of Tennessee Responsible Conduct of Research and the Collaborative Institutional Training Initiative (CITI) Social and Behavioral Research Training.
5. Both the P.I. and the P.I.'s dissertation advisor, John G. Orme, Ph.D., have been trained in the University of Tennessee Responsible Conduct of Research and the University of Tennessee Responsible Conduct of Research and the Collaborative Institutional Training Initiative (CITI) Social and Behavioral Research Training.
6. In reports or publications from this study, we will never report anything that can identify you or your child.

BENEFITS

This research will help us determine if the app Proloquo2Go™ is useful in enhancing communication for young children with autism who have not developed age-appropriate language.

Previous research has indicated that using computer assisted therapy and apps for autism such as Proloquo2Go™ can be useful in enhancing skills for children with autism. Your child may experience an enhanced ability to communicate during ABA therapy by utilizing the app Proloquo2Go™.

CONFIDENTIALITY

All information you provide us is confidential. All information collected during the course of this study is confidential. It will be stored securely and will not be made available to anyone other than Taylor E. Krcek, M.S.W., principal investigator, Sara Gilbert, B.C.B.A., your child's therapist, and a research assistant.

CONTACT INFORMATION

If you have questions at any time about the study or the procedures, you may contact the principal investigator, Taylor E. Krcek, M.S.W., at University of Tennessee College of Social

Work, 1618 Cumberland Avenue, Knoxville, TN 37996, or (865) 974-9136 or the dissertation advisor, Dr. John G. Orme at (865) 974-6481. If you have questions about your rights as a participant, contact the Office of Research Compliance Officer at (865) 974-3466.

PARTICIPATION

Your participation in this study is voluntary; you may decline to participate without penalty. If you decide to participate, you may withdraw from the study at anytime without penalty and without loss of benefits to which you are otherwise entitled. If you withdraw before the data collection is complete, your data will be returned to you or destroyed.

CONSENT

I have read the above information. I have received a copy of this form. I agree to my child's participation in this study.

Signature of parent or guardian _____

Date _____

Please sign one line below.

I Do _____

OR

Do Not _____

give consent for my child's videotapes to be viewed by the researcher and a research assistant for this study.

Investigator's signature _____

Date _____

Appendix 3

Sample Data Collection Sheet

Name:	
Date:	

Targets	Skill (circle one)
	Manding
	Tacting
	Verbal Completion

KEY: I=independent
 G=gestural
 V=verbal
 M=model
 P=physical

Target		Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6	Trial 7	Trial 8	Trial 9	Trial 10
	I										
	G										
% Correct	V										
	M										
	P										

Target		Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6	Trial 7	Trial 8	Trial 9	Trial 10
	I										
	G										
% Correct	V										
	M										
	P										

Target		Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6	Trial 7	Trial 8	Trial 9	Trial 10
	I										
	G										
% Correct	V										
	M										
	P										

Tally Data

Instructions: Record tally data (frequency data) during intervention and baseline phases for each target.

Target:	Date:	Date:	Date:	Date:	Date:	Date:	Date:
Independent							
Prompted							
ASL							
Vocalization							

Target:	Date:	Date:	Date:	Date:	Date:	Date:	Date:
Independent							
Prompted							
ASL							
Vocalization							

Target:	Date:	Date:	Date:	Date:	Date:	Date:	Date:
Independent							
Prompted							
ASL							
Vocalization							

Appendix 4

Description of Instruments

Communication and Symbolic Behavior Scales (CSBS)

The CSBS was used in the current study prior to the implementation of the intervention phase. It was intended to assess communication and symbolic abilities of the participants. The purpose of the evaluation using the CSBS was to determine delays in social communication and expressive speech/language. In this way, the current study sought to determine a participant's communication and symbolic functioning in order to assess their candidacy for the study and to make recommendations as to whether or not the participant would be a good fit for the intervention (speech generating device). For example, a child with high scores on a measure of expressive language and social communication, such as the CSBS, would likely not require a speech generating device to communicate, but still might be able to use the device in a public setting where American Sign Language was not a common form of communication.

The CSBS is a standardized tool designed to evaluate communication and symbolic abilities of children whose functional communication age is between 6 months and 2 years. It may also be used with preschool children whose chronological age is up to 5-6 years if their developmental level of functioning is younger than 24 months. The purpose of the CSBS is threefold: for screening to identify children at risk for developmental delay or disability who need a developmental evaluation; for evaluation to determine if a child has delays in social communication, expressive speech/language, and symbolic functioning; and for evaluation to document changes in social communication, expressive speech/language, and symbolic functioning over time (Wetherby & Prizant, 2002).

Three previous studies examined the validity and reliability of the three measures of the Communication and Symbolic Behavior Scales: 1) a one-page parent-report checklist; 2) a four-page followup caregiver questionnaire (CQ); and 3) a behavior sample (BS), which is a face-to-face evaluation of the child. Participants for these studies were drawn from a pool of 603

children for the checklist and CQ (ages 6–24 months) and 364 children for the BS (ages 12–24 months). Study 1 examined the concurrent relationship of standard scores for the checklist, CQ, and BS. Large correlations were found between the checklist and CQ and moderate to large correlations were found between each of the parent report tools and the BS. Study 2 examined test-retest stability by comparing the raw and standard scores over a 4-month retest interval. The results indicated significantly greater retest raw scores but no significant differences between standard scores from test to retest for the checklist, CQ and BS, providing evidence that the three measures detect growth over short periods but produce relatively stable rankings of children. Study 3 examined the concurrent and predictive relationship of the three CSBS measures and children's outcomes on standardized tests of receptive and expressive language at 2 years of age. Moderate to large correlations were found between all of the CSBS measures and language outcomes at 2 years of age. Multiple regression analyses indicated that the three composites were significant predictors of receptive and expressive language outcomes. The findings from these three studies support the use of the CSBS as a screening and evaluation tool for identifying children with developmental delays (Wetherby, Allen, Cleary, Kublin, & Goldstein, 2002).

Motor Imitation Scale (MIS)

The MIS was used in the current study prior to implementation of the intervention phase. It was intended to assess a child's ability to imitate single-step motor imitation tasks. Motor imitation is a complex developmental phenomenon that serves important cognitive and social functions. At a social level, imitation represents one of the earliest forms of reciprocal interactions between an infant and caregiver. Mutual imitation games are thought to form the foundation for an infant's emerging ability to differentiate herself or himself from others (Stone, Ousley, & Littleford, 1997). The process of imitation also helps establish coordinated activities, mutual involvement, and shared understanding with others. At a cognitive level, Piaget (1962) described imitation as a precursor to symbolic functioning, and subsequent research has

confirmed an association between imitation and language development in normally developing infants (Iverson, 2010). Since American Sign Language was used during baseline for the current study, it was important to evaluate a participant's ability to imitate motor actions, as this skill is heavily relied upon when communicating using American Sign Language. For example, it is important to know if a child with ASD with lower ability to imitate motor actions has less ability to use American Sign Language, and may be better able to use a speech generating device to communicate.

The MIS consists of 16 items involving single-step motor imitation tasks. Items were developed to correspond roughly to Piaget's developmental sequence of imitation as outlined by Uzgiris and Hunt (1975) and Dunst (1980). Half of the items require the manipulation of objects and half involve body movements alone. In addition, in recognition of the potential impact of social meaning on imitation performance, half of the items involving objects employ meaningful actions (e.g., walking a small toy dog across the table) and the other half employ non-meaningful actions (e.g., walking a hairbrush across the table).

The MIS is presented in a playful and game-like manner. Each imitation item is demonstrated by the examiner with the instruction, "Do this" or "Do what I do" without labeling the action. Three trials of each item are allowed, with each trial consisting of a minimum of three presentations by the examiner. Response accuracy is scored on a 3-point scale; a passing response earns two points, an emerging response earns one point, and a failure earns zero points. Emerging response are defined as those involving partial imitation. The score representing the child's best performance on each item is used in calculating the total imitation score. Credit is given for immediate responses to each item. Delayed responses are not scored. Scores on the MIS range from zero to 32 (Stone, Ousley, & Littleford, 1997).

In order to determine the level of interobserver agreement, videotapes of the MIS were scored and compared with live scoring for 20% of the initial sample. Cohen's kappa, collapsing across MIS items and subjects, was .80, indicating excellent agreement (Cicchetti & Sparrow,

1981). The standardized alpha coefficient for the total MIS was .87. Additionally, a two-week test-retest reliability was calculated for an independent sample of 30 children with a mean age of 29.8 months and an ASD diagnosis, diagnosis of developmental delay, or diagnosis of behavior disorder. Results indicated test-retest reliability of .80 for the total MIS score.

Verbal Behavior Milestones Assessment and Placement Program (VB-MAPP)

The VB-MAPP was conducted prior to the study. The initial assessment was done by a therapist at the center where current study data were gathered. The VB-MAPP assessment is used bi-annually by the BCBA as a means to assess therapeutic progress and acquisition of new skills. The VB-MAPP is an assessment tool, curriculum guide, and skills-tracking system used to help guide the instruction of language and critical learner skills for children with autism or other developmental disabilities.

Applied verbal behavior model interventions typically involve manipulation of establishing operations. These may occur too infrequently in the typical environment for a child with autism to develop a mand repertoire. Practitioners arrange the environment such that the learners will mand for preferred items or missing items (Sundberg, Loeb, Hale, & Eigenher, 2001). Another common feature of the applied verbal behavior approach is pairing of antecedents of strong verbal operants with stimuli that weakly control other verbal operants (i.e., stimulus transfer procedures) to teach new verbal operants. For example, a picture that evokes a tact, “cat” will be used to teach the intraverbal “Can you name an animal?” and subsequently faded to transfer control to the verbal antecedent ([Drash, High & Tudor, 1999](#); [Finkel, & Williams, 2001](#); [Sundberg, Endicott, & Eigenheer, 2000](#)). Thus, mands and tacts are incorporated as important outcome variables in the current study. So, tools such as the VB-MAPP, consistent with the applied verbal behavior approach guide assessment and intervention efforts (Sundberg & Partington, 1998; Sundberg & Michael, 2001).

The VB-MAPP has objective measurement criteria that make it effective for use in both treatment and research outcomes. It is a criterion-referenced assessment tool, curriculum guide,

and skills tracking system that is used in research studies published in gold standard journals such as *The Journal of Applied Behavior Analysis* (e.g., Grannon, & Rehfeldt, 2012). The VB-MAPP is most commonly used to assess individuals with ASD and other developmental disabilities, but can also be used to assess for delays in language development. It is intended for use only by individuals who have training in Applied Behavior Analysis (ABA). Individuals such as behavior analysts, speech-language pathologists, school psychologists, and special educators use the VB-MAPP to assess strengths and weaknesses in skills and behaviors that might impede language and social development. The results of the VB-MAPP help to prioritize intervention needs, provide feedback to parents and professionals, and guide curriculum planning (Sundberg, 2008).

The VB-MAPP was developed by Sundberg and Esch (2008), and is a continuation of over 30 years of research in language assessment and intervention, as they apply to individuals with ASD (Esch, LaLonde, & Esch, 2010; Sundberg, 2008). The VB-MAPP contains an individual scoring protocol and a user's guide. The main components of the VB-MAPP are as follows: Milestones Assessment (Focuses on 170 milestones that serve as the foundation of language, learning, and social development); Barriers Assessment (Focuses on barriers that may impede the acquisition of new skills); Transition assessment (Guides planning for educational needs); Task Analysis and Skills Tracking (Checklist of skills that can be used for daily curriculum activities and skills tracking); and Users Guide (Provides scoring criteria, examples, and tips for the tests, as well as an overview of Skinner's analysis of verbal behavior). The Milestones Assessment is broken down into three levels: Level 1 (0-18 Months), Level Two (18-30 Months), and Level Three (30-48 Months). Participants in the current study fell into Level 1 or 2 on the VB-MAPP Milestones Assessment.

The greatest limitation to the VB-MAPP is the lack of psychometric evaluation. Sufficient reliability and validity of assessments is not a default assumption, but rather, a consideration that requires empirical investigation. Another potential limitation of the VB-MAPP is that

administration can be lengthy because it requires the assessor to test the child on each item, although the manual states that caregivers can be interviewed in lieu of direct administration if the report of the caregivers is deemed likely to be accurate. Once the items are administered though, results of the assessment are easily obtained and interpreted. The assessor is presented with a list of skills that need to be taught and some direction in terms of the order in which to teach the skills; however, there is no clear presentation of what the prerequisites are for each item. While the items are not directly linked to curricula, the items are meant to guide curriculum design (Gould et al., 2011).

Appendix 5

VB-MAPP Milestones Master Scoring Form													
MYP score													
Date of Work													
Set of Milestones		0	1	2	3	4	5	6	7	8	9	10	11

Wp	Spw	Prw	Uw	Uw
100%				
100%				
100%				
100%				

Level 3

	Exp	Exp	Spw	Uw	Pr	Spw	Uw	Pr	Spw	Uw	Pr	Spw	Uw
15													
14													
13													
12													
11													

Level 2

	Exp	Exp	Spw	Uw	Pr	Spw	Uw	Pr	Spw	Uw	Pr	Spw	Uw
10													
9													
8													
7													
6													

Level 1

	Exp	Exp	Spw	Uw	Pr	Spw	Uw	Pr	Spw	Uw
5										
4										
3										
2										
1										

VB-MAPP Milestones Master Scoring Form

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Milestones Assessment: LEVEL 1 (0-18 MONTHS)

(T) = Direct testing; (O) = Observation; (E) = Either testing or observation; (TO) = Timed observation

MAND

TOTAL SCORE:

ASSESSMENT			
1st	2nd	3rd	4th

Does the child use words, signs, or pictures to ask for desired items or activities?

- | 1st | 2nd | 3rd | 4th | Item Description |
|-----|-----|-----|-----|---|
| | | | | 1. Emits 2 words, signs, or PECS, but may require echoic, imitative, or other prompts but no physical prompts (e.g., cracker, book) (E) |
| | | | | 2. Emits 4 different mands without prompts (except What do you want?) — the desired item can be present (e.g., music, slinky, ball) (T) |
| | | | | 3. Generalizes 6 mands across 2 people, 2 settings, and 2 different examples of a reinforcer (e.g., mands bubbles from mom and dad, inside and outside, a red bottle and a blue bottle) (E) |
| | | | | 4. Spontaneously emits (no verbal prompts) 5 mands — the desired item can be present (TO: 60 min.) |
| | | | | 5. Emits 10 different mands without prompts (except, What do you want?) — the desired item can be present (e.g., apple, swing, car, juice) (E) |

Comments/notes:

TACT

TOTAL SCORE:

ASSESSMENT			
1st	2nd	3rd	4th

Does the child tact people, objects, body parts, or pictures?

- | 1st | 2nd | 3rd | 4th | Item Description |
|-----|-----|-----|-----|--|
| | | | | 1. Tacts 2 reinforcing items (e.g., people, pets, characters, or favorite objects) (T) |
| | | | | 2. Tacts any 4 items (e.g., people, pets, characters, or other objects) (T) |
| | | | | 3. Tacts 6 non-reinforcing items (e.g., shoe, hat, spoon, car, cup, bed) (T) |
| | | | | 4. Spontaneously tacts (no verbal prompts) 2 different items (O) |
| | | | | 5. Tacts 10 items (e.g., common objects, people, body parts, or pictures) (T) |

Comments/notes:

Milestones Assessment: LEVEL 2 (18-30 MONTHS)

(T) = Direct testing; (O) = Observation; (E) = Either testing or observation; (TO) = Timed observation

MAND

TOTAL SCORE:

Assessment			
1st	2nd	3rd	4th

Does the child demonstrate frequent and spontaneous manding primarily controlled by motivation (MOs)?

1st	2nd	3rd	4th

6. Mands for 20 different missing items without prompts (except, e.g., What do you need?) (e.g., mands for paper when given a crayon) (E)

1st	2nd	3rd	4th

7. Mands for others to emit 5 different actions or missing actions needed to enjoy a desired activity (e.g., open to get outside, push when on a swing) (E)

1st	2nd	3rd	4th

8. Emits 5 different mands that contain 2 or more words (not including, I want) (e.g., Go fast. My turn. Pour juice.) (TO: 60 min.)

1st	2nd	3rd	4th

9. Spontaneously emits 15 different mands (e.g., Let's play. Open. I want book.) (TO: 30 min.)

1st	2nd	3rd	4th

10. Emits 10 new mands without specific training (e.g., spontaneously says Where kitty go? without formal mand training) (O)

Comments/notes:

TACT

TOTAL SCORE:

Assessment			
1st	2nd	3rd	4th

Does the child tact nouns and verbs?

1st	2nd	3rd	4th

6. Tacts 25 items when asked, What's that? (e.g., book, shoe, cat, dog, hat) (T)

1st	2nd	3rd	4th

7. Generalizes tacts across 3 examples of 50 items, tested or from a list of known generalizations (e.g., tacts 3 different cars) (T)

1st	2nd	3rd	4th

8. Tacts 10 actions when asked, for example, What am I doing? (e.g., jumping, sleeping, eating) (T)

1st	2nd	3rd	4th

9. Tacts 50 two-component verb-noun or noun-verb combinations, tested or from a list of known two-component tacts (e.g., washing face, Joe swinging, baby sleeping) (T)

1st	2nd	3rd	4th

10. Tacts a total of 200 nouns and/or verbs (or other parts of speech), tested or from an accumulated list of known tacts (T)

Comments/notes:

Appendix 6

INFORMED CONSENT STATEMENT--THERAPIST

Effectiveness of Proloquo2Go™ in Enhancing Communication Skills for Children with Autism during ABA Therapy

INTRODUCTION

You are invited to participate in a dissertation research study at the University of Tennessee examining the effectiveness of Proloquo2Go™ in enhancing communication skills for nonverbal children with autism. The proposed study asks the question, "Does the utilization of the app Proloquo2Go™ delivered via iPad® enhance the tacting, manding, and verbal completion repertoire for nonverbal children with ASD?" The objective of the study is to determine the effectiveness of utilizing Proloquo2Go™ to teach tacting, manding, and verbal completion during Applied Behavior Analysis (ABA) therapy.

INFORMATION ABOUT PARTICIPANTS' INVOLVEMENT IN THE STUDY

This study will last approximately three months. Over this time frame, you will be given the opportunity to use an iPad® with the application Proloquo2Go™ during ABA therapy with the nonverbal children you work with on a regular basis. Proloquo2Go™ is an augmentative and assistive communication app which enables children with low expressive language skills to communicate by touching icons on the iPad® screen. This study is specifically interested in data pertaining to tacting (labeling objects), manding (requesting objects), and verbal completions (e.g., "ready, set, ____.") You will be asked to participate in two trainings with Taylor E. Krcek, principal investigator and Sara Gilbert, B.C.B.A. During these trainings you will learn how to use the iPad® and the Proloquo2Go™ app. After training, you will assist in delivering assent forms to children, data collection, and videotaping while adhering to the intervention protocol. You have the option to decline videotaping for the purposes of this study with no penalty. You may choose to withdraw from the study at any time with no penalty and with no consequence to your position as a therapist at Knoxville Center for Autism.

RISKS

Federal regulations require researchers to classify research involving children into one of four categories and to document their discussions of the risks and benefits of the proposed research study. This study poses a minimal risk to participants. Children may feel some discomfort or stress when asked to learn a new device like an iPad®. Likewise, children may experience discomfort or stress when the iPad® is removed. Use of the iPad® is to stop immediately if a child experiences moderate to severe stress as evidenced by anxious behaviors, crying, hitting, etc. There is no penalty for withdrawing from the study.

Risks for therapists delivering the intervention may include an increased use of time to learn and deliver the intervention protocol and data collection techniques. Therapists may also feel stress when learning a new intervention. If therapists find the stress of learning a new intervention too stressful, they may withdraw from the study at anytime with no penalty.

The final risk for involvement in this study is a breach of confidentiality. All therapists' and children's information and therapeutic progress will be kept confidential. Access to this

information will be given only to you, Sara Gilbert, B.C.B.A., Taylor E. Krcek, M.S.W., the principal investigator, and a research assistant who will watch video of therapy and take data.

We are very careful to protect therapists' and children's information and will do so in a number of different ways:

1. We will keep all data collected from the study in a locked filing cabinet in a University of Tennessee Office in Henson Hall. Access to this cabinet is provided only to the principal investigator, Taylor E. Krcek, M.S.W. and Dr. John G. Orme, Ph.D. When paper data is input into a computer, it will be destroyed.
2. We will input and transport data on a laptop computer and USB drive which are password protected. The only individuals with access to the password are the principal investigator, Dr. John Orme, and Sara Gilbert, B.C.B.A.
3. We will store all video on a computer which is password protected. The only individuals with access to the password are the principal investigator, Dr. John Orme, and Sara Gilbert, B.C.B.A. When the video is no longer needed for data collection, it will be destroyed.
4. The research assistant (and P.I.) who will view video footage of therapy to record data will sign a letter of confidentiality and will be trained in the University of Tennessee Responsible Conduct of Research and the Collaborative Institutional Training Initiative (CITI) Social and Behavioral Research Training.
5. In reports or publications from this study, we will never report anything that can identify you.

BENEFITS

This research will help us determine if the app Proloquo2Go™ is useful in enhancing communication for young children with autism who have not developed age-appropriate language.

Previous research has indicated that using computer assisted therapy and apps for autism such as Proloquo2Go™ can be useful in enhancing skills for children with autism. The children for whom you do therapy may experience an enhanced ability to communicate during ABA therapy by utilizing the app Proloquo2Go™.

INCENTIVE

You will receive a \$25 gift card for your training in the intervention (Proloquo2Go™). If you withdraw from the study after training, you may keep the gift card.

CONFIDENTIALITY

All information you provide us is confidential. All information collected during the course of this study is confidential. It will be stored securely and will not be made available to anyone other than you, Taylor E. Krcek, M.S.W., principal investigator, Dr. John Orme, Sara Gilbert, B.C.B.A., and a research assistant who has signed a letter of confidentiality.

CONTACT INFORMATION

If you have questions at any time about the study or the procedures, you may contact the principal investigator, Taylor E. Krcek, M.S.W., at University of Tennessee College of Social Work, 1618 Cumberland Avenue, Knoxville, TN 37996, or (865) 974-9136 or the dissertation advisor, Dr. John G. Orme at (865) 974-6481. If you have questions about your rights as a participant, contact the Office of Research Compliance Officer at (865) 974-3466.

PARTICIPATION

Your participation in this study is voluntary; you may decline to participate without penalty. If you decide to participate, you may withdraw from the study at anytime without penalty and without loss of benefits to which you are otherwise entitled. If you withdraw before the data collection is complete, your data will be returned to you or destroyed.

CONSENT

I have read the above information. I have received a copy of this form. I agree to participate in this study.

Signature of therapist _____

Date _____

Please sign. I Do _____

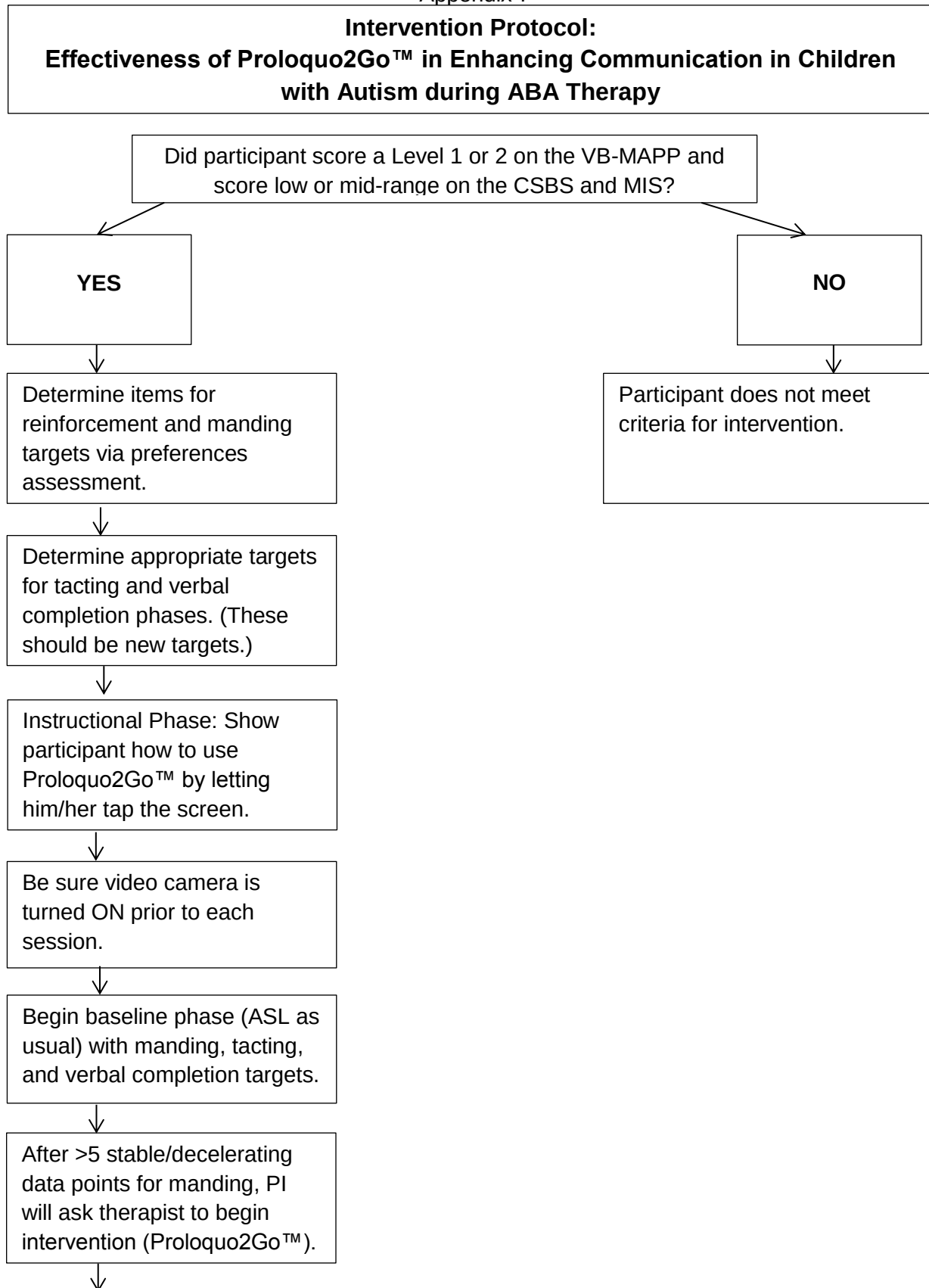
OR

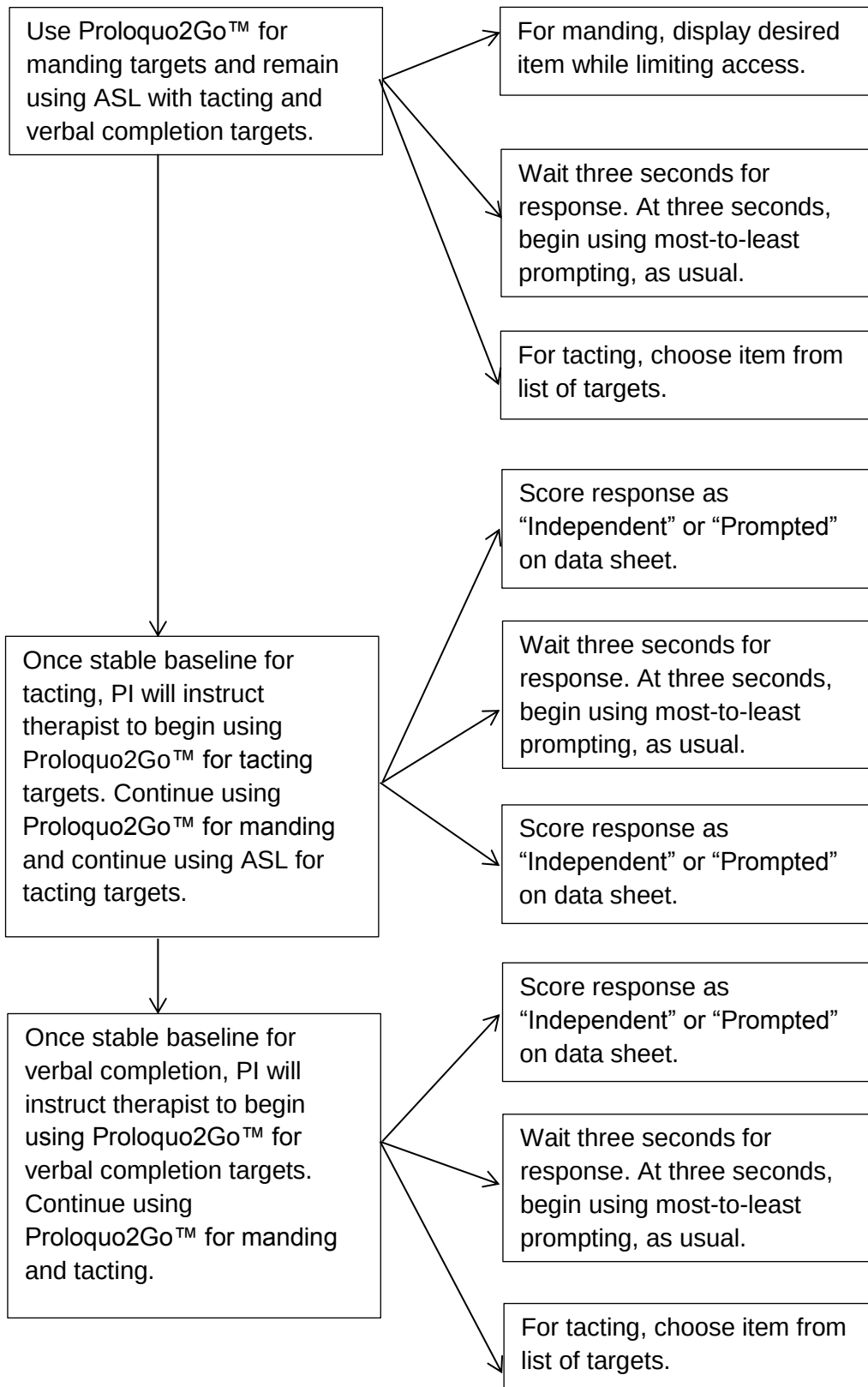
Do Not _____

give consent for videotapes of my therapy sessions to be viewed by the researcher and a research assistant for this study.

Investigator's signature _____

Date _____





Appendix 8

Procedural Fidelity Checklist

Date: _____ Time: _____ Therapist: _____

- _____ Instructional Phase: Therapist appropriately introduced iPad® to participant (if applicable.) (e.g., Allowed participant to tap screen and hear Proloquo2Go™ app.)
- _____ Therapist used items from preferences assessment to guide selection of targets and reinforcers.
- _____ Therapist turned video camera ON.
- _____ Therapist used ASL during baseline phase for Manding, Tacting, and Verbal Completion targets, as appropriate.
- _____ Therapist used Proloquo2Go™ during intervention phase for Manding, Tacting, and Verbal Completion targets, as appropriate.
- _____ Therapist waited 3 seconds before prompting.
- _____ Therapist used correct language per phase of study (e.g., “What is this?” for Tacting phase).
- _____ Therapist used most-to-least prompting.
- _____ Therapist recorded each participant response on data collection sheet with a check mark.
- _____ Therapist stopped the intervention immediately if participant became overly stressed.
- _____ out of 10.
- _____ % adherence to procedure.

Appendix 9

Confidentiality Statement of Investigator

Effectiveness of Proloquo2Go™ in Enhancing Communication Skills for Children with Autism during ABA Therapy

As a member of this project's research team, I understand that I will have access to confidential assessments, including the VB-MAPP. I will be watching video of participants and collecting data. The information in these videos has been revealed by research participants who participated in this project on good faith that their videos would remain strictly confidential. I understand that I have a responsibility to honor this confidentiality agreement. I hereby agree not to share any information in these videos and/or the data with anyone except the primary researcher of this project. Any violation of this agreement would constitute a serious breach of ethical standards, and I pledge not to do so.

Research Team Member

Date

Appendix 10

Confidentiality Statement of Research Assistant

Effectiveness of Proloquo2Go™ in Enhancing Communication Skills for
Children with Autism during ABA Therapy

As a member of this project's research team, I understand that I will be watching video of participants and collecting data. The information in these videos has been revealed by research participants who participated in this project on good faith that their videos would remain strictly confidential. I understand that I have a responsibility to honor this confidentiality agreement. I hereby agree not to share any information in these videos and/or the data with anyone except the primary researcher of this project. Any violation of this agreement would constitute a serious breach of ethical standards, and I pledge not to do so. I will receive a \$25 gift card to a local retail store for my participation in this study.

Research Team Member

Date

Appendix 11

Language to Use to Introduce the Study to Child Participants

Effectiveness of Proloquo2Go™ in Enhancing Communication Skills for Children with Autism during ABA Therapy

ABA Therapist: Hello, (child's name). Today, we are going to use an iPad®. I will say, "What's this?" and then you will use the iPad® to give me your answer. (Examiner demonstrates using iPad®.) Just like always, if you work hard, you will get (insert child's reinforcer here.) Do you want to try the iPad®? (Child's response if able.) Great! I think you will have fun. If you do not want to do play with the iPad®, you can say, "No thanks" or sign "No thanks" (Therapist demonstrates sign for "no thank you" or "no" depending on child's ability.)

Thank you for your help! We will play with the iPad® right here at the table. You will sit on this chair and I will sit here and write. Are you ready? (Child's response.) Let's go!

II. The therapist will use the following procedures during the course of intervention:

- Maintain a pleasant facial expression.
- Give reinforcement by means of these example comments: "You're working really hard." "Good work." "I can see that you are being careful." "That's right!" "I'm proud of your hard work." "Turn your listening ears on."

III. The therapist will use the following procedures at the end of test administration:

- If the child wishes to stop during the testing, the therapist will maintain a neutral expression, close the iPad®, and say, "All right. Thank you for helping me again."
- When testing is completed, the therapist will say, "Thank you for helping me today. You have worked really hard. Here are some (reinforcers specific to child). You may choose one. You are all done for today."

IV. These behavioral management guidelines will be followed during test administration:

- Prompts will include phrases such as: "Remember to stay in your seat so you can do a good job." "Turn your listening ears on." "Listen carefully." "Please don't touch the ____."
- Each child will also follow a specific behavior plan created individually by his or her therapist.
- If the child exhibits severe behavior concerns (e.g., hitting, kicking, screaming), the study will be stopped immediately.

CITI Collaborative Institutional Training Initiative

Social & Behavioral Research - Basic Curriculum Completion Report

Printed on 8/27/2012

Learner: Taylor Krcek (username: tkrcek)

Institution: University of Tennessee-Knoxville

Contact Information 5506 Lake Shore Drive
 Knoxville, TN 37920 USA
 Department: Social Work
 Phone: 440-655-1831
 Email: tkrcek@utk.edu

Social & Behavioral Research - Basic/Refresher: Choose this group to satisfy CITI training requirements for Investigators and staff involved primarily in Social/Behavioral Research with human subjects.

Stage 1. Basic Course Passed on 08/27/12 (Ref # 8548809)

Required Modules	Date Completed	Score
Inst. Page	08/26/12	no quiz
Belmont Report and CITI Course Introduction	08/26/12	2/3 (67%)
Students in Research	08/27/12	10/10 (100%)
History and Ethical Principles – SBR	08/26/12	5/5 (100%)
Defining Research with Human Subjects – SBR	08/26/12	5/5 (100%)
The Regulations and The Social and Behavioral Sciences – SBR	08/26/12	4/5 (80%)
Basic Institutional Review Board (IRB) Regulations and Review Process	08/26/12	4/5 (80%)
Assessing Risk in Social and Behavioral Sciences - SBR	08/26/12	4/5 (80%)
Informed Consent – SBR	08/27/12	5/5 (100%)
Informed Consent	08/27/12	4/4 (100%)
Privacy and Confidentiality – SBR	08/27/12	5/5 (100%)
Research With Protected Populations - Vulnerable Subjects:	08/26/12	4/4 (100%)

An Overview		
Research with Prisoners – SBR	08/26/12	2/4 (50%)
Vulnerable Subjects - Research Involving Prisoners	08/26/12	4/4 (100%)
Research with Children – SBR	08/26/12	1/4 (25%)
Vulnerable Subjects - Research Involving Children	08/26/12	1/3 (33%)
Research in Public Elementary and Secondary Schools - SBR	08/26/12	4/4 (100%)
Vulnerable Subjects - Research Involving Pregnant Women, Human Fetuses, and Neonates	08/26/12	3/3 (100%)
International Research – SBR	08/26/12	1/3 (33%)
Research and HIPAA Privacy Protections	08/26/12	1/5 (20%)
Vulnerable Subjects - Research Involving Workers/Employees	08/26/12	4/4 (100%)
Conflicts of Interest in Research Involving Human Subjects	08/26/12	3/5 (60%)
Unanticipated Problems and Reporting Requirements in Social and Behavioral Research	08/26/12	3/3 (100%)
Cultural Competence in Research	08/26/12	3/5 (60%)
Elective Modules	Date Completed	Score
Records-Based Research	08/27/12	2/2 (100%)

For this Completion Report to be valid, the learner listed above must be affiliated with a CITI participating institution. Falsified information and unauthorized use of the CITI course site is unethical, and may be considered scientific misconduct by your institution.

Paul Braunschweiger Ph.D.
Professor, University of Miami
Director Office of Research Education
CITI Course Coordinator

Appendix 13

Study Description

Effectiveness of Proloquo2Go™ in Enhancing Communication Skills for Children with Autism during ABA Therapy

You are invited to participate in a dissertation research study with Taylor E. Krcek, M.S.W. under the supervision of John G. Orme, Ph.D.

Purpose: Determine the effectiveness of Proloquo2Go™ in enhancing communication skills for children with autism.

Process: This study will last approximately 3 months and will take place at Knoxville Center for Autism during your child's regularly scheduled therapy. You have the option to decline videotaping if you do not wish for your child to be videotaped. Your child will be read a brief assent form before beginning the study. If at any time your child becomes anxious or stressed, the study will be stopped immediately.

Your Rights: We'd like to have your help in this study, but you have the right not to be a part of the study with no penalty. If you decide you'd like to help, you can change your mind and decide not to participate without penalty. If you withdraw from the study, all of your child's identifying information will be destroyed within 24 hours. Services you receive at Knoxville Center for Autism will not be affected in any way by your decision.

Discomfort and Risks: This study poses a minimal risk to participants. Your child may feel some discomfort or stress when asked to learn a new device like an iPad®. Likewise, your child may experience discomfort or stress when the iPad® is removed. Your child's therapist is instructed to stop immediately if your child experiences moderate to severe stress as evidenced by anxious behaviors, crying, hitting, etc.

The final risk for involvement in this study is a breach of confidentiality. All of your child's information and therapeutic progress will be kept confidential. Access to this information will be given only to your child's therapist, Sara Gilbert, B.C.B.A., Taylor E. Krcek, M.S.W., the principal investigator, and a research assistant who will watch video of your child's therapy and take data.

We are very careful to protect your child's information and will do so in a number of different ways:

1. We will keep all data collected from the study in a locked filing cabinet. Access to this cabinet is provided only to the principal investigator, Taylor E. Krcek, M.S.W., Sara Gilbert, B.C.B.A. and your child's therapist. When data is input into a computer, all identifying information will be destroyed.
2. We will input and transport data on a laptop computer and USB drive which are password protected. The only individuals with access to the password are the principal investigator and Sara Gilbert, B.C.B.A.
3. We will store all video on a computer which is password protected. The only individuals with access to the password are the principal investigator and Sara Gilbert, B.C.B.A. When the video is no longer needed for data collection, it will be destroyed.

4. The research assistant who will view your child's video to record data will sign a letter of confidentiality and will be trained in the University of Tennessee Responsible Conduct of Research.

5. Both the P.I. and the P.I.'s dissertation advisor, John G. Orme will be trained in the University of Tennessee Responsible Conduct of Research.

6. In reports or publications from this study, we will never report anything that can identify you or your child.

Benefits: This research will help us determine if the app Proloquo2Go™ is useful in enhancing communication for young children with autism who have not developed age-appropriate language.

Previous research has indicated that using computer assisted therapy and apps for autism such as Proloquo2Go™ can be useful in enhancing skills for children with autism. Your child may experience an enhanced ability to communicate during ABA therapy by utilizing the app Proloquo2Go™.

Confidentiality: All information you provide us is confidential. All information collected during the course of this study is confidential. It will be stored securely and will not be made available to anyone other than Taylor E. Krcek, M.S.W., principal investigator, Sara Gilbert, B.C.B.A., your child's therapist, and a research assistant.

Contact Information: If you have questions at any time about the study or the procedures, you may contact the principal investigator, Taylor E. Krcek, M.S.W., at University of Tennessee College of Social Work, 1618 Cumberland Avenue, Knoxville, TN 37996, or (865) 974-9136 or the dissertation advisor, Dr. John G. Orme at (865) 974-6481. If you have questions about your rights as a participant, contact the Office of Research Compliance Officer at (865) 974-3466.

Appendix 14

Example of Proloquo2Go™ Screen



VITA

Taylor Krcek Evans was born Taylor Eastin Krcek on November 21, 1983 in Mantua, Ohio. The only child of Robert and Vivian Krcek, she was raised in the Cleveland, Ohio area. She graduated from North Royalton High School in 2002 and attended The Ohio State University between 2002 and 2009, earning a Bachelor of Arts degree in Psychology (minor in Disability Studies) and a Master of Social Work degree. She completed several internships with various agencies serving individuals with disabilities and their families, including the Franklin County Board of MR/DD. She also had paid work experience during this time as an Applied Behavior Analysis therapist for children with autism. In 2009, she moved to Knoxville, Tennessee to complete her doctoral degree at the University of Tennessee, Knoxville. This dissertation completes her requirements for the Doctor of Philosophy in Social Work degree with an expected date of graduation as May 2015.

Taylor is married to Nathaniel J. Evans, and has one daughter, Anna, who is nearly one year old. She currently resides in Danielsville, Georgia with her family.