

AN EXAMINATION OF THE IMPACT OF AN
ASSISTIVE TECHNOLOGY DEVICE
ON THE QUALITY OF ADULT/YOUNG CHILD INTERACTIONS.

By

Diane M. Plunkett

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Chairperson, Eva Horn, Ph.D.

Claudia Dozier, Ph.D.

Sean J. Smith, Ph.D.

Susan Palmer, Ph.D.

Barbara J. Thompson, Ph.D.

Date Defended: 12/16/2013

The Dissertation Committee for Diane M. Plunkett
certifies that this is the approved version of the following dissertation:

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Chairperson Dr. Eva Horn

Date approved: 12/16/2013

ABSTRACT

The purpose of this study was to gain greater understanding of the potential benefits of assistive technology (AT) devices on young children's social development. Specifically, changes to the quality of the adult/young child social interactions as a function of the child's access to and use of his/her personal AT device was examined. Using a multielement single-case design, the quality of adult/young child social interactions were examined during snack time when the child used his personal AT device; and the adult/young child social interactions were examined when the personal AT device was not available to the child. Results indicate that the quality of caregiver/young child interactions were significantly enhanced when the AT device was utilized by the child. Implications for practice and future research are discussed.

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CHAPTER 1: INTRODUCTION

Assistive technology (AT) has the potential to assist very young children in successfully accessing and then engaging their environment and thus helping them attain critical developmental milestones (Mistrett et al., 2004, 2001; Temple, 2006). Scholars and practitioners in the field of early education and intervention have promoted the provision of AT for young children with special needs through three primary avenues (a) policy, (b) family and professional wisdom, and (c) research-based evidence. The key support for AT for young children with special needs comes from several federal initiatives. The U.S. Federal government provides a framework for assistive technology devices and services to support persons with disabilities with the original legislative mandates of the Technical Related Assistance for Individuals with Disabilities Act of 1988, or Tech Act, as it is now known (Tech Act, 1988). What emerged from original initiatives is now embodied in the Individuals with Disabilities Education Improvement Act of 2004 (IDEA), the federal education program that assists states in developing and implementing systems of comprehensive services for all eligible individuals with disabilities, birth through 21 years of age (IDEA, 2004).

IDEA requires AT to be considered and provided for an eligible child if it is determined that the child needs such technology to access and participate in everyday activities and to assist with the child's learning. IDEA specifically defines AT as:

Any item, piece of equipment, or product system, whether acquired commercially modified or customized, that is used to increase, maintain, or

improve the functional capacities of a child with a disability. The term does not include a medical device that is surgically implanted, or the replacement of such device [34CFR§300.5]

In fact, the most substantial policy support for AT as an appropriate intervention for young children with special needs derives from IDEA Part C (i.e., infant/toddler programs birth through 2 years of age) and Part B, Section 619 (i.e., preschool special education 3 through 5 years of age).

The primary professional organizations in the field of early childhood education and early childhood special education promote AT for young children with special needs and its use as a recommended practice. The leading advocates of AT use are the National Association for the Education of Young Children (NAEYC) and the Division of Early Childhood (DEC) of the Council for Exceptional Children (CEC). Through position papers and their respective recommended practices guidelines, both professional organizations strongly support the position that AT devices and services help improve the quality of life for young children and their families (NAEYC, 2011; Sandall, Hemmeter, McLean, & Smith, 2005). In the early childhood profession, AT is believed to enhance development, independence, and positive child and family interactions (Sandall et al., 2005). When used appropriately, professionals suggest, AT may even support and extend traditional materials for children and thus benefit their learning (NAEYC, 2011).

Support for AT for persons with disabilities has garnered much attention in the last decade. An increasing number of literature reviews and syntheses have

emerged that specifically delineate AT support and demonstrate effectiveness for persons with disabilities across age ranges. Reviews and syntheses of the existing scholarship offer a snapshot of research-based evidence for the use of AT with young children through adulthood (e.g. Campbell, Milbourne, & Wilcox, 2006; Kelly & Smith, 2011; Lancioni, O'Reilly, Cuvo, Singh, Sigafoos, & Didden, 2007; Mistrett, et. al., 2001; Snell, Chen, & Hoover, 2006).

Previous scholarship shows clearly that young children make gains when having access to assistive technology (Campbell et al., 2006). However, the authors repeatedly note that, while efficacy research of AT for very young children is available, each report identifies the need for additional research to move AT beyond the designation as a promising practice (Campbell et al., 2006; Kelly & Smith, 2011; Lancioni et al., 2007; Mistrett et al, 2001; Snell et al., 2006). However, the limited number of rigorous efficacy research studies is not the only need identified across these reports. Additional notes of concern were presented with the traditional focus of AT as a method for improving a skill deficit or scaffolding the development of a single skill, rather than the potential whole child perspective (Mistrett et. al., 2001).

In addition to the need for an explicit framework and rigorous research, current research confirms a lack of consensus as to which evaluative scale provides definitive answers to the question of evidence-based interventions and practice. (Cook, Tankersley, & Landrum, 2011; Gersten & Edyburn, 2007). Campbell et al. utilized The American Academy for Cerebral Palsy and Developmental Medicines (AACPDMD) Levels of Classification (2005) to report evidence. Mistrett et. al.,

(2001), by contrast, utilized the scale from Osher and Kane (1985), while Kelly and Smith (2011) applied definitions offered by legislative guidance. Thus the appropriate evaluative framework for this review, (i.e., the systematic guidelines developed specifically for the types and levels of evidence needed to identify an intervention practice as evidence-based and effective) were utilized (Odom, 2005). For this research synthesis of the relevant studies, scales promoted by special education scholars Horner, Carr, Halle, McGee, Odom, and Wolery (2005) were used for analyzing single-subject design studies. Likewise, the special education scales promoted by Gersten, Fuchs, Compton, Coyne, Greenwood and Innocenti (2005) were used for analyzing quantitative research design studies.

The following two sections provide an overview of two major components of this dissertation: (a) an up-to-date synthesis of studies with assistive technology practices for young children between 0 and 5 years of age within the context of its potential impact on the achievement of critical early childhood child outcomes, and (b) a description of the methods for this dissertation study, a multielement single-case design to investigate the impact of assistive technology on one of the early childhood outcome domains, which, as shown in this based on the outcome of this literature synthesis, has limited research evidence.

In order to review the state of research, identify differences among the studies, and locate larger problems in the scholarship, the literature synthesis presents an original analysis of the existing empirical literature on the use of AT with young children. It is answers the question: Is there sufficient evidence to consider AT

interventions evidence-based practice for supporting young children's acquisition of each of the three early childhood child developmental outcomes? In this way, the synthesis presents the current standing of AT and its reported benefits and limitations. The synthesis defines a specific and original framework for understanding AT utilization as an avenue for supporting young children in meeting federally defined critical early childhood child outcomes. The early childhood child outcomes, defined by the Office of Special Education Programs (OSEP), for Part C and Part B 619 of IDEA program reporting, provide an excellent framework for organizing the research evidence base. This allows an understanding of how young children benefit from AT through a broader lens of multidimensional child skills development rather than a more narrow lens of a single skill attainment. Thus, the literature synthesis paved the direction for the dissertation research study itself, which focuses on the benefits of AT in supporting young children's developmental outcomes in the area of positive social emotional skills, including social relationships.

Research Study

This dissertation research study was designed to contribute to the field by generating further evidence demonstrating the efficacy of AT in supporting young children's achievement of important early learning outcomes. To that end, the research addressed gaps in previous studies by incorporating: (a) more rigorous methodological design, (b) studies with very young children in natural settings, and (c) a targeted focus on the relationship and achievement of AT in supporting

caregiver/young children's interactions as a part of positive social emotional skills outcome area.

This study utilized a single-subject multielement design across multiple sessions. Chapter 3, the methods section, describes the research design as well as the participants, measures, and procedures of the study. Chapter 4, the research results section, reports the findings, provides a visual representation of the data analysis, and presents the relevant effect size data. Chapter 5, the discussion section, presents the evaluation of results, limitations of the study, and implications generated for future research, policy and practice.

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CHAPTER 2: LITERATURE SYNTHESIS

Advancements of technology and its applications have the potential for enhancing AT devices, services, and support, thus resulting in significant improvement in the quality of life for young children and their families (Sandall, Hemmeter, Smith, & McLean, 2005). The field of early intervention/early childhood special education has provided strong support for the use of AT by way of policy mandates (i.e., IDEA, 2004) and recommended practices (i.e., DEC of CEC Recommended Practices, Sandall et al., 2005). Yet, the research evidence for AT efficacy in positively affecting the quality of life for young children and their families appears to be less well established.

The purpose of this literature synthesis is to examine the existing empirical literature on the use of AT with young children to answer the following question: Is there sufficient evidence to consider AT intervention an evidence-based practice for supporting young children's acquisition for each of the OSEP early childhood child outcomes? In order to answer this question sufficiently, a brief review of the previous literature syntheses and of the policy and professional support for AT use with young children is necessary.

Legislative Policy

The U.S. Federal government mandates consideration for assistive technology devices and services supporting children with disabilities. What emerged from original initiatives is now embodied in the Individuals with Disabilities Education Improvement Act of 2004 (IDEA), the federal education program that assists states in

developing and implementing systems of comprehensive services for all eligible individuals with disabilities, birth through 20 years of age (IDEA, 2004). IDEA specifically defines AT as:

Any item, piece of equipment, or product system, whether acquired commercially modified or customized, that is used to increase, maintain, or improve the functional capacities of a child with a disability. The term does not include a medical device that is surgically implanted, or the replacement of such device [34CFR§300.5].

Thus, it is from this definition-focusing on IDEA Part C (i.e., infant/toddler programs birth through 2 years of age) and Part B, Section 619 (i.e., preschool special education 3 through 5 years of age) programs in particular-that substantial policy support for AT as an appropriate intervention for young children with special needs is found.

Professional Positions

From a professional wisdom perspective, AT for young children with special needs is promoted as a recommended practice by the primary professional organizations for the field of early childhood education and early childhood special education, specifically the National Association for the Education of Young Children (NAEYC) and the Division of Early Childhood (DEC) of the Council for Exceptional Children (CEC). Moreover, through position papers and their respective recommended practices guidelines, both professional organizations provide strong support for the position that AT devices and services help improve the quality of life

for young children and their families (NAEYC, 2011; Sandall, Hemmeter, McLean, & Smith, 2005).

Finally, from research evidence, literature reviews and syntheses, experts delineate AT as effective for persons with disabilities across wide age ranges in the last decade. The following reviews and synthesis offer a summary of research-based evidence for the use of AT with young children through adulthood (e.g., Campbell, Milbourne, & Wilcox, 2006; Kelly & Smith, 2011; Lancioni, O'Reilly, Cuvo, Singh, Sigafoos, & Didden, 2007; Mistrett, et. al., 2001; Snell, Chen, & Hoover, 2006).

Mistrett et. al., (2004) examined AT use with infants and toddlers. They focused on five typical routines in the daily lives of infants/toddlers and their families and the use of an AT device developed specifically to enhance children's participation in these routines (i.e., waking and bedtime, bath time, meal time, story time and play time). Seventy-four percent of the devices reviewed were simply described without any presentation of reliable results indicating effectiveness of the AT device (Mistrett et al., 2001).

Campbell, Milbourne, Dugan, and Wilcox, (2006) reviewed articles published between 1980 and 2004 focusing on AT with infants and young children. In the examination of the studies, Campbell et. al., (2006) noted the primary teaching strategy was the opportunity to access and/or use the AT device. They noted that for the most part studies reported that children were able learn with practice to use the AT device competently. However, in discussing the implications for future research of their review they identified a substantial need for more well-controlled, high

quality -single-subject and randomized group design studies conducted in a broader variety of settings.

Snell, Chen, and Hoover, (2006) provided an analysis of intervention research published between 1997 and 2003 specifically focused on augmentative and alternative communication (AAC) for individuals with severe disabilities from birth through 20 years of age. Snell et.al., (2006) reported several shortcomings in the current research literature: Among the shortcomings was the inconsistent level of experimental rigor. For instance, the measure of treatment fidelity was frequently unavailable, and participant descriptions were inconsistent and incomplete. Some studies provided a narrative description while others primarily described participants by standardized assessment scores.

Lancioni, O'Reilly, and Basili, (2007) examined Picture Exchange Communication System (PECS) and voice output communication aides (VOCAs) research studies published between 1992 and 2006 for persons between 3 and 42 years of age. Lancioni et.al., (2006) found in their research reviews, only 3 of the 39 students utilizing VOCAs or similar systems were not benefited. (see Dyches, 1998; Sigafoos, Didden, & O'Reilly, 2003), which supports the effectiveness of these AT interventions. However, Lancioni et.al., (2006) raised concerns regarding the need to examine carefully whether participants used the systems in meaningful ways outside of intervention.

More recently, Kelly and Smith (2011) examined research literature published between 1965 and 2009 on AT use by persons with visual impairment between 3 and

21 years of age. The majority of the articles reviewed (48%) discussed theories, beliefs, or practices rather than report on implementation of empirical research. Kelly and Smith noted that, while a considerable knowledge base was present, the research on effective use of AT for students with visual impairment using rigorous, scientific-based methods was “close to nonexistent” (p.79).

What we gain from the previous syntheses is the clear understanding that young children make gains when accessing assistive technology (Campbell et al., 2006). While efficacy research of AT for very young children is available, each of these reviewed studies calls for additional research to move AT beyond the designation as a promising practice (Campbell et al., 2006; Kelly & Smith, 2011; Lancioni et al., 2007; Mistrett et al, 2001; Snell et al., 2006).

However, the limited number of rigorous efficacy research studies is not the only problem identified across these syntheses. Each of them additionally expressed concern with the limitations of the traditional perspective that AT is primarily a method for ameliorating a skill deficit or scaffolding the development of a single skill. They identified the need for a more comprehensive perspective on the whole child, not just one of the child’s skills. Campbell et.al., (2006) noted that the literature has started only very recently to focus on AT as a means to enhance the performance of very young children in everyday activities and routines.

In addition to the need for an explicit framework and more rigorous research, the current research syntheses reveal a lack of consensus on the scales that could provide a definitive answer to the question of levels of evidence. Campbell et. al.,

(2006) utilized The American Academy for Cerebral Palsy and Developmental Medicines (AACPDM) Levels of Classification (AACPDM, 2005). Mistrett et. al., (2001) utilized the scale from Osher and Kane (1985), while Kelly and Smith (2011) applied definitions offered by legislative guidance.

Presented in 2005, research evidence standards for the field of special education research were presented. The field of special education supported the need for a special education framework necessary for evaluating levels of research evidence. Thus, authors, Horner, Carr, Halle, McGee, Odom, and Wolery (2005) presented rigorous criteria for single-subject design studies, and Gersten, Fuchs, Compton, Coyne, Greenwood and Innocenti, (2005) for quantitative research design studies.

Literature Synthesis Method

For the following literature synthesis, the researcher performed the following activities: (a) identified intervention studies that examined the use of assistive technology for children ages birth through 5 with a disability or developmental delay; (b) organized the identified studies according to the Office of Special Education Programs (OSEP) early childhood child outcomes they support; (c) analyzed the identified studies for each early childhood child outcome for their quality based standards that have been proposed for evaluating research in special education (i.e., as presented by Gersten et. al, (2005) for quantitative research methods and by Horner et., al., (2005) for -single-subject research methods) and (d) determined whether the AT interventions assessed by the identified studies and used to support young

children in meeting OSEP early childhood child outcomes could be considered “an evidence-based practice” given the criteria outlined by Horner et al. (2005) and Gersten et al. (2005). Specific criteria for research designation as evidence based are offered later in this chapter.

Identification of Studies

The synthesis by Campbell et. al., (2006) served as a guide for identifying potential intervention studies. Specifically, fifty authors cited by Campbell et. al., (2006) and the key terms reported were used to begin the search process. Searches using these author names and key terms were conducted spanning the years 1975-2011. The year 1975 was used as the earliest date since it corresponds with the passage of the Education for All Handicapped Children Act of 1975 (PL-94-142), which was the first strong legislative support for the use of assistive technology for children with disabilities. The key terms included a combination of participant terms (e.g. infant, toddler, child, preschool) and intervention terms (e.g. disability aid, communication aid, mobility aid, self-help device, personal equipment, augmentative communication, augmentative and alternative communication, AAC, AT device communication aids, AT technology, and VOCA). The searches were completed using each of the following databases: MEDPLUS, ERIC, PsychInfo, Academic OneFile, ArticleFirst, Science Direct, Google Scholar, and WorldCat.

Next, a hand search of the following relevant journals was conducted:

Augmentative and Alternative Communication; Autism; The International Journal of Research and Practice; Journal of Applied Behavior Analysis; Journal of Early

Intervention; Journal of Special Education Technology; Journal of Speech; Language and Hearing Research; and Seminars in Speech and Language. Additionally, an ancestral search using the references from literature reviews and syntheses specifically targeting assistive technology was conducted (e.g., Abbott, Brown, Evett, Standen & Wright, 2011; Alper & Raharinirina, 2006; Floyd, Canter, Jeffs, & Judge, 2008; Henderson, Skelton, & Rosenbaum, 2008; Isabelle, Bessey, Dragas, Blease, Shepherd & Lane, 2002; Kelly & Smith, 2011; Lancioni, O'Reilly, & Basili, 2001; Lancioni, O'Reilly, Cuvo, Singh, Sigafos, & Didden, 2007; Millar, Light, & Schlosser, 2006; Mirenda, 2001; Ostry, Wolfe, Rusch, 2009; Preston, & Carter, 2009; Schlosser, Wendt, Angermeier, & Shetty, 2005; Snell, Chen, & Hoover, 2006; Sulzer-Azaroff, Hoffman, Horton, Bondy & Frost, 2009; Tien, 2008; Wilkinson, & Henning, 2007).

Inclusion criteria were established for the synthesis. The articles had to meet all of the following criteria in order to be included. Articles selected: (a) were published in a peer-reviewed journal between 1975-2011; (b) were written in English; (c) presented research in which at least half of the participants were young children ages birth through five years of age; (d) presented research in which at least half of the participants were identified as experiencing a disability or developmental delay; (e) focused on the use of an AT device or AT intervention, excluded prosthetic devices for limb replacement (because these corrective or supportive devices are typically prescribed by a physician); and (f) reported empirical data about practices used to promote children's learning and development. Non-empirical works, such as

discussion papers, literature reviews, position papers, unpublished dissertations or theses, manuscripts, conference presentations, as well as manuscripts submitted but not accepted for publication were excluded, even if they focused on assistive technology. Sixteen articles published between January 1, 1975 and October 1, 2011 met the established research criteria. Table 1 provides a summary of the studies included: (a) authors and dates of the publication; (b) number of participants (n); (c) participants' age in months; (d) participants' characteristics; (e) research design; (f) assistive technology; and (g) early childhood child outcome categorization.

Organization by Early Childhood Child Outcomes

As noted earlier, the Office of Special Education Programs (OSEP) has requested that states receiving federal funding for early intervention (Part C) and special education preschool programs (Part B, section 619) report data on attainment of child and family outcomes (ECO, 2009a). Specifically, for the purpose of accountability, states must report the percentage of infants and toddlers with Individualized Family Service Plans (IFSPs) and preschool children (i.e., 3 through 5 year olds) with Individualized Education Plans (IEPs) who demonstrate improvements in their: (a) positive social emotional skills (including social relationships); (b) acquisition and use of knowledge and skills (including early language/communication and early literacy); and (c) appropriate behaviors to meet their needs. OSEP uses the resulting data to support program planning, research, and early intervention services with the intention of allowing young children to be “active and successful participants during their early childhood years and in the future in a

variety of settings.” As noted in the introduction, in this synthesis the definition for critical developmental outcomes for young children with disabilities, which was proposed and put in use by OSEP, is the definition for categorizing the dependent variable of each of the identified AT studies used. That is, each identified study’s intervention target (i.e., dependent variable) was compared to the three broad areas of the OSEP early childhood child outcomes and the studies were grouped accordingly.

Therefore, the first step in this process was to identify the dependent variable(s) for each AT intervention for each of the 16 studies (See Table 1). Each study was then categorized according to the early childhood child outcome (ECO) that best described the reported intervention outcome targeted. Table 1 provides the early childhood outcome(s) assignment for each study. Some studies were categorized under multiple early childhood child outcomes depending upon the reported intervention. To complete the grouping, an additional reviewer confirmed the dependent variable and classification to the relevant early childhood child outcomes. The study grouping resulted in the following: (1) Two of 16 studies (12.5%) addressed positive social emotional skills (Hanson, & Hanline, 1985; Schepis et al., 1998); (2) fourteen of the 16 studies (87.5%) (Aitken et al., 1983; Butler et al., 1984; Butler, 1986; Daniels et al., 1995; DiCarlo et al., 2000 ; Dunst, et al., 1985; Hanson & Hanline, 1985; Horn et al., 1987; Horn et al., 1992; O’Connor et al., 1986; Schepis et al., 1998; Segond et al., 2007; Sullivan & Lewis, 1990; Sullivan & Lewis, 2000) addressed acquisition and use of knowledge and skills, including communication, language, and literacy; and (3) eleven of the 16 studies (68.75%)

(Aitken et al., 1983; Butler et al., 1983; Butler et al., 1984; Butler, 1986; Cook, Liu & Hoseit, 1990; Daniels et al., 1995; Dunst, et al., 1985; Hanson et al., 1985; Horn et al., 1987; Horn, et al., 1992; Schepis et al., 1998; Segond et al., 2007) addressed the ability to take appropriate actions to meet needs.

Assessment of Individual Study Research Quality

In 2005, the special education community began to formulate systematic guidelines for specifying types and levels of evidence that were necessary to identify a practice as evidence -based and thus as an effective intervention (Odom, Bratlinger, Gersten, Horner, Thompson, & Harris, 2004). Specifically, for single-subject design research Horner, et. al., (2005) described specific criteria and for experimental and quasi-experimental research Gersten et. al., (2005) presented criteria. In 2009, Chard, Ketterlin-Geller, Baker, Doabler, and Apichatabutra, created a scoring rubric using a Likert scale based on these same criteria. To determine the quality of the evidence for each early childhood child outcome, the guidelines, that is the rubrics, developed by Chard et. al., (2009) for single-subject designs and experimental and quasi-experimental were used to provide a quantitative scoring of each of the 16 identified studies to assess the quality of the research methodology and implementation.

Figure 1 and Figure 2 provide a copy of Chard's rubric for both single-subject design research (see Figure 1 for single-subject rubric) and experimental/quasi-experimental design research (see Figure 2 for experimental/quasi-experimental rubric). A brief description of the rubrics and how they were applied in this synthesis follows. As shown in Figure 1 (single-subject design research) and Figure 2

(experimental design research), the first column provides a listing of quality indicators for each type of research methodology organizing them by categories (e.g., single-subject designs the quality indicator categories include: Participants and Setting, Independent Variable, Baseline, Experimental Control/Internal Validity, External Validity and Social Validity). After developing the list of quality indicators and recognizing that most research studies were implemented with a range of adherence to rigorous methodological standards, Chard et. al., (2009) developed a 4-point rating scale to allow for the assessment of this potential range. A score of 1-point would reflect a quality indicator that was not documented within the published report, whereas a score of 4-points indicates all criteria or characteristics of the quality indicator were reported.

To establish an overall quality rating for each study identified, quality indicators rubric criteria proposed by Horner et. al., (2005) and Gersten et. al., (2005) and quantified by Chard et. al.,(2009) were applied to each study. In doing so, the quality ratings for both the single-subject and the experimental/quasi-experimental research were relatively low. As the scores (see Table 2 aggregate rating for -single-subject research) and (see Table 3, for aggregate rating for experimental and quasi-experimental research) indicate, several key quality indicators were absent within the identified studies for this synthesis.

While there is agreement about the necessity for setting standards of research quality in order to move the special education field towards higher quality research, no clarifying “lens” exists. Applying such a critical lens may be possible by using the

rubric created by Chard et. al.,(2009) or other similar rating systems for assessing the quality of research. The lens offered in this synthesis applies indicators proposed by Horner et. al., (2005) and quantified by Chard et. al., (2009) with additional refinement (Cook, Tankersley & Landrum, 2011).

For single-subject research design, therefore, this researcher offers a more precise rating scale (see Table 4 for Aggregate quality indicator score and rating scale for single-subject research articles):

- The study is inadequate when more than five indicators fall within 2.00 and indicators of 1.00 are present in areas other than indicator #7.
- The study is adequate and low quality when all but two quality indicators are met within 2.0 and indicators #1-#6 scored above 1.00.
- The study is adequate when all but one quality indicators are met within 1.50 and indicators #1-#6 scored above 1.00.
- The study is adequate and high quality when all but one indicator are met within 1.00 and no indicators scored a 1.00.

The rating scale does not alter the criteria for achieving the highest level of quality designation, because the defining attributes of “adequate with high quality” meet both the criteria set forth by Horner et. al., (2005) and those used by Chard and et. al., (2009). (see Table 4 for Aggregate quality indicator score and rating scale for single-subject research articles). The exclusion of a social validity measure (Indicator #7) does not mean that research fails to contribute to the determination of

a practice as “evidence-based.” This is particularly true in an analysis of the very early research in the field of special education. Studies completed between the early 1980s and into the early 1990s neither had the benefit of the scholarship in how to assess social validity, nor the expectations for the inclusion of social validity assessment as a critical element of single-subject research, which is now common in the field (Schwartz & Baer, 1991).

With regards to the quality criteria for experimental/quasi-experimental design research, Gersten et. al., (2005) provided the following rating levels of quality: (a) inadequate-more than two indicators scored as 2.00 and indicators of 1.00 are present; (b) adequate and low quality-all but two quality indicators are met at least at the 2.00 level and no indicator scores of 1.00 are present; (c) adequate-all but one quality indicator met within 1.50 and no indicator score of 1.00 is present; (d) adequate and high quality -all but one indicator met within 1.00 and no indicators scored a 1.00 (see Table 5 for Aggregate quality indicator score and rating for experimental and quasi-experimental research articles).

Specifically, Gersten et. al., (2005) proposed that a research study could be considered high quality when at least three of the four indicators were present. Gersten et. al., (2005) argued that a study is high quality only when three of the four indicators are met in addition to the consideration of *preferred* indicators. Even though Horner et. al., (2005) did not offer a similar set of preferred indicators for the single-subject design research, it seems reasonable that a similar standard of meeting all but one indicator may still result in a high level of quality. Chard et. al., (2009),

on the other hand, set a global standard in that *all* indicators had to be present to be coded as high quality without consideration of preferred indicators. Thus, using the four levels of quality, the 16 studies were classified as follows: two studies (12.5%) (O'Connor & Schery, 1986; Sullivan & Lewis, 1990) demonstrated an "adequate with high quality" level of research quality; nine studies (56.25%) (Butler, 1986; Daniels, Sparling, Reilly & Humphry, 1995; DiCarlo & Banajee, 2000; Dunst, Cushing, & Vance, 1985; Hanson & Hanline, 1985; Horn & Warren, 1987; Horn, Warren, & Reith, 1992; Schepis, Reid, Behrmann, & Sutton, 1998; Segond, Weiss & Sampaio, 2007) demonstrated an "adequate" level of quality; one study (6.25%) (Sullivan & Lewis, 2000) demonstrated "adequate with low level of quality;" and three studies (18.75%) (Aitken & Bower, 1983; Butler, Okamoto, & McKay, 1983; Butler, Okamoto & McKay, 1984) demonstrated an "inadequate level of quality."

Assessment of rater reliability. To complete the analysis of the set of studies for this synthesis, a primary rater completed the appropriate rubric for each of the identified studies. Two additional raters served as reliability raters with *one* reliability rater completing the ratings of the single-subject research design studies and the other reliability rater completing the ratings of the experimental/quasi-experimental research design studies. Both reliability raters were doctoral candidates studying early childhood special education with minors in educational research. For reliability rater training, each reliability rater was first assigned to a research design category (e.g., single-subject or experimental/quasi-experimental design). Second, each rater read two articles, from the Chard and colleague (2009) synthesis, that were

about their assigned research design category. Third, the raters practiced the application of the relevant rubric.

Chard et. al., (2009) considered ratings reliable if the overall scores for each quality indicator agreed within 1-point of the findings. As each rater scored within acceptable parameters, the reliability raters then moved to the identified studies for this synthesis. The analysis for this synthesis involved one primary rater, as mentioned previously, and two reliability raters. Each rater was asked to use the corresponding rubric and independently evaluate the identified research articles. Interrater reliability was calculated by dividing the number of exact matches on ratings at the component level by the total number of exact matches and disagreements and multiplying by 100. This resulted in reliability of 43% for the group of -single-subject studies and 33% for the group of experimental/quasi-experimental studies. Since the application of this rubric is relatively new, additional interrater reliability calculations were considered. When calculating interrater reliability to include exact matches and one-point discrepancies, reliability for single-subject studies was 100%. When calculating interrater reliability to include exact matches and one-point discrepancies for experimental/quasi-experimental studies were 78%. The interrater reliability calculations were derived prior to determining the final scoring consensus. Initial ratings were entered into a table format and evaluated for correspondence. Scores differing by more than 1.0 point were reviewed and discussed in order to arrive at an accepted final score. In instances where the two raters were unable to reach a consensus for the individual quality indicator score, a

third independent rater was available to provide an arbitration score. This independent rater, a senior researcher in the field of early childhood special education, was blind to the initial ratings, which increased the likelihood of an unbiased final score.

Synthesis Results

The results of the literature synthesis are organized by the three early childhood child outcomes (i.e., early childhood child outcome one: positive social emotional skills including social relationships, early childhood child outcome two: acquiring and using knowledge and skills including early language/communication and early literacy, and early childhood child outcome three: appropriate behaviors to meet their needs). Each section begins with OSEP definition of the outcome followed by a brief discussion of how the studies addressed the OSEP early childhood child outcome. Finally, the section present the levels of evidence for the effectiveness of AT interventions in supporting young children's attainment of the early childhood child outcomes based upon the reviewed studies.

Early Childhood Child Outcome 1: Positive Social Emotional Skills

OSEP defines positive social emotional skills as:

Making new friends and learning to get along with others is an important accomplishment of the early childhood years. Children develop a sense of who they are by having rich and rewarding experiences interacting with adults and peers. They also learn that different rules and norms apply to different everyday settings and that they need to adjust their behavior accordingly.

This outcome involves relating to adults, relating to other children, and for older children, following rules related to groups or interacting with others.

The outcome includes concepts and behaviors such as attachment/separation/autonomy, expressing emotions and feelings, learning rules and expectations in social situations, and social interactions and social play (ECO, 2009b).

Keeping in line with the established quality criteria offered by Horner et al., (2005) documentation of an evidence-based practice requires multiple single-subject studies. Criteria include (a) minimum of five single-subject studies meet minimally acceptable methodological criteria and document experimental control have been published in peer reviewed journals, and (b) the studies are conducted by at least three different researchers across at least three different geographical regions and (c) the five or more studies include a total of at least 20 participants (Horner, et al., 2005, p.176).

As mentioned previously, only two studies (Hanson et al., 1985; Schepis et al., 1998) addressed the first early childhood child outcome. Specifically, Hanson and Hanline (1985) used switch access, which resulted in increased, motor activity and smiling by the child. Schepis (1998) reported VOCA interactions between child and adult resulting in an increase in communication interactions. Thus, both results allow the children to increase in behaviors that are foundations of social interactions (i.e., smiling and communication) (Hanson & Hanline, 1985). Therefore, in answering the question, ‘Do we have research evidence for AT interventions as an

evidence -based practice supporting very young children's attainment of OSEP early childhood child outcome one?' the response is: not at this time. A minimum of five studies is necessary to meet the evidence-based criteria (Chall et al., 2007; Horner et al., 2005).

Early Childhood Child Outcome 2: Acquiring and Using Knowledge and Skills

What follows is OSEP's full definition of the second early childhood outcome, acquiring and using knowledge and skills including early language/communication and early literacy:

Over the early childhood period, children display tremendous changes in what they know and can do. The knowledge and skills acquired in the early childhood years, such as those related to communication, pre-literacy and pre-numeracy, provide the foundation for success in kindergarten and the early school years. This outcome involves activities such as thinking, reasoning, remembering, problem solving, number concepts, counting, and understanding the physical and social worlds. It also includes a variety of skills related to language and literacy including vocabulary, phonemic awareness, and letter recognition (ECO, 2009b).

Fifteen of the identified studies were categorized as addressing the second early childhood child outcome (i.e., acquiring, and using knowledge and skills-including early language/communication and early literacy). Eight -single-subject design (Butler, 1986; Daniels et al., 1995; DiCarlo et. al., 2000; Dunst, et al., 1985; Hanson & Hanline, 1985; Horn et al., 1987; Horn et al., 1992, Schepis et al., 1998)

and four experimental/quasi-experimental (O'Connor et al., 1986; Segond, et al., 2007; Sullivan & Lewis, 1990; Sullivan & Lewis, 2000) were determined to have adequate quality ratings to be considered within this synthesis of evidence (see Table 2 and 3 for aggregate quality indicator scores for single subject research and experimental and quasi-experimental research respectively).

The established quality criteria offered by Horner et. al., (2005):

Documentation of an evidence-based practice requires multiple - single-subject studies a (a) minimum of five single-subject studies meet minimally acceptable methodological criteria and document experimental control have been published in peer reviewed journals. And (b) the studies are conducted by at least three different researchers across at least three different geographical regions and (c) the five or more studies include a total of at least 20 participants (Horner, et al., 2005, p. 176).

As noted, all eight of the single-subject studies addressing early childhood child outcome two met adequate levels of quality. Taken as a group of single-subject studies, Horner's first criterion was met given that a minimum of 5 met minimally acceptable methodological criteria. A total of 10 different authors working across three geographic areas were represented by the 8 studies, thus demonstrating achievement of Horner's second criterion of three different researchers across three different geographic regions. The final criterion of at least 20 participants was also met by the 8 studies given that they had a total of 32 participants (Butler, 1986;

Daniels, Sparling, Reilly, & Humphrey, 1995; DiCarlo & Banajee, 2000; Dunst, Cushing & Vance, 1985; Hanson & Hanline, 1985; Horn & Warren, 1987; Horn, Warren, & Reith, 1992; Schepis, Reid, Behrmann, & Sutton, 1998).

Because the demonstrations of skills across studies are as varied as the range of technology allows, the results are clustered around defining characteristics, which is problem solving and communication. A number of studies reported outcomes related to problem solving: Butler et. al. (1986), for instance, reported independent locomotor action with competency in seven locomotor skills, including driving straight, start/stop length of mobilization of 10 feet, turn around 90 corners, turn in 360 circles, and backing up. Daniels et. al., (1985) reported increased frequency of switch activation, increased frequency of orientation to stimulus, and increased frequency of attention to the stimulus. This occurred when the child was presented with a big red switch that activated either a computer program or toy, and when the child was given a verbal cue to “hit the switch.” Dunst et. al., (1985) reported increased head turning by the child in response to lights that were activated each time the child exhibited a fixated head turn. Horn and Warren (1987) reported increased motor-skill and response-contingent learning because each child had separate reinforcing target behaviors (e.g., head to midline, sitting, batting, and weight bearing on hands in crawl position). Each time a child met the individual skill, a switch - activated toy provided reinforcement. Horn et. al., (1992) reported increased child engagement and motor development when children were positioned in appropriate adaptive equipment.

Few other studies report outcomes related to communication: DiCarlo and Banajee (2000) reported increased initiation of communication during snack time routine in the classroom when the child was presented with the device and provided with verbal prompts to make choices and request specific items by pressing the switch. Hanson and Hanline (1985) also reported results in increased leg movement and smiles. The second condition resulted in an increase in requesting, and the third condition resulted in increased motor movement bringing head to midline. In the second condition, the child was placed within reaching distance of a pressure-sensitive pad that, when touched, emitted a tone. This tone signaled to the parent the child's need for attention. Schepis et. al., (1998) reported that all children increased their communication interactions during the voice output communication aid and naturalistic teaching conditions.

Therefore, based on these eight single-subject studies using Horner's criteria for sufficient criteria, it is evident that AT interventions is an evidence-based practice. These studies show that AT interventions *are* evidence-based practices, which supports very young children's attainment of the early childhood developmental outcomes. Specifically, OSEP early childhood child outcome two: acquiring and using knowledge and skills (including early language/communication and early literacy).

Additional confirmation for AT interventions as an evidence-based practice comes also from two high-quality experimental/quasi-experimental research studies that are included in this synthesis. One of these two studies was conducted by

Segond et. al., (2007) who reported increase in response-contingent learning, increased motor movement when the child was seated in a semi-inclined position that permitted free movement of the legs and feet. The second study mentioned was conducted by Sullivan and Lewis (1990; 2000), who reported response-contingent learning and increased awareness when children were seated before a play board on which two switches were mounted.

As a reminder, criteria for assessing the level of evidence offered by Gersten et. al., (2005) are:

at least four acceptable quality studies, or two high quality studies that support the practice and (b) the weighted effect size is significantly greater than zero.

For considering a practice as promising; there are at least four acceptable quality studies or two high quality studies which support the practice; and there is a 20% confidence interval for the weighted effect size that is greater than zero (p. 162).

Early Childhood Child Outcome 3: Appropriate Behaviors to Meet their Needs

OSEP full definition of the third early childhood outcome, appropriate behaviors to meet their needs is as follows:

As children develop, they become increasingly more capable of acting on their world. With the help of supportive adults, young children learn to address their needs in ways that are more sophisticated and with increasing independence. They integrate their developing skills, such as fine motor skills and increasingly complex communication skills, to achieve goals that are of

value to them. This outcome involves behaviors like taking care of basic needs, getting from place to place, using tools (such as forks, toothbrushes, and crayons), and, in older children, contributing to their own health, safety, and well-being. It also includes integrating motor skills to complete tasks; taking care of one's self in areas like dressing, feeding, grooming, and toileting; and acting on the world in socially appropriate ways to get what one wants (ECO, 2009b).

The established quality criteria offered by Horner and colleagues are as follows:

documentation of an evidence-based practice requires multiple single-subject studies when a (a) minimum of five single-subject studies meets minimally acceptable methodological criteria and document experimental control have been published in peer reviewed journals. And (b) the studies are conducted by at least three different researchers across at least three different geographical regions and (c) the five or more studies include a total of at least 20 participants (Horner, et al., 2005, p. 176).

Twelve studies categorized under early childhood outcome three consisted of five experimental/ quasi-experimental design studies and seven single-subject design studies (see Table 2 and 3 for aggregate quality indicator scores for single subject research and experimental and quasi-experimental research respectively). Only eight studies total under this domain met adequate levels of evidence, including seven single-subject design (Butler, 1986; Daniels, et al., 1995; DiCarlo et al., 2000; Dunst,

et al., 1985; Hanson and Hanline, 1985; Horn et al., 1987; Horn et al., 1992; Schepis et al., 1998) and one experimental/quasi-experimental design (Segond et al., 2007).

Again, the demonstrations of skills across studies are as varied as the range of technology allows, which is why the results are clustered around defining characteristics,(e.g., motor skills, acting upon the environment). The study by Butler et. al., (1986) is among those that reported outcomes related to mobility. Butler et. al., (1986) reported outcomes related motor skills, specifically the demonstration of independent locomotor action with competency in seven locomotor skills: driving straight, start/stop length of mobilization of 10 feet, turn around 90 corners, turn in 360 circles, backing up.

Studies that reported outcomes related to acting upon the world for desired outcome include: Daniels et. al., (1995), who reported increased frequency of switch activation, increased frequency of orientation to stimulus, and increased frequency of attention to the stimulus when the child was presented with a big red switch activating either a computer program or toy and given a verbal cue to “hit the switch.” DiCarlo and Banajee (2000) reported an increased initiation of communication as the child was presented with the device during snack routine and provided verbal prompts to make choices and initiate request of specific items by pressing the switch, Dunst et. al., (1985) reported an increase in head turning movement when lights were activated each time the child emitted a fixated head turn. Hanson and Hanline (1985) reported an increase in leg movements and smiles, an increase in requesting, and an increase in motor movement bringing head to midline. Horn and Warren (1987) reported

increased motor skill and response contingent learning as each child had separate reinforcing target behaviors (head to midline, sitting, batting, and weight bearing on hands in crawl position) that when met a switch activated toy provided reinforcement. Horn and Warren (1992) reported increased child engagement and motor development as children were positioned in an appropriate adaptive equipment. Schepis et. al., (1998) reported all children increased their communication interactions during the VOCA and naturalistic teaching conditions.

The identified research promoting AT as an evidence-based practice which supports meeting early childhood child outcome three: Appropriate behaviors to meet their needs are emerging. There were seven single-subject studies by three different researchers across three separate regions and 32 participants where 20+ are necessary for evidence-based practice determination (Butler, 1986; Daniels, et al., 1995; DiCarlo et al., 2000; Dunst, et al., 1985; Hanson & Hanline, 1985; Horn & Warren, 1987; Horn et al., 1992; Schepis et al., 1998). As for the consideration of experimental/quasi-experimental research to support AT intervention as an evidence-based practice, there was only one experimental/quasi experimental study that was categorized under early childhood outcome three; it did not meet the criteria for high-quality level of evidence. (Segond et al., 2007)

Discussion

This literature synthesis began with two encompassing purposes. The first was to move AT beyond the designation as a promising practice and provide a definitive answer to the question of levels of evidence. The second was to move the

field of intervention to a broader, whole-child perspective and away from the traditional focus on AT as a method for improving a skill deficit or scaffolding the development of a single skill.

The proposal within this synthesis, using criteria for evidence-based practice, continues to push the question. Thus, the specific question addressed in this literature synthesis is: Do we have evidence for AT interventions as an evidence-based practice supporting young children's attainment of early childhood developmental outcomes? Yes, for outcomes demonstrating utilization of AT interventions for children to acquire and use knowledge and skills. The skills, included early language and early literacy (OSEP early childhood child outcome two) and demonstrating appropriate behaviors to meet needs (OSEP early childhood child outcome three).

The body of single-subject research in the area of AT with young children continues as larger than the body of experimental/quasi experimental research, which may be as it should be. AT interventions should always focus primarily on the individual child's needs, which this focus does not lend itself well, to the rigor of experimental and quasi-experimental research. AT interventions within the field of practice range from very simple to technologically sophisticated and very complex. This is difficult to reflect with research methods and even more so when attempting to place AT intervention research under scrutiny. However, what practitioners acknowledge and scholars attempt to demonstrate with research, are the vast improvements AT makes in a young child's life.

As substantiated in this literature synthesis, evidence for the use of AT with young children remains insufficient. However, this insufficiency leads to the following question: does the lack of research evidence in early intervention cause practitioners to limit their use of AT with young children? Practitioners must be cognizant of the AT benefits have for young children, even when there is a lack of reporting. Practitioners must consider AT interventions as the means for enabling children to explore, learn, interact, and continually build skills beginning at a very young age. This literature synthesis also demonstrates AT can be utilized for more than a single skill replacement or scaffold for skill development. Therefore, reorientation of AT intervention outcomes makes it possible to focus on the benefits of AT as more than a single skill replacement. Thus, the following research dissertation study, which examines the impact of AT on social skill attainment, seeks to answer the following four questions:

- Does the quality of the adult social interactions improve when the AT device is present than when the device is not present?
- Does the quality of the young child's social interactions improve when the AT device is present than when the device is not present?
- Does the frequency of the young child's social communication behavior increase with the presence of an AT device than when the device is not present?
- Does the child's level of engagement increase in frequency and complexity when the AT device is present than when the device is not present?

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Figure 1

Quality Indicators of Single-subject Research Articles and Reports

1. Participants and Setting	1	2	3	4	Score
Ample characteristics (e.g. age, gender, disability, diagnosis)	No detail	Limited detail provided	Some detail provided	Ample detail provided	
Process for selecting participants	No description of selection process	Procedures described but not appropriate and/or with limited detail	Procedures described are appropriate but minimally described	Procedures were appropriately described	
Critical features of the physical setting	No descriptions provided	Limited description provided	Some descriptions provided	Detailed descriptions provided to allow replications	
2. Dependent Variable	1	2	3	4	Score
Description of dependent variable	No description provided	Limited description provided	Some description provided but not operational	Operational description provided	
Measurement procedure	No procedure provided or not quantifiable variables	Procedure provided but no quantifiable variables	Procedure provided but only some variables quantifiable	Procedure provided and all variables quantifiable	
Measurement validity and description	No valid measures and description not replicable	No valid measures or description not replicable	Some measures valid; description is replicable	Measures are valid and description is replicable	
Measurement frequency	No repeated measures	Measurement repeated but very infrequently	Measurement repeated but infrequently	Measurement repeated frequently	
Data collected on reliability (minimal standards: IOA = 80%; Kappa = 60%)	No reliability data reported	Reliability data incorrectly collected or analyzed	Reliability data reported but minimal standards not met	Reliability data reported and minimal standards are met	
3. Independent Variable	1	2	3	4	Score
Description of independent variable	Only name or vague description of IV provided	IV described with little detail	Major components of IV provided with some detail (e.g. scripts provided)	All components of IV described in detail with efforts to communicate precision	
IV manipulation	IV is provided with no control	Little control exercised (e.g. monitor, scripts)	Condition assignment is planned	Random assignment to condition	

(Figure continues)

Figure 1 (Continued)

4. Baseline	1	2	3	4	Score
DV measurement	DV not measured objectively	DV measured infrequently; data is missing or not stable	DV measured frequently but no stable	DV measured frequently and is stable before intervention	
Description of baseline condition	No description of baseline	Vague description of baseline	Baseline description detailed but limited	Baseline description detailed and extensive	
5. Experimental control/internal validity	1	2	3	4	Score
Design demonstrates experimental effect	No demonstration of experimental effect	Only one demonstration of experimental effect	More than one demonstration of experimental effect	Three or more demonstrations of experimental effect	
Design controls for common threats to internal validity (e.g. elimination of rival hypothesis)	No control for threats to validity	Few threats controlled	Most threats controlled	All threats controlled	
Pattern of results	Results do not suggest experimental control	Results suggest a change in trend; level, or variability	Results document a change in trend, level or variability	Results document a pattern of experimental control	
6. External validity	1	2	3	4	Score
Replication of effects (e.g. across participants, settings, or materials to establish external validity)	No effort to replicate efforts	Few replications attempted	Some replication attempted	Multiple replications across variables	
7. Social validity	1	2	3	4	Score
Importance of DV	No importance			Important	
Importance of magnitude of change in DV	No importance	Somewhat important	Important	Very important	
Practicality and cost effectiveness of implementation of IV	Impractical and not cost effective	Either practical or cost effective but not both	Some evidence of practicality and cost effectiveness	Practical and cost effective	
Typical nature of implementation of IV	IV implementation in atypical manner	IV implemented either in typical context or typical agent, not both	Implementation extended in somewhat typical contexts and with a somewhat typical agent (e.g. certified teachers)	Implementation extended in typical contexts with typical agents (e.g. certified teachers)	

Note: IOA =Interobserver agreement; IV = independent variable; DV = dependent variable.

Adapted from: "Repeated reading interventions for students with learning disabilities: Status of the evidence. D.J. Chard, :L.R., Ketterlin-Geller, S.K. Baker, C. Doabler, & C. Apichatabutra, C. 2009. Exceptional Children, 75, 263-281

Figure 2

Quality Indicators of Experimental and Quasi-experimental Research Articles and Reports

Description of Participants	1	2	3	4	Score
Information about diagnosis or difficult	No evidence and/or description	Little evidence and/or description	Some evidence and/or description	Ample evidence and/or description	
Samples are comparable across conditions on relevant characteristics	No procedures for comparability	Procedure described but not appropriate	Procedure appropriate but minimally described	Procedures appropriate and adequately described	
Information about interventionists or teachers; comparability across conditions	No information or description provided; no information about comparability across groups	Some information or description provided; no information about comparability across groups	Some information or description provided; some information about comparability across groups	Sufficient information or description about interventionists provided; comparable across groups	
Descriptions and implementation of intervention and comparison conditions	1	2	3	4	Score
Description of intervention and implementation procedures	Minimal description provided; no details	Some description provided; limited details	Some description provided; general details lacking specificity for replication	Description clear and specific replication	
Description of fidelity of implementation procedures	No information provided	Some information provided; evaluation and effects on intervention impact not described	Some information provided; evaluation and effects on intervention impact minimally described	Sufficient information provided; evaluation and effects on intervention impact described	
Description of comparison condition activities	Minimal description Provided; no details	Some description provided; limited details	Some descriptions provided; general details lacking specificity for replication	Description clear and specific for replication	

Note: IOA =Interobserver agreement; IV = independent variable; DV = dependent variable.

Adapted from: "Repeated reading interventions for students with learning disabilities: Status of the evidence. D.J. Chard, :L.R., Ketterlin-Geller, S.K. Baker, C. Doabler, & C. Apichatabutra, C. 2009. *Exceptional Children*, 75, 263-281

(Figure continues)

Figure 2 (Continued)

Outcome measures	1	2	3	4	Score
Multiple measures or measures of generalized performance (were multiple measures used to measure the DV? Were measures of generalized performance used?)	Only used measure tightly aligned to intervention	Used measure tightly aligned to intervention along with one other measure	Used measure of generalized performance	Used multiple measure and measure of generalized performance	
Appropriateness of data collection times	No information about timing provided	Timing of administration of outcome measures not appropriate	Timing of administration of outcome measures somewhat appropriate	Timing of administration of outcome measure appropriate	
Data analysis	1	2	3	4	Score
Data analysis linked to research questions/ hypothesis; considered unit of analysis	No information about data analysis provided	Data analysis techniques not appropriate given the research questions/hypothesis; unit of analysis may or may not have been appropriate	Data analysis techniques mostly appropriate given research questions/hypothesis (alternate methods could be used that were more elegant); used appropriate unit of analysis	Data analysis techniques appropriate given the research questions/ hypothesis; used appropriate unit of analysis	
Effect size calculation	Effect size not reported	Effect size reported but not interpreted	Effect size reported but not accurately interpreted	Effect size reported and accurately interpreted	

Notes: IOA =Interobserver agreement; IV = independent variable; DV = dependent variable.

Adapted from: "Repeated reading interventions for students with learning disabilities: Status of the evidence. D.J. Chard, L.R., Ketterlin-Geller, S.K. Baker, C. Doabler, & C. Apichatabutra, C. 2009. Exceptional Children, 75, 263-281

Table 1

Studies Included in the Research Synthesis

Author Publication date	N	Participants Age in mo	Participants characteristics	Research design	Assistive technology	ECO
Aitken, S, & Bower, T.G.R. (1983)	10 7	5-25 4.6 yr-9.9 yr	Congenital blindness	Group- no control	Sonic Guide	2 3
<p>Intervention: A wooden object was introduced first in the midline. Then the object was moved to and from the child's face horizontally in the midline. This procedure was carried out for 25 trials without touching the subject's face, and then for the same number of trials, ending with the object contacting the child's face. Once the object had been successfully located by the child it was then presented in a position off the midline, randomized as to right or left and at a different distance.</p> <p>Results: Increased exploring environment, reaching and tracking and responding to an approaching object</p>						
Butler, C., Okamoto, G.A., & McKay, T.M. (1983).	9	20-39 unstated age distribution reported.	Cerebral palsy & other orthopedic disabilities	Group(pre/ post w/one tx) no control	Adapted motorized wheelchair	3
<p>Intervention: The parents were asked to introduce the motorized wheelchairs at home, to allow supervised play with the motor turned on and to respect any resistance to engage in further activity.</p> <p>Results: competent driving defined as starting, stopping, driving straight in narrow corridors, turning corners, backing and coming in close to people and furniture. Additional interest movement was noted (e.g. riding rocking horse, playing baseball, going 'hiking' with the family).</p>						
Butler, C., Okamoto, G. A., & McKay, T.M. (1984)	13	20-37 unstated age distribution reported. Mean age 31.3	Cerebral palsy & other orthopedic disabilities	Group (pre/post w/one tx) no control	Adapted motorized wheelchair	2 3
<p>Intervention: Children were provided tiny-tot or child-size powered wheelchairs, preschool manual wheelchairs with Solo units, and homemade chair with Solo Unit. The parents were asked to introduce the motorized wheelchairs at home, to allow supervised play with the motor turned on and to respect any resistance to engage in further activity.</p> <p>Results: Independent locomotor action with competency in seven locomotor skills. Driving straight, start/stop length of mobilization of 10 feet, turn around 90 corners, turn in 360 circles, backing up.</p>						

Notes: N= number of participants; ECO – OSEP early childhood child outcomes

(table continues)

Table 1 (Continued)

Studies Included in the Research Synthesis

author publication date	N	Participants age in mo	Participants characteristics	Research design	Assistive technology	ECO
Butler, C. (1986)	6	23-38 unstated age distribution reported.	Myelomeningocele; spastic quadriplegia CP, congenital malformation of the limbs, chronic spinal muscular atrophy, limb deficiency, hypotonic quadriplegia	Single- subject (multiple baseline across subjects)	Adapted motorized wheelchair	2 3
<p>Intervention: Children were provided an adapted motorized wheelchair in natural, free response environment.</p> <p>Results: Increased frequency of self-initiated physical interaction with objects, physical interaction with objects, changes of location in space. Competent control of motorized wheelchair by achieving seven driving skills Driving straight, start/stop, length of mobilization of 10 feet, turn around 90 corner, turn in 360 circle, backing up. Increase change in location, increased independent mobility, heightened curiosity, increased communication, reduction in demanding behaviors</p>						
Cook, A.M., Liu, K.M., & Hoseit, M.S. (1990)	9	N=8-35) N=1(38/gestational age 35) Typical N=3(6-18)	Cerebral palsy, microcephaly, developmental disability, quadriplegia, seizure, chromosomal anomaly (trisomy 17q and monosomy 14q)	Group (2 phase tx repeated across subjects) no control	Mini - mover robotic arm	3
<p>Intervention: A switch was placed in front of child and an object to be retrieved was placed in view of the child but out of reach. The child was required to press the switch continuously to continue the task movement and retrieve the object.</p> <p>Results: Obtained out of reach objects</p>						
Author Publication date	N	Participants Age in mo	Participants characteristics	Research design	Assistive technology	ECO
Daniels, L.E., Sparling, J.W., Reilly, M., & Humphry, R. (1995)	2	24; 40	Hydroencephaly, profound mental retardation, visual loss; multicystic encephalomalacia, spastic quadriplegic cerebral palsy with moderate mental retardation	-Single- subject (alternating tx)	Switch (Big Red)	2 3
<p>Intervention: The child was presented with a big red switch activating either a computer program or toy and given a verbal cue to "hit the switch."</p> <p>Results: Increased frequency of switch activation; increased frequency of orientation to stimulus; and increased frequency of attention to the stimulus</p>						
DiCarlo, C.F., & Banajee, M. (2000)	3	18-28	Chromosomal abnormality, Angelman's syndrome	Single- subject multiple baseline	Voice output device w/switch activation	2

<p>Intervention: The child was presented with the device during snack routine and provided verbal prompts to make choices and initiate request of specific items by pressing the switch. The device produced the word associated with the chosen item.</p> <p>Results: Increased initiation of communication during snack routine in classroom</p>						
Dunst, C.J., Cushing, P.J., & Vance, S.D. (1985)	6	<36 research started at ages 7-12 mo. Completed between 24- 36 mo.	Severe hypotonia, seizure disorder; seizure disorder; profound mental retardation, spastic diplegia; severe motor dysfunction; encephalopathy, spastic quadriplegia, microcephaly	Single subject (ABA)	visual light display	2 3
<p>Intervention: The child was placed in crib and supports arranged to support midline position and provide stabilization of posture. Lights were illuminated by experimenter each time child emitted a fixated head turn.</p> <p>Results: Increased head turning movement</p>						
Author publication date	N	Participants age in mo	Participants characteristics	Research design	Assistive technology	ECO
Hanson, M.J., & Hanline, M.F. (1985)	3	8-25	Spastic quadriplegia, Down syndrome, & cerebral palsy with seizure disorder	-Single-subject (ABA or ABABA)	Switch	1 2 3
<p>Intervention: A separate response contingent interventions was designed for each child based upon child need. In the first condition the child was placed upon a vibratory pad with a vertical kick panel at a distance that allowed her foot to touch it when her leg was extended. When her foot activated the kick panel the vibratory pad provided feedback. In the second condition, the child was placed within reaching distance of a pressure sensitive pad that when touched would emit a tone. This tone signaled to the parent the need for attention. In the third condition, the child a device that combined auditory and visual feedback was placed in front of the child's face. When the child brought his head to midline the switch was pressed by the parent to activate the light and sound device.</p> <p>Results: First condition resulted in increased leg movement and smiles, the second condition resulted in an increase in requesting, and the third condition resulted in increased motor movement bringing head to midline.</p>						
Horn, E.M., & Warren, S.F. (1987)	2	17; 24mo	Severe developmental delays; cerebral hypotonia	-Single- subject (multiple probe with 2 nd subject replication	Corner sitter, and switch activated toys	2 3
<p>Intervention: Each child had separate reinforcing target behaviors (head to midline, sitting, batting, and weight bearing on hands in crawl position) that when met a switch activated toy provided reinforcement.</p> <p>Results: Increased motor skill and response contingent learning</p>						
Horn, E.M., Warren, S.F., & Reith, H.J. (1992)	6	N=3 (16-28) N=3 (48-60)	Cerebral palsy	Single-subject (ABAB multi- treatment)	Switch	2 3
<p>Intervention: Multiple conditions were implemented. The children were positioned in appropriate adaptive equipment designed to provide support during the performance of target behavior. Immediate contingent reinforcement was provided as long as the child engaged in the target behavior.</p> <p>Results: Increased child engagement and motor development</p>						
O'Connor, L., & Schery, T.K. (1986)	8	22-38 mo. N=7 (22-35) N=1 (38)	Down syndrome; developmental delay; severe emotional disorder	Group; repeated measures; two intervention conditions repeated	Computer aid language program	2

				for all subjects		
<p>Intervention: Vocabulary items were presented through one of two separate programs with differing theme contexts. Each child was assigned a training vocabulary from one context for the computer aided intervention and the other vocabulary for traditional therapy. In the computer aided context pictures representing vocabulary items were available and if the child depressed a picture on the keyboard, a large matching color graphic came up on the monitor screen and the child heard the corresponding word. Objects identical to the context vocabulary pictures were displayed out of reach of the child on top of the computer monitor. Each child was asked "What do you want?" by a clinician. At any time the child pressed an object key the clinician would hand the object to the child for a brief period. This was followed by verbal praise for attending or requesting objects, and generally promoting the child's interest in the computer and toys.</p> <p>Results: Increased language (vocabulary) acquisition</p>						
Schepis, M.M., Reid, D.H., Behrmann, M.M., & Sutton, K.A. (1998)	4	3 yrs. & 5 yrs.	Autism	Single subject	Voice Output Communication Aid (VOCA) (e.g Cheap Talk & Black Hawk)	1 2 3
<p>Intervention: Following teacher training of naturalistic instructional strategies the child was provided with the VOCA during the targeted classroom routine. The child was allowed to freely explore the VOCA for 1 minute (e.g. pressing switches and listening to messages) Following the initial demonstration of the VOCA the VOCA was provided with no further instruction to the target child at the beginning of subsequent sessions for the routine.</p> <p>Results: All children displayed an increase in communicative interactions during the VOCA and naturalistic teaching condition, relative to baseline in each classroom routine.</p>						
Segond, H., Weiss, D., & Sampaio, E. (2007)	36	3.5-10 mo.	Blind	Quasi-experimental	Visio-tactile sensory substitution device	2 3
<p>Intervention: The child was seated in a semi-inclined position that permitted free movement of the legs and feet. Reinforcement in the form of visual, tactile or auditory stimulation (TVSS – tactile vision substitution system) was provided if the child's foot movement (kick) caused the white strip to pass through the field of the micro camera.</p> <p>Results: Increased response contingent learning, increased motor movement</p>						
Sullivan, M.W., & Lewis, M.(1990)	10	2.5 - 15.5 mo	Physical and mental handicaps due to cerebral palsy, Down syndrome, prematurity with neurological insult, developmental delay	Group (pre/posttest with no control or random assignment)	Switch activated toys	2
<p>Intervention: Toys and switches were mounted on a special panel. Typically two switches were available at any time. One was designated at the response to be learned and the other was nonresponsive. Children were seated before a play board on which two switches were mounted. Activity on one of the switches activated a toy or other consequence but contact with the other switch had no result.</p> <p>Results: Response contingent learning and increased awareness</p>						
Author	N	Participants age in mo	Participants characteristics	Research design	Assistive technology	ECO
Sullivan, M., Lewis, M. (2000)	120	<18 mo	Down syndrome (n=60); cerebral palsy (n=40); other disability (n=40)	Group (pre/posttest with no control or random assignment)	Switch	2
<p>Intervention: Toys and switches were mounted on a special panel. Typically two switches were available at any time. One was designated at the response to be learned and the other was nonresponsive. Children were seated before a play board on which two switches were mounted. Activity on one of the switches activated a toy or other consequence but contact with the other switch had no result.</p> <p>Results: Response contingent learning and increased attention</p>						

Notes: N= number; ECO – early childhood child outcomes

Table 2.

Aggregate quality indicator score for single-subject research

Indicator	#1	#2	#3	#4	#5	#6	#7
Study	Participant /Setting	DV	IV	BL	EC/ internal Validity	External Validity	Social Validity
Butler, C. (1986)	2.5	3.3	2.015	3.25	4	4	1
Daniels, L.E., Sparling, J.W., Reilly, M., & Humphry, R. (1995)	3.165	3.5	2.835	3.5	3.853	3	1
DiCarlo, C.F. & Banajee, M. (2000)	3.665	3.7	2.67	3.5	3.5	2	1
Dunst, C.J., Cushing, P.J., & Vance, S.D. (1985)	2.5	3.9	2.33	3.5	3.835	3	1
Hanson, M.J. & Hanline, M.F. (1985)	2.835	3.835	2.6	3.5	4	4	1
Horn, E.M. & Warren, S.F. (1987)	3.5	4	3.0	4	4	4	1
Horn, E.M., Warren, S.F., & Reith, H.J. (1992)	3	4	2.835	4	3.835	4	3.625
Schepis, M.M., Reid, D.H., Behrmann, M.M., & Sutton (1998)	4	3.8	3.33	4	4	4	1.75
Notes: DV-dependent variable; IV-independent variable; BL-baseline EC-experimental Control							

Table 3

Aggregate Quality Indicator Score for Experimental and Quasi-experimental Research

Study	Description of participants	Intervention/ comparison conditions	Outcome measures	Data analysis
Aitken, S. & Bower, T.G.R. (1983)	1.84	1.67	3	1.25
Butler, C., Okamoto, G.A., & McKay, T.M.(1983)	2.165	1.5	1.5	1
Butler, C., Okamoto, G.A., & McKay, T.M.(1984)	1.33	1.335	2.25	1.25
Cook, A.M., Liu, K.M., & Hoseit, M.S.(1990)	2.33	1.67	2	1
O'Connor, L. & Schery, T. K. (1986)	3.835	3.33	3.5	3
Segond, H., Weiss, D., & Sampaio, E. (2007)	2.835	3.33	2.5	4
Sullivan, M.W. & Lewis, M.(1990)	3.33	3	4	2.125
Sullivan, M. & Lewis, M. (2000)	2.415	2.165	2.75	1.5

Notes: DV-dependent variable; IV-independent variable; BL-baseline EC-experimental Control:

Table 4

Aggregate quality indicator score and rating scale for single-subject research articles

Indicator	#1	#2	#3	#4	#5	#6	#7	Level	Rating scale
Study	Participant /Setting	DV	IV	BL	EC/ internal Validity	External Validity	Social Validity		
Butler, C. (1986)	2.5	3.3	2.015	3.25	4	4	1	<input type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/>	Adequate – high quality <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> All but one indicator score ≥ 3.0 and no indicator scored a 1.
Daniels, L.E., Sparling, J.W., Reilly, M., & Humphry, R. (1995)	3.165	3.5	2.835	3.5	3.853	3	1	<input type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/>	Adequate <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> all but one quality indicator are met within 1.50 and indicators #1-#6 scored above 1.00
DiCarlo, C.F. & Banajee, M. (2000)	3.665	3.7	2.67	3.5	3.5	2	1	<input type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/>	
Dunst, C.J., Cushing, P.J., & Vance, S.D. (1985)	2.5	3.9	2.33	3.5	3.835	3	1	<input type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/>	Adequate – low quality <input checked="" type="checkbox"/> All but two indicators ≥ 2.0 and no score of 1 for indicators #1 -#6.
Hanson, M.J. & Hanline, M.F. (1985)	2.835	3.835	2.6	3.5	4	4	1	<input type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/>	
Horn, E.M. & Warren, S.F. (1987)	3.5	4	3.0	4	4	4	1	<input type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/>	Inadequate <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
Horn, E.M., Warren, S.F., & Reith, H.J. (1992)	3	4	2.835	4	3.835	4	3.625	<input type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/>	5+ indicators fall ≤ 2.0 and indicators of 1 are present.
Schepis,	4	3.8	3.33	4	4	4	1.75	<input type="checkbox"/>	

M.M., Reid, D.H., Behrmann, M.M., & Sutton (1998)								<input checked="" type="checkbox"/> <input checked="" type="checkbox"/>	
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Notes: DV-dependent variable; IV-independent variable; BL-baseline EC-experimental Control

Table 5

Aggregate quality indicator score and rating for experimental and quasi-experimental research articles

Study	Description of participants	Intervention/ comparison conditions	Outcome measures	Data analysis	Level	Rating
Aitken, S. & Bower, T.G.R. (1983)	1.84	1.67	3	1.25	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	Adequate- high quality <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> All but one indicator score ≥ 3.0 and no indicator scored a 1.
Butler, C., Okamoto, G.A., & McKay, T.M. (1983)	2.165	1.5	1.5	1	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	
Butler, C., Okamoto, G.A., & McKay, T.M. (1984)	1.33	1.335	2.25	1.25	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	Adequate <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> All but one indicator ≥ 2.5 met and no indicator scored a 1
Cook, A.M., Liu, K.M., & Hoseit, M.S. (1990)	2.33	1.67	2	1	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	
O'Connor, L. & Schery, T. K. (1986)	3.835	3.33	3.5	3	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/>	Adequate-low quality <input checked="" type="checkbox"/> All but two indicators ≥ 2.0 and no indicator scored a 1.
Segond, H., Weiss, D., & Sampaio, E. (2007)	2.835	3.33	2.5	4	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/>	
Sullivan, M.W. & Lewis, M. (1990)	3.33	3	4	2.125	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/>	Inadequate <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> 2+ fall ≤ 2.0 and indicators of 1 are present.
Sullivan, M. & Lewis, M. (2000)	2.415	2.165	2.75	1.5	<input checked="" type="checkbox"/>	

CHAPTER 3: METHOD

The researcher chose a multielement single case design to examine the impact of assistive technology (AT) on the adult/young child dyad's social interactions. The multielement single-case research design is also known as an alternating treatment design (Tawney & Gast, 1984), multiple schedule design (Hersen & Barlow, 1976), multielement baseline design (Sidman, 1960; Ulman & Sulzer-Azeroff, 1975); and a simultaneous treatment design (Kazdin & Hartmann, 1979). However, for this study the "multielement single-case design" will be used because of its "historical precedence, technical accuracy, and inclusiveness" (Kennedy, 2005, p. 137). The basic feature of the design is the rapid alternation of two different interventions, conditions, or elements with an individual or group of learners (Tawney & Gast, 1984). This design allowed for a comparison of the two different conditions: (a) condition 1-when AT was available and (b) condition 2-when AT was not available to the young child.

The following method section is organized in the following order: participant recruitment, participants and setting, experimental procedures, and data collection methods.

Recruitment. In order to locate qualified participants for this study, the researcher contacted IDEA, Part C-Infant Toddler Services provider programs in multiple Midwestern states requesting information via email and by phone contact, on the number of children who were using an AT device. Eleven providers (30%) reported having children using an AT device. Across these 11 agencies, 134 potential

participants were reported. In addition, several private agencies providing services to families and their young children with disabilities were contacted for recruitment of potential research participants.

Criteria. The following criteria were used to select participants from the group of eligible children: (a) The child was diagnosed with developmental disability or delay as per their state criterion, as defined in Part C or Part B of IDEA, and was between the ages of 12 through 59 months; (b) the child used an AT device whose purpose was to support adult/young child's social interactions, (i.e., AT devices considered for inclusion were voice output communication aid or picture/symbol choice board but did not include items such as a build-up handle spoon or adaptive positioning equipment) (c) the child had the daily opportunity for adult/young child interaction at meal or snack time; and (d) the child had not been diagnosed with complex oral motor feeding issues.

The criteria for adult participants were as follows: (a) The adult was an early childhood interventionist or professional equivalent (e.g. speech language pathologist), who routinely worked with the child during the feeding/mealtime routine; or (b) the adult was a primary caregiver for the identified child during a daytime meal or snack.

The researcher was able to identify two potential child participants by discussing the eligibility criteria with all of the programs' directors. Both child participants selected for this study attended the same private early intervention center. The center was located in a multicounty metropolitan area with a population of 2.34

million. The private center creates individualized programs for each child and family by a team of physical, occupational and music therapists, speech language pathologists, early childhood special education teachers, behavior analysts and paraprofessionals.

After discussing the project with the children's parents, the director provided them with a consent form and brief questionnaires that the researcher had specifically designed for this study. As shown in Appendix A, the questionnaires ask for parent input regarding the: (a) child's current developmental abilities; (b) nature of mealtime for the child, including oral motor status and social communication interaction between a caregiver and the child; and (c) the child's AT device and use of the device.

Participants and Setting

Two identified children attended a private Midwest urban center that serves children with developmental disabilities from birth through 5 years of age. Children who are served by the center have been diagnosed with a range of conditions including Down syndrome, muscular dystrophy, cerebral palsy, spina bifida, autism and other developmental delays and disabilities. As part of the program, a team of physical, occupational, music and speech therapists, and early childhood special education (ECSE) teachers design individualized programs for each child and his or her family.

Process. During the initial meeting with the parents of the child, David, and the classroom teacher, Linda, the researcher clarified the purpose of the study

including the research process. The researcher explained the videotaping would be done during the snack time routine of the classroom for 5 to 8 consecutive weekdays (M-TH). Additionally, specific dates were determined for videotaping the sessions for later analysis. Questions from both the early childhood special education (ECSE) teacher and parents were answered during this time. The ECSE teacher, Linda, parents, program director, and researcher agreed to communicate changes to this schedule in advance by using email, texting, or phone to ensure that all parties were kept informed.

Child. The participant in this study was David, a 40 month-old male with a primary diagnosis of Pervasive Developmental Disorder (PDD). David's parents reported a typical birth and uneventful pregnancy with the exception of his mothers' pregnancy induced hyperthyroidism. He was reported to be developing typically, although he had a history of ear infections. For instance, David met developmental milestones on time, such as walking, and early language and communication milestones, such as waving "bye-bye," and saying "mama," and "dada."

At approximately 17 months of age, however, David's communication, particularly his verbal skills, appeared to stall and regress. He no longer used words he had previously used. At that time, his family physician diagnosed David's developmental delay. Within a few weeks, David received early intervention services through Part C of IDEA. Specific services will be outlined later in this section. Seven months later, at 24 months of age, David was enrolled in private program where he continued to receive Part C services. Upon transitioning from Part C

services at 36 months to Part B services, David's parents declined intervention services through the local school district (i.e., Part B Section 619 of IDEA). David's parents indicated believing services offered through the local school district were not intensive enough to meet David's needs and, instead, continued in the same private early intervention program.

At approximately 28 months, David's parents consulted with a neurologist concerning his development. The neurological exam and imaging indicated atrophy of the frontal lobe, which was believed to explain his regression of skills. David was prescribed Namenda (i.e., Memantine Hydrochloride), by his neurologist, which is commonly prescribed treatment of moderate to severe dementia of the Alzheimer's type. David's parents reported developmental improvements in response to the drug. He began to produce sounds, words, and imitate phrases. Since David had been taking Namenda for 10 months prior to this study any changes noted in his behavior specific to the research questions are not considered attributable to Namenda.

At the beginning of the study, David had been in his current classroom setting for 4 months transitioning in at 36 months of age. In the classroom setting, David and his four classmates were identified with pervasive developmental delays or identified on the autism spectrum. The children's daily schedule included circle time, work time, hand washing/toileting, snack time, book reading, and playground time. Each week, David received the following services specifically developed for his needs: (a) one 30-minute session with a physical therapist; (b) one 30-minute session with a music therapist; (c) two 30-minute sessions with an occupational therapist, (d) five

30-minute sessions with speech language pathology services; and (e) four 30-minute sessions of applied behavior analysis intervention sessions. The 6-½ hours of specialized services were provided within the classroom context. The physical, occupational and speech language pathology therapists provided their services individually or in groups and left the classroom after their sessions. The ECSE was the only staff who facilitated the picture communication system.

The individualized services as well as the communication system that David was expected to use were tailored to his needs. David used picture communication symbols to communicate choices during snack and meal times. His ECSE teacher reported that David had been using picture symbols for slightly more than a year, approximately 14 months, since he was 26 months old. The picture symbols were laminated color line drawings approximately 2 by 2 inches with a Velcro back. The choice-making board on which the symbols were placed was the outside cover of an 8 ½ by 11 inches three-ring binder with four vertically-placed Velcro strips. His communication system, thus, consisted of placing several picture communication symbols appropriate to the task or activity in which he was preparing to participate. For example, at the end of circle time and in preparation for transition to centers, picture symbols for activities for communicating activity preferences were provided, and during snack time the choices consisted of 5-6 picture symbols of the available snack items (i.e., gluten free crackers, pretzels, cookies, dried fruit, cereal, applesauce, pudding, juice). The teaching assistant placed the unused symbols within a plastic bag on the inside of the three-ring notebook.

Adult. David's ECSE teacher, Linda, routinely worked with David during the snack time routine and therefore met the inclusion criteria. Linda's role as the ECSE was to provide daily planning and facilitating those plans for the children in the classroom. Linda agreed to participate in all sessions. She was a 35 year-old woman who holds a Masters in Special Education, a teaching license in Early Childhood/Early Childhood Special Education, and certification as a Board Certified Behavior Analyst. Linda had worked for the private early intervention program for five years and had previous experience as a private behavioral consultant. At the time she participated in this project, Linda had experience working with David daily as his ECSE teacher for four months.

Research Staff. The researcher was assisted by three doctoral students in special education, two of whom served as videographers and one of whom served as reliability coder. The primary researcher discussed the purpose of the study, each participant's role, and timeline for data collection with the program director, ECSE teacher, and David's parents. The researcher also served as the primary data coder and conducted the training for the reliability coding. Two of the research staff served as videographers because they had previous experience with the hand-held video camera equipment and classroom videographing. They were given verbal and written instructions for the classroom placement of the video equipment and the recording procedures. The videographers were non-intrusive and influenced neither the interactions nor the data collection. The reliability coder was a doctoral candidate in special education with an emphasis in early childhood development. She had

extensive experience with observational data collection procedures, coding, and reliability assessment. The specifics of reliability coder training are provided later in this chapter.

Classroom Setting. The research setting was the child participant's regular, self-contained classroom for children ages 36-60 months who were expected to benefit from a structured applied behavior analysis intervention approach. As a general rule, the program implemented a gluten-free diet and supported parents in providing the same diet for their children in the classroom as was provided at home. The class, at the time of the study consisted of four boys and one girl with developmental delay/disabilities. Adults in the classroom included one ECSE teacher, Linda, and three assistants. The children attended class three hours a day, five days a week. Their daily routine included circle time, work time, hand washing/toileting, snack time, book reading, and playground time, in this order. Therapists provided specialized services such as OT, PT, and Speech to students individually as part of the classroom routine. Data collection for the study occurred during the snack time routine, which typically lasted between 20-30 minutes with all children and the four adults, i.e., teacher and teaching assistants, present. Specialized services were not provided during data collection.

Experimental Procedures

This study's main feature consisted of alternating between two 10-minute conditions during the comparison phase, the 20-minute snack time session: (a) the AT condition during which the device was available and (b) the non-AT condition during

which the AT was not available. A multi-element single case design was implemented with the adult/young child dyad during the snack time sessions to compare the quality of adult/young child interactions when the AT device was available (i.e., Condition 1) and when the AT device was not available (i.e., Condition 2).

Baseline phase. Prior to the comparison phase, a baseline phase was implemented to better understand the status of AT use by the young child. Thus, the baseline phase was an examination of “practice, as is” This means that the researcher did not introduce, change, or alter the routine during the baseline, but rather observed the use of AT during the snack time routine. To gather this information, three strategies were used in the following order: (1) observation with anecdotal notes; (2) a brief follow-up interview with the adult, the ECSE teacher, Linda, and (3) adult/young child social interaction rating of a video-taped segment of the snack time activity using an adapted version of the *Indicators of Parent Child Interactions* (IPCI) (Baggett, Carta, & Horn, 2004) tool. Note that specific information about this measure is provided in the “data collection procedures” section. All three strategies were implemented and completed across the two-day baseline phase.

The summarized anecdotal notes of the observations provided a rich description of the snack-time routine in the classroom. The descriptions give context and depth to the child-adult and adult-child conversations and interactions. Transition to the snack time activity began with the children being called to the table individually from circle time by Linda. Each child then entered the hand-washing

area and was helped by an assistant teacher to ensure proper hand washing. After hand washing each child was seated at the table in their assigned seat. David located his seat at the kidney shaped table with verbal and physical prompting. Snack time began with Linda, ECSE teacher speaking to the group as a whole and introducing the items available for snack. Each child had their individual AT device placed directly in front of them. Teaching assistants were seated directly behind the children, providing individual support (i.e., verbal prompt, physical prompt, and physical assistance) as needed.

The role of the teaching assistant was (1) to place picture symbols on the board as the teacher introduced each snack item and then (2) to remove the picture symbols from the individual child's board as the item became unavailable, and (3) if a child began to move away from the table or visually wander from the snack time routine, the assistant physically prompted or physically assisted the child back to the table for engagement with the snack time routine. Snacks were not placed on the child's plate until the child requested an item. The snack time routine typically started once the children were all seated and lasted approximately 20 minutes.

The summarized anecdotal notes taken by the researcher also served as a guide for conducting the brief interview with the adult, the ECSE teacher Linda. The researcher asked the following questions for clarification: (a) "Were the observed sessions typical of the snack time routine?" (b) "Did anything particularly change in the presence of the researcher?" and (c) "Did David demonstrate typical use of his AT device?" Linda, the ECSE teacher, verified that the routine was typical and that the

presence of the researcher did not alter the essence of the snack time routine. She acknowledged that David demonstrated efficient use of his AT device with only minimal prompting. She also noted that he repeatedly initiated successful requests for snack items with his AT device throughout the episodes as was typical of his snack time routine.

Finally, as noted, the *IPCI* (Baggett et al., 2004) adult/young child interaction rating tool was used on the videotaped baseline snack session in order to understand level and quality of the social interaction during a typical snack session. The coding for the baseline phase was conducted in the same manner as the coding for the snack session. Specifics regarding the tool and video coding procedures are presented later in this section. Analysis of the quality of the social interaction during the baseline phase will be presented in the results section.

Comparison phase. In a multielement single-case design, experimental control is demonstrated when the response quality (i.e., quality of the adult/young child interaction) varies by conditions (i.e., Condition 1: AT and Condition 2: non-AT) such that a consistent difference occurs in the level and/or trend of respective data patterns (Kennedy, 2005). For the current study, it was hypothesized that the level and quality of social interaction between the adult and the child would be consistently higher and of a better quality during the AT condition than during the non-AT condition.

The AT condition was defined as David having access to his device in order to make snack choices and communicate his choice. The AT condition began during

snack time when the AT device, the communication binder, was placed in front of David, with David seated at the table. The non-AT condition began when (a) either the adult removed the communication binder from the table and made it inaccessible and out of sight to David or (b) the session began with AT the communication binder was not placed in the sight of David until the ten minute session ended. The ending of the session was indicated to the assistant by visual cue from the researcher. As each session was timed for two conditions, each snack session was comprised of two data collection episodes. To ensure equity across conditions, the order of the two conditions were counterbalanced. Specifically, the order was balanced such that (a) an equal number of sessions occurred for each condition (i.e., two sessions with AT, two sessions without AT), and (b) an equal number of sessions began with the AT in place as did sessions without the AT in place or present. Counterbalancing is necessary in a multielement single-case design to avoid interaction and carryover effects (Hersen & Barlow, 1978). (See Appendix B for the counterbalanced schedule).

Data Collection Method

Data collection procedures involved two different observation rating scales (i.e., *IPCI* and *STARE*) and a partial interval recording procedure. Measures are presented in the following sections as they apply to the four research questions. (See Table 6 for the organization of the research questions and alignment of each measure with the expected outcome data.). Thus, first the *IPCI* (Baggett, Carta & Horn, 2004) will be presented for addressing the first and second research question. Next, the

partial interval recording procedure will be described to address the third research question. Finally, the *STARE* (McWilliams, 2000) will be presented for addressing the fourth research question. Data coding procedures and interobserver agreement for each measure or data collection procedure will be provided in the following sections.

IPCI. The Indicator of Parent-Child Interaction (*IPCI*) (Baggett et. al., 2004) is a rating scale designed to measure the quality of parent and child interactions, and for ways in which the involved adults' responses promote positive social-emotional behaviors in the child. The *IPCI* assesses the quality of the parent-child interaction in two domains: parental/caregiver and child. Each domain is further divided into subdomains such that the parental/caregiver domain, which includes subdomains of parental/caregiver facilitators and interrupters; and the child domain, which includes subdomains of child engagement and child reactivity/distress.

The parental/caregiver subdomain, called facilitators, is “comprised of five key elements, which include acceptance/warmth, descriptive language, following child’s lead, introducing/extending child’s interest and stress reducing strategies” (see Appendix C for *IPCI* scoring sheet) (Baggett et. al., 2006, p70). The parental/caregiver subdomain interrupters include “three key elements: critical comments/voice tone, restrictions/intrusions, and rejecting child bids for support” (Baggett et. al., 2006, p. 70). In contrast, the child subdomain, engagement, is “comprised of positive feedback, sustained engagement, and follow-through” (Baggett et. al, 2006, p. 71). The difficulty subdomain, referred to as distress, includes “overwhelmed by negative affect, externalizing behaviors, such as tantrums

and internalizing behaviors such as withdrawing from interactions” (Baggett et al., 2006, p. 71). Behaviors were scored on a 4-point scale where 0 = Never; 1 = Rarely/Mild; 2 = Sometimes; 3 = Often/Severe and N/0 = No Opportunity. Scoring was determined by reviewing the 10-minute segment and by tallying on the score sheet to keep “a sense” of how often demonstrations of behaviors occurred. The tallies are not intended to determine scoring but rather provide guidance as to frequency.

Baggett and Carta (2006) assessed 65 children over 350 observations in the psychometric property development of the *IPCI* (2006). Overall domain interobserver agreement was at 87.4% based on 49 observations. However, agreement on the child domains was at 91.2%, which was higher than the interobserver agreement on the parent domains (84.8%). The test retest reliability for caregiver subdomains, facilitators, and interrupter was high at .926 and .928 respectively. The child engagement and child distress subdomains each had lower test retest reliability. The scores were at .767 and .367 respectively. Further description related to the social validity and criterion-related validity may be found in Baggett & Carta, 2006.

As shown in Table 6, the *IPCI* measure was used to answer research question one and two. Consequently, the following section will address research questions 1 and 2 by identifying specific subcomponents of the *IPCI* that are linked to the question, then move to describing the data coding procedures and interobserver agreement for those subcomponents.

Research question 1-adult social interactions. The first research question was: “Does the quality of the adult social interactions improve when the AT device is

present than when the device is not present?”. To answer the first research question, the researcher examined the parental/caregiver domain ratings of the *IPCI* (Baggett et al., 2004) and whether there were (a) higher ratings for the AT condition on the *IPCI* caregiver facilitation domain (i.e., acceptance/ warmth, descriptive language, follows child lead, maintains and extends, and stress reducing strategy) and (b) lower ratings on the *IPCI* caregiver interrupter domain (i.e., criticism, harsh voice, restrictive/intrusions, reject’s child bid).

Research question 2-child social interactions. To answer the second research question, “Does the quality of the young child’s social interactions improve when the AT device is present than when the device is not present?” the two *IPCI* (Baggett et al., 2004) sub-domain ratings of the child domain were used. That is, the researcher coded the child engagement subdomain items (i.e., positive feedback, sustained engagement, follow-through) in order to assess whether AT use resulted in higher levels of child engagement. The researcher also coded the child reactivity/distress subdomain (i.e., irritable/fussy /cry, external distress, frozen/watchful/ withdrawn) with the expectation that the child would receive a lower rating when the AT device was in place.

Data coding for IPCI. Coding for both the adult and child social interaction was completed by the researcher. First, the researcher reviewed the items for the specific domain to be scored (i.e., parent/caregiver domain or child domain) including the item definitions provided in the *IPCI* manual (Baggett et al, 2004). Second, the researcher viewed the video recording and marked tally marks on the rating sheet

next to each *IPCI* item when an item example was observed. Immediately afterwards, each of the domain items was scored by the researcher using the *IPCI* rating sheet, which was based on behaviors observed across the full episode.

This process was repeated with the second domain. All items were scored on a 4-point scale of relative frequency, where 0 = never, 1 = rarely, 2 = sometimes or inconsistently, and 3 = often and consistently. For example, if the adult did not make any descriptive comments during the observation, a score of '0' was assigned for the parental/caregiver domain, adult facilitation subdomain, item # 2: descriptive language.

The parental/caregiver domain consisted of two subdomains: adult facilitation and adult interrupters. The adult facilitation subdomain consisted of five items, acceptance/warmth; descriptive language; follows child's lead; maintains and extends and stress reducing strategies. The adult interrupters subdomain consisted of three items, harsh criticism, restrictions/ intrusions, and rejects child bid.

The child domain consisted of two subdomains, child engagement and child reactivity/distress. The child engagement subdomain contains three items, positive feedback, sustained engagement, and follow-through. The child reactivity/distress subdomain contains three items also, irritable/fuss/cry, external distress, and frozen/watchful/withdrawn.

Adult and child behaviors were coded on a Likert scale ranging from 0 (i.e., never) to 3 (i.e., often). Scores were added for each domain separately (e.g. caregiver facilitator behavior, caregiver interrupter, child engagement, child distress). The total

for each domain were added together and divided by the possible total for each individual domain and used to calculate an overall percentage of that behavior. The percentage was calculated by totaling the scores across the sessions and divided by the overall score possible. Each score for that particular domain, was hand graphed for examination of a clear comparison between scores for the AT and non-AT conditions.

Interobserver agreement for IPCI. The researcher was the primary data coder and coded all sessions. A second trained observer who was naïve to the specific experimental procedures of the study conducted reliability coding. The researcher trained the reliability coder using the following procedures in the following order:

1. The researcher provided the reliability coder with a copy of the *IPCI* User's Manual (Baggett et al, 2004) and a copy of the adapted *IPCI* rating sheet (i.e., adapted to for only one activity – snack time rather than the four activities on the *IPCI* rating form.
2. After the reliability coder read the provided material, the researcher discussed the coding process, answered questions, and provided clarification.
3. The reliability coder and researcher practiced coding by using video samples available through the *IPCI* training.

4. The researcher, as primary coder, and the reliability coder completed the *IPCI* practice coding, and when a minimum criterion of 85% for each subdomain was attained, each began coding the study video episodes.

Interobserver agreement scores were calculated with the following formula:

Percent Agreement = $\left[\frac{\text{Number of Agreements}}{\text{Number of Disagreements} + \text{Agreements}} \right] \times 100$. Interobserver reliability was assessed on 25% of the sessions. Specifically, 25% (i.e., 1 of 4) of the sessions in the baseline phase; 25% (i.e., 2 of 8) of the AT sessions and 25% (i.e., 2 of 8) of the non-AT sessions during the comparison phase were coded by two observers to assess interobserver reliability.

For the *IPCI* measure, the overall interobserver agreement was 93% (range 90-100%). Specifically for the caregiver ratings, the agreement for the caregiver facilitators was 90% (range 80-100) and for the caregiver interrupters was 100%. For the child ratings agreements for child engagement was 92% (range 90-98) and child distress was 92% (range 90-96).

Research question 3-child social initiations. The third research question was: “Does the frequency of the young child’s social communication behavior increase with the presence of an AT device than when the device is not present?” To answer this third research question, the researcher used a partial-interval recording procedure to record the child’s social initiation attempts. Social initiation attempts included conventional and unconventional communication (e.g. jargon, echolalia, hand leading), linguistic and prelinguistic communication (e.g., reaching and

grabbing, eye gaze, crying, facial expressions, body postures, vocal approximations, pointing).

Observational partial interval data coding. A partial-interval observation recording procedure was used to estimate the frequency and duration of child social initiations with the adult in both conditions. Partial interval recording is an interval recording method, which involves observing the occurrence and nonoccurrence of relevant behavior during the test periods. For this recording method in general, the length of an observation session is identified, and the time is broken down into smaller, equally long intervals. Using this method in this study, the researcher divided each 10-0minute observational session into 10-second intervals. The intervals needed to be long enough to allow for demonstration of the behavior of interest, and short enough to allow for the maximum number of ratings, on the other hand. The decision was based on the assumption that the smaller the time interval, the more accurate the estimate of the occurrence of the behavior (Kennedy, 2005; Powell, Martindale & Kulp, 1975). In partial interval recording, the observer marks down whether a behavior occurs any time during the interval by documenting a "+" for occurrence and a "-" for nonoccurrence. The child may engage in a behavior multiple times during the interval or only once for a "+" to be documented. Partial interval observation procedures are particularly useful for behaviors that do not have a clear start and end (Kennedy, 2005). Interval observational systems also have the advantage of allowing for more precise statements of interobserver agreement by permitting computation of point-by-point reliability. Once the recording is complete,

the observer counts the number of intervals in which the behavior was observed and a percentage of intervals with the behavior is documented.

For this study, the videotaped sessions were edited so that a visual and audible cue was provided every 10 seconds to cue the coder to move to the next recording interval on the data sheet. If at any point during the ten-second interval the coder observed the child behavior, a plus (+) was entered on the data sheet for that interval. If the 10-second interval ended with no instance of the child behavior, the coder recorded a minus (-) and moved to the next interval.

Interobserver agreement for partial interval observation coding. The researcher was the primary data coder and coded all sessions. A second trained observer who was naïve to the specific experimental procedures of the study conducted reliability coding on a subset of episodes. The researcher trained the reliability coder using the following procedures:

1. The researcher provided the reliability coder with a copy of the definitions and reviewed a sample video clip not being coded for reliability.
2. After the reliability coder read the material provided, the researcher discussed the coding process with the coder, answered any questions, and provided clarification.
3. The reliability coder and researcher practiced coding using the video clip.
4. The reliability coder completed the practice coding and proceeded then to the video coding.

5. Interobserver agreement was assessed for two (i.e., one AT and one Non AT) of the eight sessions or for 25 percent of the coded episodes.

Interobserver agreement was calculated by the number of agreements/(number of agreements + disagreements) x 100. Interobserver agreement for the child social communication behaviors was 96% for the AT episode and 98% for the non-AT episode.

STARE. The Scale of Teachers' Assessment of Routine Engagement (STARE) (McWilliam, 2000) is a rating scale for measuring child engagement levels and interactions within the context of classroom routines. Authors, Casey and McWilliam (2007) reported that *STARE* ratings are accurate and equally valid as the Engagement Quality Observation System III (E-Qual III) (McWilliam & de Kruif, 1998). The E-Qual III is a momentary time-sampling device for coding children's observed engagement levels (i.e., sophisticated, differentiated, focused attention, unsophisticated, and non-engagement). Casey and McWilliam reported that the *STARE*

“can be a useful way to obtain valid readings of children's participation in classroom activities, for structured activities, there was 100% agreement (within one rank) between (a) the teacher's rank order and her STARE ratings for each child and (b) the teacher's rank order and the E-Qual III data. For two children, there was 100% agreement between the level of engagement we observed the child to display for the most amount of time and the teacher's STARE ratings; for the other three

children agreement within one rating was 100%, 100% and 91%” (Casey & McWilliam 2007, p. 13).

The researcher used the *STARE* to answer research question four, and as such the following section will address the research question, data coding, and interobserver agreement. The researcher made adaptations to the *STARE* for the purposes of assessing more subtle changes in engaged time and complexity of engagement across repeated measures. The primary adaptation for this study was to add descriptions and exemplars to the *STARE* rating system. The *STARE* is comprised of two components, engagement, and complexity. The researcher accomplished the engagement scoring by observing the video recorded episode and determining the rating. The engagement for the current study indicates the child engagement within the snack time routine and, more specifically, the engagement during the routine with the adult.

At the end of a 10-minute observation, the researcher in the role of the observer completed estimations of the percent of time that the child was engaged in the activity using the 5-point scale. Figure 10 provides the guide for the observer, including (a) the *STARE* definition for engaged and nonengaged behaviors and specific rating options, and (b) a definition for each rating option for the *STARE* duration of engagement.

A second rating feature of the *STARE* is engagement complexity. This rating is separate from the first. Again a continuum is used for rating complexity. In this case, only the engaged behaviors are considered. Specifically, the observer after

viewing the 10 minute session rated the child's complexity of engagement using the following 4-point scale: 1-*nonengaged*; 2-*unsophisticated*; 3-*average*; and 4-*advanced* (see Figure 10 for specific examples of each rating).

Research question 4 – child engagement and complexity. To answer the fourth and final research question, “Does the child’s level of engagement increase in frequency and complexity when the AT device is present than when the device is not present?” the researcher used the *STARE* (McWilliam, 2000). The application of the *STARE* targeted the engagement during snack time with the adult/young child dyad. As noted earlier, the *STARE* rating of the child’s engagement was rated ranging from *almost none of the time* to *half the time* to *almost all of the time*. Similarly, the *STARE* definition of complexity was used to rate how David spent the majority of his “engaged time” during the snack time routine. This means that the complexity was rated as either *nonengaged* (e.g. David staring off, crying), *unsophisticated* (e.g. banging spoon, random movement of objects), *average* (e.g., typical interaction with materials or typical mealtime behaviors, or *advanced* (e.g., makes, builds, or uses contextually bound language).

Data coding procedure for STARE. Each AT and non-AT episode was viewed and scored for snack time routine engagement and complexity. Coding was completed by the coder first reviewing the rating form (see Appendix D for the *STARE* coding sheet) for the specific definitions and rating options for both engagement and complexity. The researcher then viewed the complete 10-minute video recording making tally marks and notes on the rating form. Immediately

following the viewing of the video episode, each section of the rating form was rated by the researcher based on the behaviors observed across the full episode.

Interobserver agreement procedure for STARE. The researcher was the primary data coder and coded all sessions. A second trained observer who was naïve to the specific experimental procedures of the study conducted reliability coding on a subset of sessions (i.e., two of eight, 25%). The researcher trained the second coder using the following procedures:

1. The researcher provided the coder with a copy of the definitions and reviewed a sample video clip not being coded for reliability.
2. After the coder read the provided material provided, the researcher discussed the coding process, answered questions, and provided clarification.
3. The coder and researcher practiced coding using the video clip.
4. The reliability coder completed the practice coding and proceeded then to the video coding.
5. Interobserver agreement was assessed for two (i.e., one AT and one Non AT of the eight sessions or for 25 percent of the coded episodes for child engagement. Interobserver agreement was calculated by the number of agreements/(number of agreements + disagreements) x 100. Interobserver agreement for the child engagement behaviors was 100% for the AT episode and 100% for the non-AT episode. Interobserver agreement was

assessed for two (i.e., one AT and one Non AT of the eight sessions or for 25 percent of the coded episodes for child engagement.

6. Interobserver agreement was assessed for two (i.e., one AT and one Non AT of the eight sessions or for 25 percent of the coded episodes for complexity. Interobserver agreement was calculated by the number of agreements/(number of agreements + disagreements) x 100. Interobserver agreement for the complexity was 100% for the AT episode and 100% for the non-AT episode. The sessions coded for complexity were the same sessions coded for child engagement but not coded at the same time.

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Table 6

Research Question by Measure and Outcome Data

Research Question	Measure	Outcome Data
Is the quality of the adult's social interactions of higher quality when the AT device is present than when the device is not present?	IPCI Caregiver Items	Higher rating in IPCI caregiver facilitation (i.e. acceptance/warmth, descriptive language, follows child lead, maintains and extends, stress reducing strategy) Lower rating in IPCI caregiver interrupter (i.e. criticism, harsh voice, restrictive/intrusions, reject's child bid)
Is the quality of the young child's social interactions of higher quality when the AT device is present than when the device is not present?	IPCI Child Engagement and Reactivity/Distress Items	Higher rating in IPCI Child Engagement (i.e. positive feedback, sustained engagement, follow through) Lower rating in IPCI Child Reactivity/Distress (i.e. irritable/fuss/cry, external distress, frozen/watchful/withdrawn)
Is there an increase in the frequency of the young child's social initiations with the presence of an AT device than when the device is not present?	Partial interval Recording	Higher rate of occurrence of social initiations
Is the child's level of engagement higher and of greater complexity when the AT device is present than when the device is not present?	STARE-modified engagement and complexity items	Higher rating in STARE-modified engagement (i.e. with adult; with materials) Higher rating in STARE-modified Complexity (i.e. nonengaged, unsophisticated, average, advanced, sophisticated)

APPENDICES

APPENDICES

APPENDIX A: Parent Questionnaire

Directions: The following questionnaires are designed to ask you about your child's information, current mealtime routine, the feeding skills of your child with a disability and AT device in order to ensure if your child meets the criteria established for participation in this study. Please fill in the blank or check the most appropriate match with your answer. Thank you!

Child Information

Child's name: _____

Gender: M F

Age: _____ years _____ months

Services your child with a disability receives:

____ Early childhood special education (ECSE)

____ Speech, language, hearing (SPL)

____ Occupational Therapy (OT)

____ Physical Therapy (PT)

____ Music therapy

How would you describe your child's disability or developmental delay?

Assistive Technology Device Questionnaire

Please fill in the blank or check ☒ the most appropriate match with your answer.
Thank you!

The AT device the child uses can best be described as a (an):

_____ adapted feeding device (e.g. built-up spoon; oversized utensil)

_____ mobility device (e.g. walker, wheelchair)

_____ communication device (e.g. Big Red; Intertalk, choice board)

_____ other: please describe _____

APPENDICES

APPENDIX B: Counterbalance Schedule

AT Condition Counterbalance Schedule:

Session	Condition
Baseline	AT in place
Baseline	AT in place
Baseline	AT in place
Baseline	AT in place
1	NAT
	AT
2	AT
	AT
3	AT
	NAT
4	NAT
	AT
5	AT
	NAT
6	NAT
	NAT

APPENDICES

Appendix C: *IPCI* Scoring Sheet

IPCI Scoring Sheet

Indicator of Parent Child Interaction (IPCI) Rating Sheet

Child Code:		Overall Never = 0 Rarely/Mild =1 Sometimes = 2 Often/Severe =3
Setting:		
Caregiver Facilitator	Acceptance/Warmth	0 1 2 3
	Descriptive Language	0 1 2 3
	Follows Child Lead	0 1 2 3
	Maintains and Extends	0 1 2 3
	Stress Reducing Strategy	0 1 2 3
Caregiver Interrupters	Criticism/Harsh Voice	0 1 2 3
	Restrictions/Intrusions	0 1 2 3
	Rejects Child's Bid	0 1 2 3
Child Engagement	Positive Feedback	0 1 2 3
	Sustained Engagement	0 1 2 3
	Follow Through	0 1 2 3
Child Reactivity/Distress	Irritable/Fuss/Cry	0 1 2 3
	External Distress	0 1 2 3
	Frozen/Watchful/Withdrawn	0 1 2 3

Never =0 (Never)

Rarely/Mild =1(Once; Mild for Cg Interrupters and Child Distress

Sometimes = 2 (Inconsistent)

Often/Severe = 3 (Often, Consistently); Severe for Cg Interrupters and Child Distress

No Opportunity = N/O No opportunity to observe

APPENDIXES

Appendix D: *STARE* coding sheet and instructions

STARE* Modified

Guide to Rating the Amount of Time Spent Engaged in Activity

1) Make notes in the comments section of the protocol regarding the child's engagement/non-engagement using the following definitions/observable behaviors

•**Engaged** – eyes on teacher; responding verbally or nonverbally to teacher's questions; following teacher directions; engages in choral responding; raising hand, nodding head, shaking head, leaning toward and other no-verbal body language indicating interest in and attendance to activity.

•**Nonengaged** - wandering physically and/or visually; staring into space; engaged in inappropriate behaviors such as aggression, crying etc.; repetitive vocalizations and or physical behaviors; unrelated to activity; casually looking around

2) At the end of 10 minute observation make an estimate of the % of time that the child was engaged in the activity using the 5 point scale and circle appropriate item on protocol

Rating	Description of Rating
1 – Almost None of the Time	Less than 30 seconds (approximately 5%)
2 – Little of the Time	45 seconds (approximately 7.5%) to 4 minutes (approximately 39%)
3 – Half of the Time	4 minutes (approximately 40%) to 5 minutes (50%)
4 – Much of the Time	5 minutes (approximately 51%) to 8 minutes (80%)
5 – Almost all of the Time	Over 8 minutes (more than 80% of the time)

*Adapted from McWilliams, R. A. (2000). Scale for Teachers' Assessment of Routines Engagement (STARE). Chapel Hill: Frank Porter Graham Child Development Center, University of North Carolina at Chapel Hill.

Guide to Rating the Complexity of Engagement in Activity

1) Make notes on the comments section of the protocol regarding the characteristics of the child's engagement during the observation.

2) At the end of the 10-minute session rate the child's complexity of engagement using the following 4 point scale and definitions.

Rating	Description of Rating
1 - Nonengaged Unoccupied behaviors or behaviors that interfere with engagement with activity.	<ul style="list-style-type: none"> • No/limited eye contact with the teacher and/or prolonged looking at other, non-related activities (e.g. their friend beside them, other areas of the classroom) • Unoccupied behaviors such as staring off • Sits in a manner that makes it difficult for them to see or listen • Behaviors that are interfering with listening (e.g. crying, repeatedly getting up, spacing out) • Encourages others around them to also be unengaged (e.g. talking to them, touching them)
2 - Unsophisticated Basic level of engagement that sets the sets the occasion for being engaged	<ul style="list-style-type: none"> • Keeps hands to self • Waits to respond • Needs prompting including verbal, gesture, touch • Limited responses to questions posed by the teacher and/or answers with responses that are off target (e.g. limited extension of picture symbol)
3 - Average In general if child is doing what is expected of him or her (use developmental appropriate expectations here)	<ul style="list-style-type: none"> • Sits in a manner that allows them to listen to teacher (e.g. body shifted to look at the teacher) • Follows routines with no prompts • Participating appropriately with expectations of activity • Follows directions with no prompts • Answers questions posed by the teachers in a manner that relates to the activity with no prompts • Makes eye contact with the teacher without prompt • Responds appropriately to the activity (e.g. making comments, asking questions, laughing, gasping)
4 - Advanced Child initiates questions about activity or materials	<ul style="list-style-type: none"> • Shows excitement for activity • Encourages others around them to listen and participate in the book (e.g. pointing to teacher, not engaging in other discussions) • Using key vocabulary words in questions or conversations • Sharing ideas about how the book/activity concepts relate to their lives • Initiates requests/commenting/ interactions

Scale of Teacher's Assessment of Routines Engagement (STARE) Modified*

Child Name:		Date:		Time:	
Activity Number and Type:			Number of Children:		
Amount of Time Engaged in Activity	Almost none of time 1	Little of the Time 2	Half of the Time 3	Much of the Time 4	Almost all of time 5
Comments:					
Complexity of Engagement	Nonengaged 1	Unsophisticated 2	Average 3	Advanced 4	
Comments:					
Contextual Notes:					

CHAPTER 4: RESULTS

The purpose of this study was to examine the impact of AT on the social interactions between an adult and young child dyad. Four primary questions were addressed in the `research: (1) Does the quality of the adult social interactions improve when the AT device is present than when the device is not present? (2) Does the quality of the young child's social interactions improve when the AT device is present than when the device is not present? (3) (4) Does the frequency of the young child's social communication behavior increase with the presence of an AT device than when the device is not present? Reporting of the results is organized around these four questions.

Research Question 1-Adult Social Interactions

To address the first research question related to the impact of the AT device on the quality of the adult social interaction, data gathered from the *Indicator of Parent-Child Interaction* (IPCI) (Baggett, Carta, Horn, 2004) were analyzed. As noted earlier, the *IPCI* (Baggett, et. al., 2004) is a rating scale designed to provide information about parent and child interactions and ways in which parents or other primary caregivers respond to the child, which promote or inhibit positive social-emotional behaviors. (The term adult will be used as the term is indicative of the examined primary caregiver relationship). While the *IPCI* assesses the quality of the adult-child interaction by rating both the caregiver's behavior and the child's behavior, for this research question only the ratings of the caregiver behavior were

used. Furthermore, the adult behavior ratings on the *IPCI* were divided into the two domains of facilitators and interrupters.

Caregiver facilitator behaviors. The facilitation domain are further divided into 5 items for rating the adult facilitative behaviors of: (1) Demonstration of acceptance/warmth; (2) Use of descriptive language; (3) Following child's lead; (4) Maintains and extends interaction and (5) Use of stress reducing strategies. Higher ratings (i.e., 4-point scale (i.e., 0-3) of relative frequency, where 0 = never, 1 = rarely, 2 = sometimes or inconsistently, 3 = often and consistent), in each of these 5 facilitator items indicates a more positive adult-child interaction.

As noted earlier, with a multielement single case design, the researcher was able to compare the effects of two different conditions (i.e., AT and non-AT) on the behavior of focus (i.e., caregiver facilitative behaviors) (Tawney & Gast, 1984). To compare the two conditions, data for each condition are plotted separately on a single graph and visual inspection was used to determine if one condition is consistently associated with a different rating level of the target behavior. Thus, as shown in Figure 3, for caregiver facilitator behaviors the mean ratings across the 5 facilitator items are presented for AT and non-AT conditions. In viewing Figure 3, not only are the ratings of caregiver facilitator behaviors greater (i.e., more positive) during the AT than during the non-AT condition but also there is no overlap between the ratings. Visual inspection thus provides strong support for the availability of the AT device having a positive impact on the use of facilitative behaviors by the adult.

The magnitude of the difference can also be assessed by comparing the rating means and ranges as presented in Table 6. The overall mean rating (i.e., mean rating across the 5 facilitator items) across all AT sessions was 2.67 (range 2.25-2.75) where a rating of 3.00 represents that the adult often and consistently engaged in positive and facilitative interactions with the child. The mean rating for facilitator items across all non-AT sessions was 1.25 (range 1.00-1.75) where a rating of 1.00 indicates that the adult rarely engaged in facilitative interactions with the child. When comparing the adult mean ratings of facilitator behaviors under both conditions (i.e., AT versus non-AT) again a marked difference is evident with the adult providing a higher frequency of facilitator behaviors during the AT sessions. A mean difference score of 1.42 calculated by subtracting the non-AT mean (i.e., 1.25) from the AT mean (i.e., 2.67) indicates that on average the adult scored 1.42 points higher during the AT condition again confirming the positive impact of the AT condition. A final demonstration of the magnitude of differences can be seen by using the rating ranges for each condition. That is, when comparing the lowest overall rating for the AT condition (i.e., 2.00) with the highest rating for the non-AT condition (i.e., 2.00) the AT conditions' lowest rating was equal to the highest rating for the non-AT condition.

Caregiver interrupter behaviors. As previously noted the caregiver interrupter domain consisted of 3 items: (1) use of harsh criticism, (2) restrictions/intrusions, and (3) rejections of child bids. To compare the two conditions, the mean caregiver ratings across the 3 interrupter items are plotted

separately for each condition on a single graph and presented in Figure 4. Visual inspection of Figure 4 verifies that the ratings of the caregiver interruptive behaviors are slightly higher (more negative demonstrations) during the non-AT condition than the AT condition. Visual inspection thus provides support for the AT condition having an ameliorating effect on the adult interrupter behaviors.

The magnitude of the difference can also be assessed by comparing the rating means and ranges as presented in Table 7. The overall mean rating across the 3 interrupter behaviors across all AT sessions was .06 (range 0-0.33) where a 0 represents never. The overall mean rating for interrupter items across all non-AT sessions was .11 (range 0-0.17) where a 0 represents never and a 1.00 represents the adult interrupter behavior was rare. A mean difference score of 0.05, calculated by subtracting the AT mean (i.e., 0.06) from the non-AT mean (i.e., .11) indicates that on average the caregiver scored 0.05 points higher during the non-AT condition, again confirming a slight positive impact of the AT condition.

Research Question Two-Child Social Interaction

To address the second research question related to the impact of the AT device on the quality of the child social interactions, data gathered from the ratings of the child behaviors of the *IPCI* (Baggett, et al., 2004) were analyzed. The child behavior ratings are divided into the two domains of child engagement and child reactivity/distress.

Child engagement behaviors. The child engagement domain is further divided into 3 items for rating the child engagement of: (1) positive feedback (2)

sustained engagement and (3) follow through. Higher ratings (i.e., 4-point scale of relative frequency, where 0 = never, 1 = rarely, 2 = sometimes or inconsistently, and 3 = often and consistently), in each of these 3 engagement items indicates a more positive level of child engagement. To compare the two conditions, the mean child ratings across the 3 engagement items are plotted separately for each condition on a single graph and presented in Figure 5. Visual inspection of Figure 5 verifies that not only are the ratings of child engagement behaviors greater (i.e., more positive) during the AT condition than the non-AT condition, there is no overlap between the ratings. Thus, visual inspection provides strong support for the AT condition having a positive impact on the child's engagement behaviors.

The magnitude of the difference can also be assessed by comparing the rating means and ranges represented in Table 8. The mean rating across the child engagement items across all AT sessions was 2.61 (range 2.33-3.00) where a 3.00 represents that the child is often and consistently engaged in positive interactions with the caregiver. The mean rating for child engagement items, across the non-AT sessions was 1.05 (range 0.67-2.00) where a score of 1.00 indicates that the child is rarely engaged with the caregiver. When comparing the engagement mean ratings under both conditions (i.e., AT versus non-AT), a marked difference is evident with the engagement behaviors occurring at a higher frequency during the AT condition. A mean difference score of 1.56 calculated by subtracting the non-AT mean (i.e., 1.05) from the AT mean (i.e., 2.61) indicates that on average the child scored 1.56 points higher during the AT condition again confirming the positive impact of the AT

condition on child engagement behaviors. A final demonstration of the magnitude of differences can be seen by using the rating ranges for each condition. That is, when comparing the lowest rating for the AT condition (i.e., 2.33) with the highest rating of the non-AT condition (i.e., 2.00) the AT conditions lowest rating is higher than the non-AT highest rating.

Child reactivity/distress behaviors. As previously noted, the child reactivity/distress domain consists of 3 items: (1) irritable/fuss/cry, (2) external distress and (3) frozen/watchful/ withdrawn. To compare the two conditions, the mean child ratings across the 3 reactivity/ distress items are plotted separately for each condition on a single graph and presented in Figure 6. Visual inspection of Figure 6 verifies that the ratings of the child reactivity and distress behaviors, while quite low for the majority of sessions, are slightly higher (i.e., more negative demonstrations) during the non-AT condition than the AT condition. Visual inspection thus provides support for the conclusion that the AT condition may have a reducing effect on the child reactivity and distress behaviors.

The magnitude of the difference can also be assessed by comparing the rating means and ranges as presented in Table 8. The mean rating across the 3 child reactivity and distress behaviors across all AT sessions was 0. The mean rating for interrupter items across all non-AT sessions was .11 (range 0-0.33) where a 0 represents never and a 1.00 represents the child's reactivity and distress behavior was rare or mild. A mean difference score of .11 calculated by subtracting the AT mean (i.e., 0) from the non-AT mean (i.e., .11) indicates that on average the caregiver scored

.11. However, as portrayed in Figure 6, there were no instances in of child reactivity/distress behaviors with the exception of the last two sessions, both of which were in the non-AT condition. Given the low occurrence of these behaviors and the occurrences in the same day, the differences noted may be more appropriately attributed to child's disposition and not the AT condition.

Research Question 3-Child Social Communicative Behavior

To address the third research question related to the impact of the AT device on David's social communicative behavior, the partial interval recording procedure previously described was used to make an estimate of the frequency of the child's use of social communicative behaviors. Social communicative behaviors for David were defined as pointing, reaching for a desired object and/or initiating/handing the adult a picture symbol. Using a partial interval recording procedure all intervals were observed for social communicative behavior and percentage calculations were conducted for each session.

To compare the two conditions, the percent of intervals observed in which a social communicative behavior occurred in a ten-minute session mean were plotted separately for each condition on a single graph and presented in Figure 7. Visual inspection of Figure 7 verifies that not only are the occurrences of social communicative greater during the AT condition than the non-AT condition, there is no overlap between the frequency. Thus, visual inspection provides strong support for the AT condition having a positive impact on the child's use of social communicative behaviors.

The magnitude of the difference was assessed by comparing the means and ranges of the child social communicative behaviors as presented in Table 9. The mean percentage of interval occurrence for child social communication behaviors across all AT sessions was 10.56 (range 6.9-14.2). The mean percent of intervals for social communication behaviors across all non-AT sessions was 5.65 (range 0.00-6.67). When comparing the mean ratings of social communication behaviors under both conditions (i.e., AT versus non-AT) again a marked difference is evident with a higher frequency of social communication behaviors occurring during the AT sessions. A mean difference score of 4.91 was calculated by subtracting the non -AT mean (i.e., 5.65) from the AT mean (i.e., 10.56). The score difference indicates that on average the child's social communication rate was 4.91 points higher (almost twice the rate of non-AT) during the AT condition, again confirming the positive impact of the AT condition. A final demonstration of the magnitude of differences can be seen by using the ranges for each condition. That is, when comparing the lowest frequency for the AT condition (i.e., 6.9) with the highest for the non-AT condition (i.e., 6.67), the AT conditions' lowest rating is still is higher than the highest rating for the non-AT condition.

Research Question 4-Child Engagement and Complexity

Data were collected on child engagement and complexity. Child engagement was defined by the child's level of engagement with materials and the adult. As noted before, an adapted version of the *STARE* (McWilliam, 2000) rating scale was used to rate the child's engagement level and complexity. The rating of level of engagement

was completed using the following five point rating: (1) almost none of the time (i.e., less than 30 seconds/approximately 5% of the observed time); (2) little of the time (i.e., 45 seconds to 4 minutes/approximately 7.5-39%); (3) half the time (i.e., 4 to 5 minutes/approximately 40-50%); (4) much of the time (i.e., 5 to 8 minutes/approximately 51-80%); and (5) almost all of the time (i.e., over 8 minutes/more than 80% of the time). To compare the two conditions, the child's level of engagement ratings were plotted separately for each condition on a single graph and presented in Figure 8 . Visual inspection of Figure 8 verifies that not only are the ratings of child engagement greater during the AT condition than the non-AT condition, there is no overlap between the ratings. Thus, visual inspection provides strong support for the AT condition having a positive impact on the level of the child's engagement during the routine.

The magnitude of the difference between the AT and the non-AT conditions can also be assessed by comparing the rating means and ranges represented in Table 10. The mean rating across the child engagement across all AT sessions was 2.34 (range 2.00-3.00) where a 3 represents half the time 4-05 minutes or approximately 40-50%. The mean rating for child engagement, across the non-AT sessions was 1.00 (range 1.00-1.00) where a score of 1 indicated child engagement in the routine at less than 30 seconds/approximately 5% of the time. When comparing the engagement mean ratings under both conditions (i.e., AT versus non-AT) again a marked difference is evident with child engagement occurring at a higher levels during the AT condition. A mean difference score of 1.34 calculated by subtracting the non-AT

mean (i.e., 1.00) from the AT mean (i.e., 2.34) indicates that on average the child scored 1.34 points higher during the AT condition again confirming the positive impact of the AT condition on child engagement behaviors. A final demonstration of the magnitude of differences can be seen by using the rating ranges for each condition. That is, when comparing the lowest rating for the AT condition (i.e., 2.00) with the highest rating of the non-AT condition (i.e., 1.00), the AT condition's lowest rating is still higher than the highest rating for the non-AT condition.

The second rating feature of the *STARE* serves the assessment of the complexity of child engagement. The continuum ranges from a score of (1) nonengaged (unoccupied behaviors or behaviors that interfere with engagement with activity); (2) unsophisticated (basic level of engagement that set the occasion for being engaged); (3) average (in general doing what is expected; and (4) advanced (initiated questions about activity or materials).

Again to compare the two conditions the ratings for each condition is plotted separately and presented in Figures 8 and 9. Using visual inspection, again it can be seen that not only are the ratings of the complexity of the child's engagement greater during the AT condition than the non-AT condition, there is also no overlap between the ratings. Thus, visual inspection provides strong support for the AT condition having a positive impact on the complexity of the child's engagement.

Again, the magnitude of the difference can also be assessed by comparing the rating means and ranges presented in Table 10. The mean rating across the child engagement complexity across all AT sessions was 2.00 (range 2.00-2.00) where a

2.00 represents unsophisticated (basic level of engagement that set the occasion for being engaged). The mean rating for child engagement complexity, across the non-AT sessions was 1.00 (range 1.00-1.00) where a score of 1.00 indicated child engagement complexity as nonengaged (unoccupied behaviors or behaviors that interfere with engagement with activity). When comparing the complexity mean ratings under both conditions (i.e., AT versus non-AT), again a marked difference is evident with child engagement complexity occurring at a higher levels during the AT condition.

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Figure 3

Caregiver Facilitator Ratings

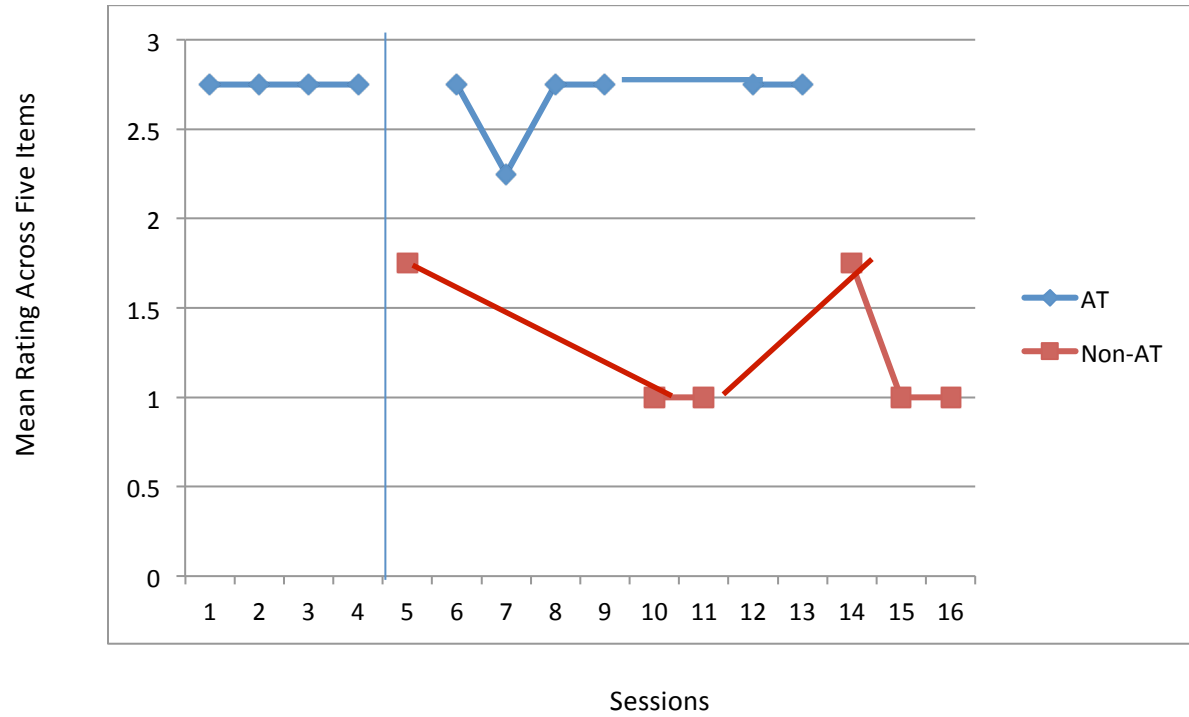


Figure 4

Caregiver Interrupter Ratings

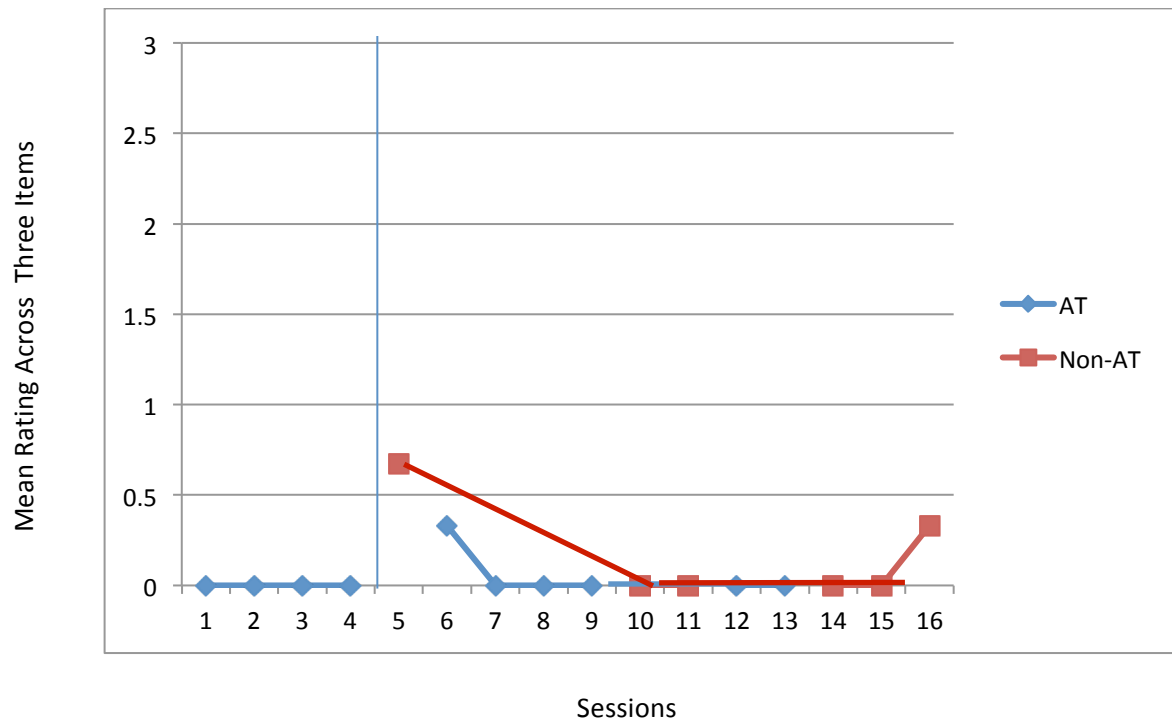


Figure 5

Child Engagement Behavior Ratings

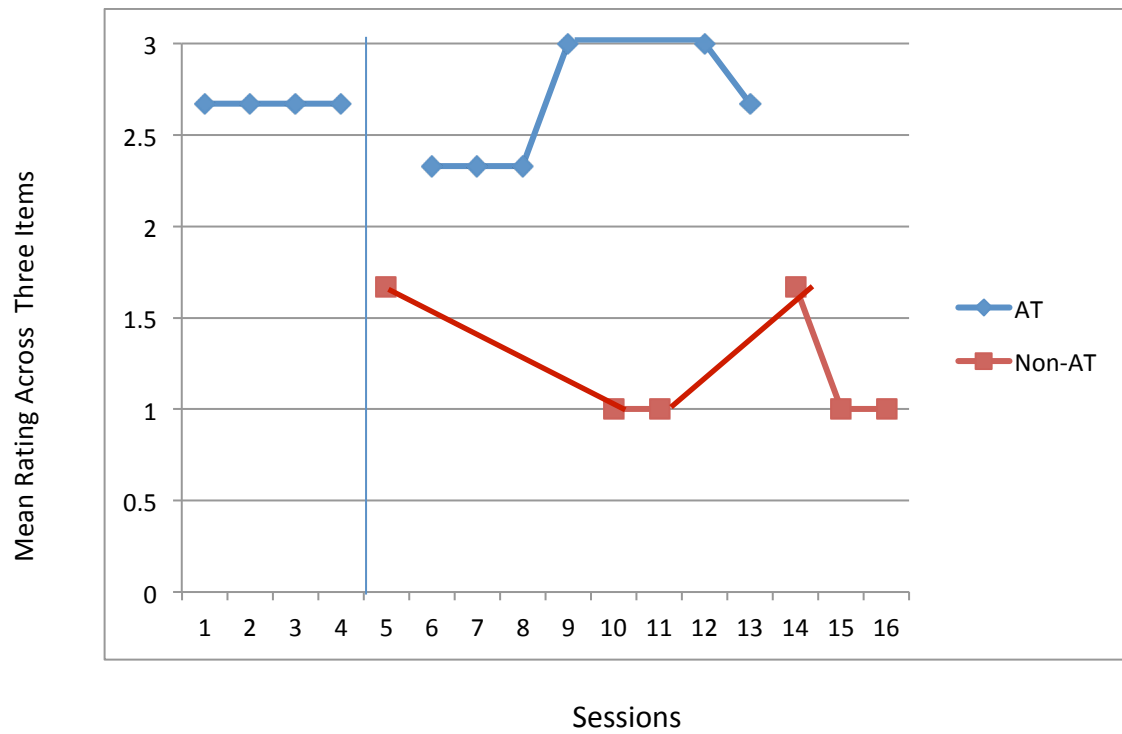


Figure 6

Child Reactivity and Distress Behavior Ratings

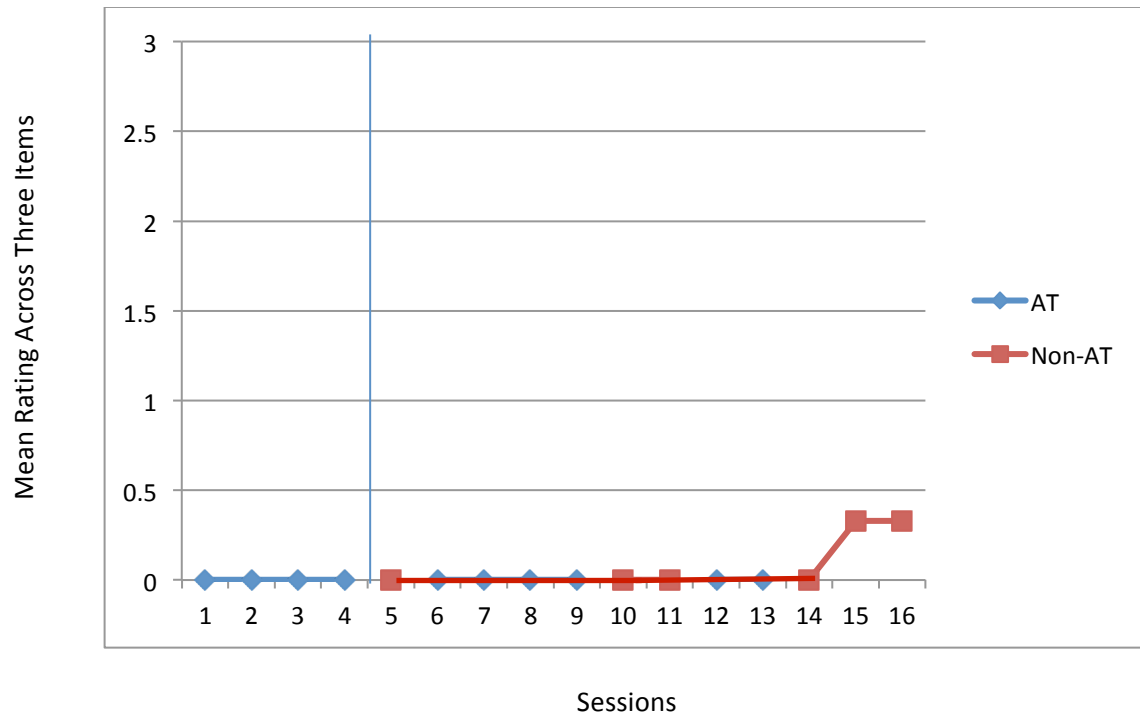


Figure 7

Child Social Communication Behavior Ratings

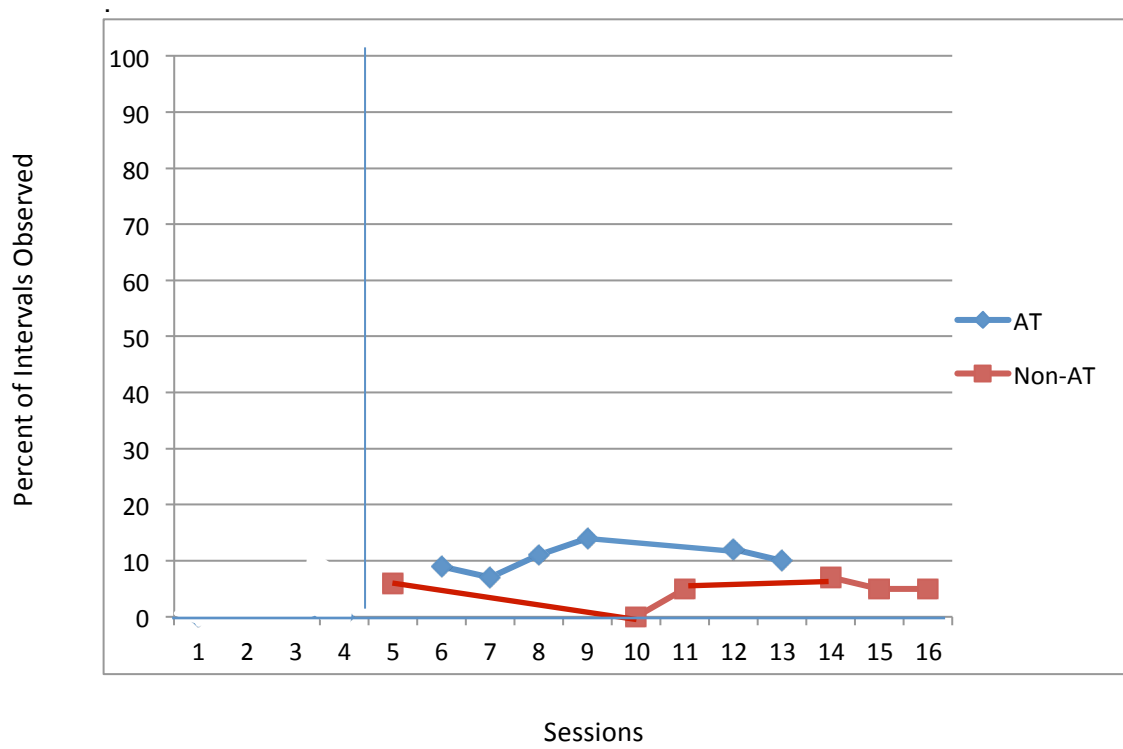


Figure 8

Child Engagement Level

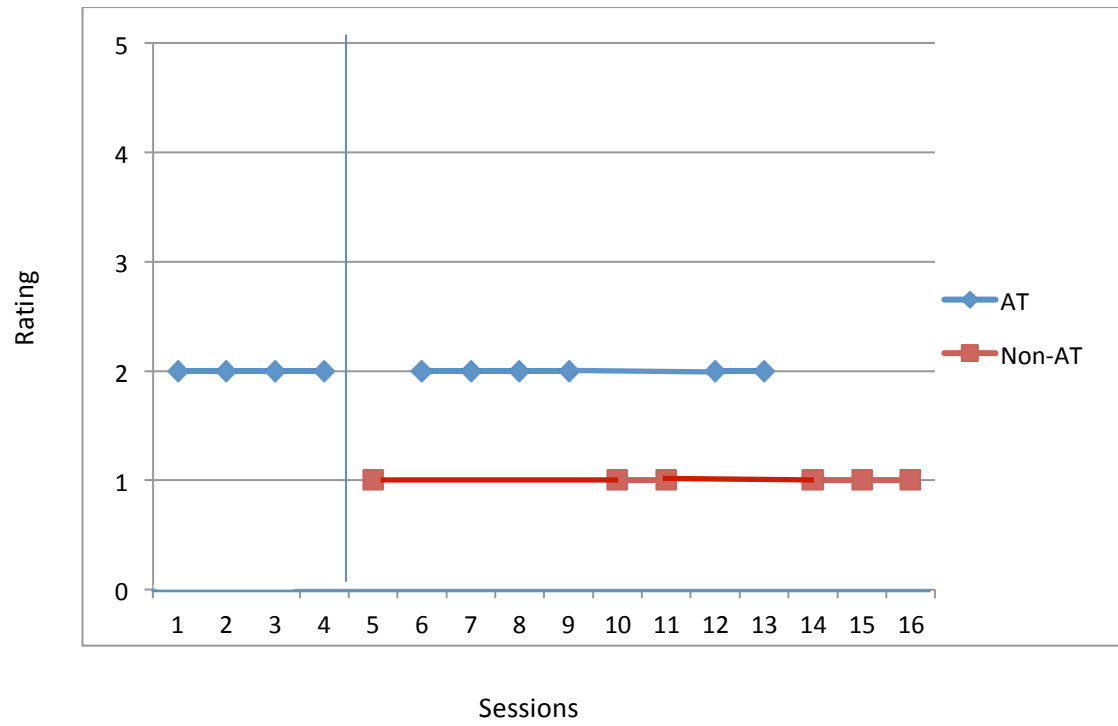


Figure 9

Child Engagement Complexity

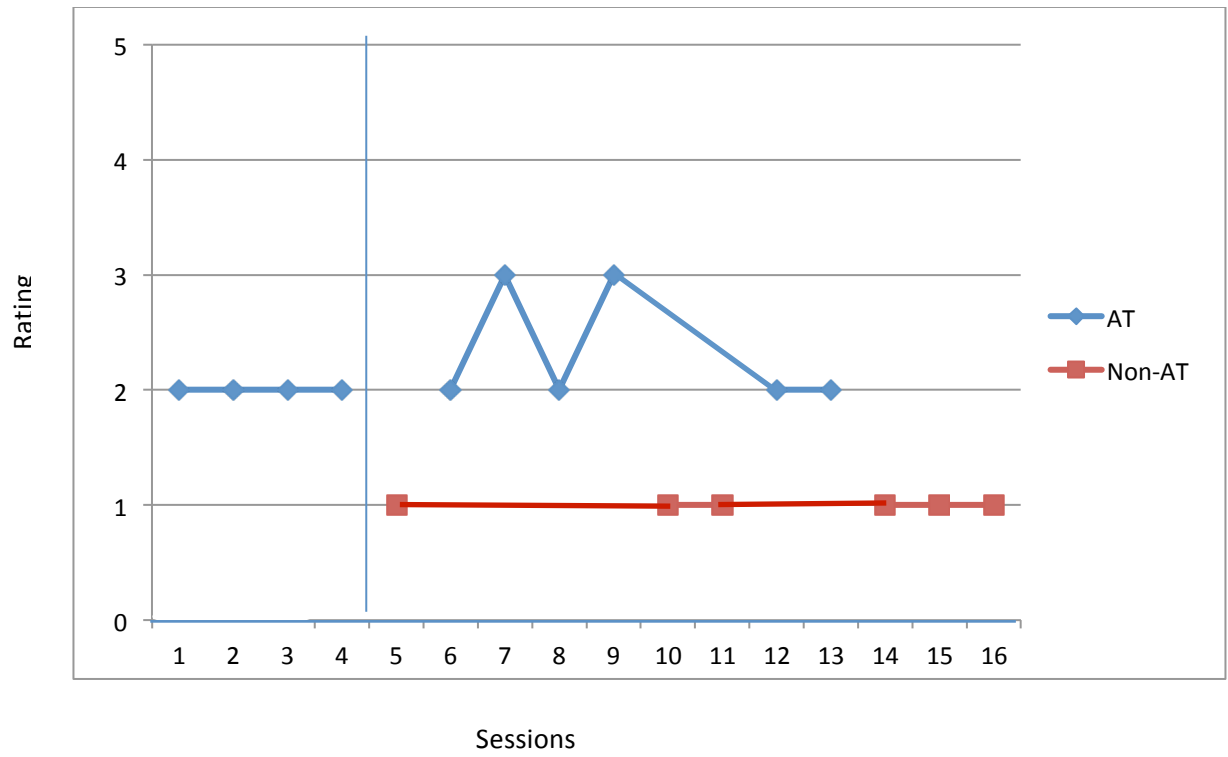


Figure 10

STARE Recording Sheet Scale of Teacher's Assessment of Routines Engagement (STARE)

*Adapted**

Child Name: Date: Time:					
Activity Number and Type: Number of Children:			Adults:		
Amount of Time Engaged in Activity	Almost none of time	Little of the Time	Half of the Time	Much of the Time	Almost all of
Comments:					
Complexity of Engagement	Nonengaged 1	Unsophisticated 2	Average 3	Advanced 4	
Comments:					
Contextual Notes:					

Table 7

Mean and Ranges for IPCI: Caregiver Facilitator Behavior Ratings

Behavior Category	AT Condition	Non-AT Condition
Acceptance/Warmth	2.83 (2.00-3.00)	1.50 (1.00-2.00)
Descriptive Language	3.00 (3.00-3.00)	1.33 (1.00-2.00)
Follow Child Lead	2.83 (2.00-3.00)	1.67 (1.00-2.00)
Maintain and Extend Interaction	2.00 (2.00-2.00)	0.33 (0-1.00)
Stress Reducing Strategies	NA	NA
Overall	2.67 (2.00-3.00)	1.21 (1.0-2.00)

Table 8

Mean and Ranges for IPCI: Caregiver Interrupter Behavior Ratings

Behavior Category	AT Condition	Non-AT Condition
Criticism/Harsh Voice	0	0
Restrictions/Intrusions	0.17 (0-1.00)	0.17 (0-1.00)
Rejects Child's Bid	0	0.17 (0-1.00)
Overall	.06 (0-0.17)	0.11 (0-0.17)

Table 9

Mean and Ranges for IPCI: Child Behavior Ratings

	AT	Non-AT
Child Engagement	2.61 (2.33-3.00)	1.06 (.67-2.00)
Child Reactivity/Distress	0 (0)	0.11 (0.33)

Table 10

Mean and Range of Percent of Intervals Observed: Child Social Communication Behaviors

	AT	non-AT
Social Communication Behaviors	10.56 (6.9-14.2)	5.65 (0-6.67)

Table 11

Mean and Ranges of Child Engagement and Complexity of Engagement Ratings

	AT	Non-AT
Engagement	2.34 (2.00-3.00)	1.00 (1.00 -1.00)
Complexity	2.00 (2.00-2.00)	1.00 (1.00-1.00)

CHAPTER 5: DISCUSSION

In the field of early intervention, assistive technology (AT) has been promoted through policy, family, and professional wisdom, but it continues to be used without strong empirical evidence for its effectiveness (Horner, 2005; Plunkett & Horn, 2007). While research suggests that AT has the potential to assist very young children in successfully accessing and then engaging their environment and thus helping them attain critical developmental milestones (Mistrett et al., 2001; Temple, 2006), previous research has not produced the levels of evidence necessary to recommend AT as an evidence-based practice in the field of special education (Plunkett & Horn, 2007).

The absence of strong evidence for AT *and* the requirements for the demonstration of young children to meeting specific federally mandated early childhood child outcomes (Office of Special Education Programs, ECO, 2004) created an imperative for the evaluation and examination of the impact of assistive technology (AT) on a young child's social interaction skills. This study makes a significant contribution to the ongoing discussion for AT as an evidence-based practice in early intervention, and specifically the use of AT with young children with disabilities.

Major Findings

In this section findings, will be discussed by each research question. First, a brief overview of the study will be presented. This will be followed by the discussion

on specific findings of the study. Finally, the limitations of the study and implications for research and practice will be discussed.

Brief overview of the study

The purpose of this study was to address the existing evidence gap supporting assistive technology (AT) as a validated intervention and practice for young children with disabilities in meeting their social and emotional needs. Furthermore, this study aims to push the field of early intervention from the traditional perspective of AT as a deficit “fix” to a broader perspective that allows professionals to acknowledge and trust that AT extends children’s developmental skills. Four specific research questions were presented for this study: (a) Does the quality of the adult social interactions improve when the AT device is present than when the device is not present? (b) Does the quality of the young child’s social interactions improve when the AT device is present than when the device is not present? (c) Does the frequency of the young child’s social communication behavior increase with the presence of an AT device than when the device is not present? (d) Does the child’s level of engagement increase in frequency and complexity when the AT device is present than when the device is not present?

To address the research questions, a multielement single-case design was utilized for one young child in a natural setting. Using a multielement single-case design allowed the researcher to examine the quality of social skill interactions during a typical routine, (i.e., snack time) routine when the child used his personal AT device (Condition one) the alternating condition as when the personal AT device was not

available (Condition two). The results support the hypothesis that, during a typical early childhood routine, the use of a personal AT device by the young child with a disability *significantly* improves the child's demonstration of social emotional skills than when the AT device is not used during a typical routine.

Adult social interactions. It was anticipated that the adult, Linda, would demonstrate higher levels of caregiver facilitation behaviors (i.e., acceptance/warmth, descriptive language, follows child lead, maintains and extends, and stress reducing strategies) and lower ratings of caregiver interrupter domain (i.e., criticism, harsh voice, restrictive/intrusions, reject's child bid) when the AT was utilized during a natural routine (Baggett, et. al., 2004). As noted previously, Linda demonstrated higher levels of facilitation behaviors when David, the participating child utilized his AT device during snack time, thus affirming the positive impact of the AT device between the adult and young child. Conversely, Linda displayed lower levels of interrupter behaviors (i.e., criticism, harsh voice, restrictions/intrusions, reject's child bid) during the snack time, routine with David's utilization his AT device. This positive interaction demonstration between Linda and David, of caregiver behaviors, are directly associated with the multiple positive effects for young children with disabilities such as increased child social responses (Dunst & Kassow, 2004) and positive changes in child behavior (Kassow & Dunst, 2005).

Child social interactions. The second research question was: "Does the quality of the young child's social interactions of higher quality when the AT device is present than when the device is not present?" It was hypothesized that the

utilization of AT by the child, David, would result in higher quality interactions with his caregiver Linda. As noted previously, the researcher used the two Indicators of Parent Child Interactions (IPCI) (Baggett et al., 2004) sub-domain ratings of the child domain (e.g., positive feedback, sustained engagement, follow-through) in order to assess whether AT use resulted in higher levels of child engagement. Conversely, an examination of the child reactivity/distress subdomain allowed measurement as to whether the AT presence resulted in lower levels of distress (i.e., irritable/fussy/cry, external distress, frozen/watchful/withdrawn). The data gathered clearly demonstrates that David displayed higher quality social interactions with Linda during the snack time routine when the AT device was present than when it was not present.

The importance of quality social interactions for David, and for children with disabilities in general, has been advocated from the inception of IDEA. The admonition for the benefit for inclusionary practices has been sounded by leaders for more than a decades. For children with disabilities quality social interactions lead greater social acceptance and stronger relationships, which in turn supports later academic success (Brown, Odom, Li, & Zercher, 1999; Buysse, Goldman, & Skinner, 2002; Odom, Zercher, Li, Marquart, & Sandall, 2006).

Child social initiations. The third research question: “Does the frequency of the young child’s social communication behavior increase with the presence of an AT device than when the device is not present?” It was anticipated that David would display a higher frequency of social communication initiations with the use of his AT

device than without it. To answer the third research question, the researcher used a partial-interval recording procedure to record the child's social initiation attempts. Social initiation attempts included conventional and unconventional communication (e.g., jargon, echolalia, hand leading) as well as linguistic and prelinguistic communication (e.g., reaching and grabbing, eye gaze, crying, facial expressions, body postures, vocal approximations, pointing). Data clearly indicated an increase in David's social communication initiations during the snack time with the AT device utilization than when the AT device was not utilized.

Child engagement and complexity. In answer to the fourth and final research question, "Does the child's level of engagement increase in frequency and complexity when the AT device is present than when the device is not present?," the researcher used the *STARE* measure (McWilliam, 2000). The *STARE* application targeted the levels of engagement during snack time between the caregiver/young child dyad. It was anticipated that David would display higher levels of engagement with both his AT device and his caregiver, Linda, and greater engagement complexity with the utilization of his AT device during the snack time routine. As a reminder to the reader, the *STARE* ratings of routine engagement range from almost none of the time to half the time to almost all of the time. Additionally, the *STARE* definition of engagement complexity was rated as non-engaged (e.g. David staring off, crying), unsophisticated (e.g. banging spoon, random movement of objects), average (e.g., typical interaction with materials or typical mealtime behaviors), or advanced (e.g., makes, builds, or uses contextually bound language). Again, as anticipated, David

demonstrated consistently higher levels of engagement with the routine both in terms of engagement with Linda and with the AT device. Equally important was the greater level of engagement complexity during the routine, with both Linda and the AT device utilization than when he did not utilize the AT device.

Limitations

In the field of early intervention, the choice of the multielement single-case design was the most appropriate methodology for generating the desired data for this research. However, more precise data using this method could be produced with a larger number of research participants, and by testing a variety of behavioral and cognitive effects of various AT devices in a variety of research settings. Whereas the results for a single participant are valid, in Horner's words, the "strength of [a multielement single-case design] study would have been increased with multiple replications across participants. Single subject design's external validity is improved if the study includes multiple participants, settings, materials, and/or behaviors" (Horner, 2005, p. 171).

Moreover, single-subject studies typically examine the effects of an intervention across at least three different participants. In spite of extensive attempts to recruit participants, it was not possible to find three or more child participants for this research who were both eligible and available. The number of eligible children was extremely low. The response from a Part C agency indicates what may underlie the crux of the limited response rate, "I'm sorry. We only have children under the age of 3." Leaving the rest of the statement to suggest, 'we don't use AT with very young

children with disabilities, we wait until they are older.” This statement, though troubling, has resonated for some time in the field of early intervention. Only about 7% of children in early intervention AT services, and such AT is typically mobility related (Campbell, Milbourne, & Wilcox, 2008). Among the potential participants who were eligible for this research study, only one participant proved viable. One parent of the eligible children did not want to consent because she felt that mealtime or snack time at the table was already stressful. She was not willing to “complicate” the routine by using the AT device during this time. The reluctance to use AT by parents in the home or natural setting has been reviewed and found related to multiple factors including, finances, availability, training and support (Lane & Mistrett, 1998; Due to the unavailability of young children utilizing AT in natural environments, recruitment was extremely limited.

Concerns related to potential confounds related to the adult must also be considered. First, while Linda was the focus adult in the adult/child dyad and remained so throughout there were others, (i.e., three teaching assistants) that were at times a part of the sessions. It is plausible that anyone of their presence or absence may have impacted the findings but there is no reason to expect that impact systematically favored one condition or the other. Another consideration to the results reported is the adult’s knowledge of the research question, and more specifically that the knowledge of the research questions could have influenced her behavior and interactions. Perhaps most unexpectedly however, was the magnitude of difference in the adult’s behavior during the non-AT condition. One possible explanation, which

bears further examination, is the practitioner's belief or unconscious behaviors related to reciprocal and responsive behaviors. Meaning in typical dyadic initiation and response behaviors, each participant in the responsive loop has expectations of behavior to another's communication initiation. When one person says hello, the response is hello. When eye contact is made for extended time, vocalizations typically follow. However, in the absence of initiation or an extended response, the communication is limited and thus the loop stops. Which would explain to a certain extent the lesser rate of engagement by the adult in the non-AT condition as David's initiations are limited and conversation extensions are not given as options on a simple choice board.

An additional limitation noted, even though Casey and McWilliam (2004) verified that *STARE* was congruent with the E-QAL III (McWilliam & De Kruif, 1998), by adhering to the established behavioral definitions for the specific routine, the scale was not reflective of the David's limited repertoire of behaviors. While it was therefore necessary to adapt the behavioral definitions and make them more specific to the child and the research setting, the complexity of the behaviors was not adequately reflected in the overall scoring. Therefore, the limited sensitivity of *STARE* might have influenced the positive results of the analysis. Adapting the behavioral definitions of *STARE* was necessary, but additional research is needed in order to validate the adapted behavioral definitions.

As the research setting was within David's natural routine and setting (i.e., classroom), the challenge of accurately portraying his level of routine engagement

and complexity was not without challenge. Clearly, David demonstrated higher levels of engagement and greater complexity of engagement with Linda and the AT device during his snack time routine when his AT device was available. Linda and the staff confirmed that all the children in the classroom were accustomed to visitations by other adults and that the observations and recording did not alter their usual routine. The presence of additional adults, who were not providing support but entering the room, pointing an atypical device at the children (i.e. video camera), and leaving the room with little or no interaction, may have nevertheless affected David or Linda's demonstration of skills.

Additionally, the results of this study cannot be generalizable to all young children with disabilities, or all AT devices, routines, or settings. David was identified with pervasive development disorder (PDD), which characteristically affects social communication and interaction skills. Snack time was chosen as a typical routine across most early childhood settings and homes. The examination of a single routine, in this case snack time, within a preschool classroom may not be representative of the child's relationship with an AT device or the relationship with an adult across multiple routines (e.g. circle time; departure; free play). At best, the results are only a snapshot of David's daily routine. What may be considered David's level of proficiency with the AT device during ten minutes of snack time may not be the same level of proficiency during a different routine.

It is also a possibility that an examination of a different AT device, rather than a low-tech communication symbol board, within the same intended "deficit fix" may

produce alternate results. What is important to remember is that the focus of David's AT was specifically an "item request" strategy and that the demonstrated skills may be considered essential for a more elaborate social communication strategy. Therefore, it would be reasonable to further define the intention of the AT device being studied and its ability to enhance children's development of early childhood skill demonstrations (Judge & Parette, 1998).

A final limitation, which cannot be completely ruled out, is the contributing influence of the food/snack items acting as potent reinforcers for the child's initiation of social communication. The strength of a reinforcer, in this case snack items, lies with the child's control and demonstrated increase in the child's behavior. Of specific consequence, is the child's demonstration of reinforced behavior in the utilization of AT for the reinforcer, food, which may be considered separately from a reinforcer of the social interaction.

Implications for Future Research and Practice

As mentioned earlier in the chapter, despite the above mentioned limitations, this study contributes substantial information for the use of AT with young children with disabilities in meeting developmental outcomes. The results of this study support the movement for the field of early intervention in considering AT as an evidence-based practice in meeting OSEP early childhood child outcomes.

Future Research

The demonstrated results, which promote the use of assistive technology with young children with disabilities as a means to develop and reinforce social emotional

skills during a typical early childhood routine, offer contributions to the literature. First, to date only a very small number of research studies have reported social emotional outcomes related to the use of assistive technology (Hanson, & Hanline, 1985; Schepis et al., 1998). Of note, the previous studies, which were conducted more than 15 years ago, have primarily occurred in settings apart from the natural environment of young children whereas the current research setting was within the natural context and during natural routines.

Second, the noted limitation of the reinforcement potential of the food for the use of the AT device should be explored further. One potential solution to reduce this confound would be to determine from the baseline the rate and quantity of snack items, then set up a third non-contingent condition for snack items.

Lastly, this study focuses on what may be considered a secondary skill acquisition, as the primary intent of the AT for the child was ‘an item request’ strategy. The skill deficit, which needed ‘fixed’. This study takes a broader contextual examination, which does not interfere with the primary function of the AT device, but rather expands the scope of skill attainment. This broadened approach supports research for promoting children with disabilities social skill acquisition and practice. Previous research acknowledges, regardless of type, children with disabilities are significantly challenged with social relationships and isolation (e.g., Guralnick, et al., 2006; Odom et al., 1999). More significantly though, while this research specifically examined AT supporting the attainment of the early childhood child outcome one, (i.e., meeting social emotional needs) this does not or should not

preclude researchers to expand the vision of AT supporting young children attaining all early childhood child outcomes, one, two and three (ECO, 2004).

Implications for Practice.

The over-riding impetus for early intervention practitioners is to be able to see AT, not as a single skill correction or skill amelioration, but rather a broad-based evidence-based intervention, which may contribute significantly to meeting early childhood outcomes if one, looks for such evidence. The importance for practitioners' understanding concerning the benefits of AT as a broad based intervention in meeting early childhood child outcomes cannot be understated. As all practitioners are planning and evaluating for demonstration of early childhood outcomes , the necessity to consider AT interventions in meeting such outcomes is paramount. For if in reporting early childhood child outcomes, the team omits the potential or existing data of the young child utilizing AT during a simple routine, but fails to acknowledge the demonstrated skills in the reporting, does that not disadvantage the child as failing to meet early childhood child outcomes. The responsibility lies within the field of the early intervention field to consider interventions which includes AT, in the least intrusive, least restrictive manner, If AT utilization provides such options ECSE practitioners have a professional obligation to seek training, advocate for administrative support and facilitate evidence-based interventions. Admittedly, ongoing concerns for ECSE practitioners regarding the time and resources it takes to collect meaningful data may be addressed by the methods of this research (Council for Exceptional Children, 2000; Commission on

Excellence in Special Education, 2002; Carter, Scruggs, 2001; Carter, Chen, Schroll & Klein, 2003). The method of the current research supports the practicality for data collection within the classroom or natural environment with observational tools, such as the *IPCI* (Baggett, Carta, & Horn, 2004) and *STARE* (McWilliam, 2003). Tools with which practitioners are typically familiar with and already use in their settings, though these two are certainly not the only observational tools which may support measurement of meeting early childhood child outcomes.

However, other than meeting mandated reporting requirements, the greater consideration for practitioners is the purposeful planning with AT (as currently mandated) (IDEA, 2004) and address the child's individual goals and intervention strategies for the whole child's developmental needs which would then facilitate meaningful engagement and broader skill acquisition. ECSE practitioners continue to be encouraged to embrace AT within naturally occurring routines and to accept that AT is within the ECSE realm and not a segregated intervention strictly for occupational or speech language therapists (Campbell, Milbourne & Wilcox, 2008). The opportunity for team collaboration in assisting children to meet broad early childhood child outcomes lies within the demonstrated results of this research.

Conclusion

In essence, this research study addresses the shortcomings for rigorous evidence addressing AT utilization as evidence-based practice in meeting critical early childhood child outcomes while specifically targeting social skills development. Second, the demonstration of AT promoting early childhood child outcome

attainment encourages the acceptance from early childhood practitioners of the necessity of AT implementation for very young children with disabilities in those natural settings. Additionally, the results support early intervention practices moving AT beyond the current use as a single skill deficit “fix” and broaden the landscape of early intervention practice. Finally, the unobtrusive and valid research conducted with a young child with disabilities in a natural setting demonstrates the feasibility of future research and encourages the further development of AT research in such natural settings.

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