EFFECTIVENESS OF TRAINING FAMILIES OF INDIVIDUALS WITH ASD AND OTHER DD IN SOCIAL-COMMUNICATION INTERVENTIONS: A SINGLE-CASE RESEARCH, EXAMINATION OF EVIDENCE-BASED PRACTICE, AND META-ANALYTIC REVIEW

A Dissertation

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ABSTRACT

Approximately 60% of adult-aged individuals with DD live with their families, and therefore, families of those individuals may have more social-communication interactions with them across time and settings. For this reason, it is critical to involve family members in the development and implementation of interventions for their children with ASD and other DD. The purposes of the present research were (1) to investigate the effects of instructional coaching on treatment integrity in primary caregiver-implemented augmentative and alternative communication intervention for an adult with ASD and on independent use of AAC of an adult with ASD; (2) to analyze the quality of the body of single-case research to determine whether primary caregiver-implemented communication interventions can be broadly considered evidence-based practices for individuals with ASD; and (3) to conduct a meta-analytic review determining the effects of family-implemented social-communication intervention in promoting social-communication skills of individuals with ASD and other DD.

Results of the first article indicated that all the caregiver participants showed high treatment fidelity after receiving training in the augmentative and alternative communication (AAC) intervention procedures while the adult with ASD infrequently used the AAC mode independently. The second article established that primary caregiver-implemented interventions could be considered an evidence-based practice (EBP) for treatment of the communication skills of individuals with ASD. Findings of

the third article indicated that the family-implemented interventions have a moderate effect on the social-communication skills of individuals with ASD and other DD. Regarding the moderator variables, no statistically significant differences were found for any potential moderators.

This study has implications for training of families of individuals with ASD and other DD in the implementation of social-communication interventions in terms of time and cost efficiency as well as determination of EBPs. Several limitations should be considered. First, only one adult with ASD participated in the first study. Second, many of the studies included in the current review did not provide the intensity of training needed to facilitate intervention implementation of families. More research Limitations and implications for future research and for practitioners were addressed.

DEDICATION

To my Lord – for your unfailing love and being my shelter in my life. Without you in my life, I am nothing.

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CHAPTER I

INTRODUCTION

Many individuals with autism spectrum disorder (ASD) and other developmental disabilities (DD) have consistently shown delayed development of their social-communication skills (van der Meer et al., 2012; Lord, Risi, & Pickles, 2004). For example, recent literature estimates that approximately 30 to 50% of individuals with ASD do not develop age appropriate spoken language (Tager-Flusberg & Kassari, 2013). In addition, those individuals with ASD and complex communication needs (CCN), i.e., those who are unable to use age-appropriate conventional speech (Light & Drager, 2007), tend to have a lack of generalization of the social-communication skills across settings and communication partners (Hong, Ganz, Gilliland, & Ninci, 2014). Previous literature have reported that individuals with ASD who acquire spoken language by five to six years old tend to have better long-term outcomes, such as high rate of employment, better academic outcomes, and positive social relationships (Howlin & Charman, 2011; Whitehouse, Watt, Line, & Bishop, 2009; Cimera & Cowan, 2009; National Research Council, 2001).

To promote the social-communication skills of individuals with ASD and other DD, various types of interventions have been investigated (Kagohara et al., 2010; Achmadi et al., 2012; Flores et al., 2012). There are 10 types of interventions that have been identified as an evidence-based practice (EBP) for the social-communication skills of individuals with ASD (National Autism Center, 2009). Those interventions include

antecedent package, behavioral package, comprehensive behavioral treatment for young children, joint attention intervention, modeling, naturalistic teaching strategies, peer training package, pivotal response treatment, self-management, and story-based intervention package (National Autism Center, 2009). Additionally, for individuals who have CCN, augmentative and alternative communication (AAC) systems have often been utilized to improve the social-communication skills of those individuals (Ganz et al., 2011). Most of the abovementioned intervention techniques tend to utilize researcher- or teacher-implemented interventions (e.g., Buckley & Newchok, 2005, Reichle et al., 2005). While those interventions have been shown effective in promoting the social-communication skills of individuals with ASD and other DD, it has been found that the researcher- or teacher-implemented interventions often have a lack of skill generalization for those individuals (Crockett, Fleming, Doeple, & Stevens, 2007; Smith, 2001). Therefore, training all key social-communication partners of individuals with ASD and other DD should be considered in order to address this issue.

Rich social-communication interaction with caregivers is considered essential to enhance language skills of young children (Haebig, McDuffie, & Weismer, 2013, McCartney, 1984). In addition, during the first three years of life, particularly for children with DD, learning experiences affect development of their cognitive and language skills (National Scientific Council on the Developing Child, 2007; Haebig, McDuffie, & Weismer, 2013). Individuals who receive special education services spend most of their hours at home with their family members (e.g., parents, siblings) (U.S. Department of Education, 2014; National Autism Center, 2009); thus, involving family

members in interventions may provide more social-communication interaction opportunities for children with ASD and other DD regardless of time and setting (Braddock et al., 2011; Steiner, Koegel, Koegel, & Ence, 2012; U.S. Department of Education, 2014). Some studies have found that caregiver-implemented interventions promote generalization of acquired skills of their children with ASD (e.g., Schreibman & Stahmer, 2013; Steiner, Gengoux, & Chawarska, 2013; Kaiser, Hancock, & Nietfeld, 2000; Rocha, Schreibman, & Stahmer, 2007). In addition, caregiver-implemented interventions have been shown to be more cost-effective than clinician-delivered interventions (Minjarez, Williams, Mercier, & Hardan, 2011). Previous literature have found that parents tend to have less parenting stress while showing an increased level of parenting competency through participating in intervention procedures for their children with ASD and other DD (Schultz, Schmidt, & Sticher, 2011). Therefore, it is critical to involve families in the development and implementation of interventions for individuals with ASD and other DD (Meadan, Ostrosky, Zaghlawan, & Yu, 2009).

In special education, particularly in intervention research for people with low incidence disabilities such as ASD and significant developmental delay, single-case experimental research design (SCED) is the most commonly implemented type of research design; thus, is important in the determination of what intervention can be considered to be EBPs (Horner et al., 2005; Tankersley et al., 2008). Although SCED studies on family-implemented interventions have been shown effective in developing the social-communication skills of individuals with ASD and other DD, few studies that investigated the effects of family-implemented interventions have reported procedural

fidelity that affirms the treatment effects (Gresham, Gansle, & Noell, 1993; Meadan, Ostrosky, Zaghlawan, & Yu, 2009). Given the lack of procedural fidelity of those studies, it may leave doubt about whether those studies accurately implemented the intervention procedures throughout the studies (Meadan, Ostrosky, Zaghlawan, & Yu, 2009). For this reason, conducting single-case research with high quality designs and strong evidence is critical (Horner et al., 2005). Therefore, by utilizing a high quality of SCED, conducting a study on family-implemented social-communication intervention is important for individuals with ASD and other DD. In addition, it has been noted that most of the studies tend to be conducted with young individuals with ASD and other DD (Ganz, Davis, Lund, Goodwyn, & Simpson, 2012; Ganz et al., 2012), leading to difficulties to generalize their findings to adult-aged individuals with ASD and other DD. Therefore, more SCED studies need to include young adolescent- and adult-aged individuals with ASD and other DD.

Legislations, including the No Child Left Behind Act of 2001 and the Individuals with Disabilities Education Improvement Act of 2004, required to use scientifically and empirically validated practices, or EBPs (Horner et al., 2005). To determine this, design quality of each study on family-implemented interventions should be evaluated. Prior to determining whether or not the family-implemented intervention meets evidence standards, studies that have poor design quality should be excluded from further review (Odom, Collet-Klingenberg, Rogers, & Hatton, 2010). Based on results of the evaluation, the following criteria should be considered to determine whether or not the family-implemented intervention can be considered an EBP (Kratochwill, Hitchcock, Horner,

Levin, Odom, Rindskopf, & Shadish, 2010). First, there should be at least five single case studies on the family-implemented interventions that either meet the evidence standards or meet them with reservations. Second, the studies must be conducted by at least three different investigators at three different sites with no overlapping authorships. Third, at least 20 experiments should be included across the studies. Although the family-implemented interventions have been shown effective in improving social-communication skills of individuals with ASD and other DD, no studies have reviewed design quality of those studies, leading to doubt about whether the family-implemented interventions can be considered an EBP.

Since characteristics of individuals with ASD and other DD and families are heterogeneous, the types of intervention utilized and procedures used in studies are varied. Furthermore, it is necessary to examine the overall effect of family-implemented on the social-communication skills of individuals with ASD and other DD through meta-analytic techniques that allow aggregating effects across the studies (Scruggs & Mastropieri, 1998; Parker et al., 2007; Kavale, 2001). In addition, since different social-communication behaviors were targeted based on characteristics of individuals with ASD and other DD, different types of social-communication interventions, and outcome measures were utilized across studies. No studies have investigated how those different factors affected outcomes variables. Therefore, investigations of what intervention components are most effective in improving the social-communication skills of individuals with ASD and other DD should be conducted.

Although different types of family-implemented communication interventions have been utilized for people with ASD and other DD, there are some common instructional methods used across those interventions (Ganz et al., 2012). Those different instructional methods can be categorized into two types, including an adult-led didactic instructional approach and an individual with disabilities-led instructional approach (Ganz et al., 2012). In an adult-led didactic instructional approach, one-on-one instruction is commonly used and often carried out in a structured setting (Ganz et al., 2012). On the other hand, an individual with disabilities-led instructional approach is designed and developed based on his or her interests and conducted in a naturalistic setting (Ospina et al., 2008). Both types of instructional approaches have been shown to be effective in enhancing the communication and language skills of individuals with ASD and other DD (Elder et al., 2005; Rocha et al., 2007; Symon, 2005; Vismara et al., 2009; Koegel et al., 2002; Kaiser et al., 2000); however, there is no review that evaluates which one yields more effectiveness in social-communication outcomes of those individuals with ASD and other DD. Furthermore, given different types of instructional approaches, it might be difficult to determine which intervention to use. Therefore, it may be beneficial for researchers and educators who work with individuals with ASD and other DD to know a type of intervention that is more effective in improving the social-communication skills of individuals with ASD and other DD than others.

To fill these gaps in the literature, in the first article of this dissertation (Chapter II), a SCED study was reported investigating the effects of instructional coaching on treatment integrity in primary caregiver-implemented augmentative and alternative

communication intervention for an adult with ASD and effects of primary caregiver-implemented augmentative and alternative communication intervention on independent use of augmentative and alternative communication of an adult with ASD. In the second article of this dissertation (Chapter III), an analysis of the quality of research was conducted and a determination was made to identify whether primary caregiver-implemented communication interventions for individuals with ASD could be broadly considered EBP. In the third article of this dissertation (Chapter IV), a meta-analysis was conducted to determine the effects of family-implemented intervention in promoting the social-communication skills of individuals with ASD and other DD. This meta-analysis included comparisons of effectiveness differentiated by critical moderator variables. These moderators included participant characteristics (i.e., age group, diagnostic category, communication and language characteristics), types of interventional approach (i.e., individual with disabilities-led instruction, adult-led didactic instruction), and outcome measures (i.e., verbal, nonverbal or recognizable words, use of AAC system, social play behaviors). Finally, the gaps in the literature were also discussed regarding family-implemented interventions to improve social-communication skills of individuals with ASD and other DD.

CHAPTER II

TEACHING CAREGIVERS TO IMPLEMENT AN AUGMENTATIVE AND ALTERNATIVE COMMUNICATION INTERVENTION TO AN ADULT WITH ASD*

According to the Centers for Disease Control and Prevention (CDC, 2012), approximately 1 out of 88 individuals in the United States has an autism spectrum disorder (ASD). Individuals with ASD present deficits in social interaction and communication skills, as well as restricted, repetitive, and stereotyped patterns of behavior (American Psychiatric Association [APA], 2000). Notably, most individuals with ASD demonstrate significant deficits in both receptive and expressive communication (Ganz et al., 2011).

Given the high prevalence of ASD, there has been research into effective interventions that enhance communication and social skills in individuals with ASD (National Research Council, 2001). Augmentative and alternative communication (AAC) systems, which are used to provide alternatives to or supplements to conventional speech (Ganz et al., 2012), are noted as a common and effective way to enhance communication in individuals with complex communication needs (CCN); that is, those who are unable to use speech effectively (IDEIA, 2004; NCLB, 2001). AAC systems have been shown to be effective with individuals with ASD who have CCN (Cafiero, 2001; Ganz, Hong, & Goodwyn, 2013; Gordon et al., 2011; Hidecker, 2010; Nunes & Hanline, 2007; Romski, 2005). Unfortunately, there are few studies that have been conducted with

adolescents or adults with ASD utilizing AAC systems (Ganz, Davis, Lund, Goodwyn, & Simpson, 2012; Ganz, Earles-Vollrath, et al., 2012). Ganz et al. (2012) analyzed 24 articles conducted on individuals with ASD and AAC systems and 58 individuals with ASD participated in those studies. Only 10% of those individuals were over the age of 15. Further, few studies have involved implementation of AAC by parents or caregivers (Reichle et al., 2005; Sigafoos et al., 2004; Sigafoos, O'Reilly, Seely-York, & Edrisinha, 2004). Thus, prior research on AAC with people with ASD is difficult to generalize to adults, particularly when implemented by common communication partners.

Primary caregiver-implemented interventions to promote the generalization of skills to multiple settings have been used effectively with individuals with ASD and their families (Ingersoll & Gergans, 2006; Symon, 2005; Kaiser, Hancock, & Nietfeld, 2000; Koegel, Schreibma, Britten, & O'Neill, 1982), though these studies have primarily been conducted on interventions other than AAC-based strategies. Since many individuals who receive special education services spend much of their time with their caregivers at home (U.S. Department of Education, 2005), it is critical for primary caregivers to participate in the development and implementation of interventions to enhance communication skills (Meadan, Ostrosky, Zaghlawan, & Yu, 2009). Meadan and colleagues systematically evaluated 12 studies conducted on primary caregivers' implemented social and communication skills interventions for individuals with ASD. Four of the 12 studies looked at generalization of the intervention, and participants in these studies successfully generalized acquired skills to different settings and people. In addition, the authors found that not only did the individuals show improvement in target

skills, but their caregivers also were able to acquire and implement new teaching skills with these individuals in home settings. Again, although experts have repeatedly recommended implementation of social and communication interventions by parents and caregivers, little research has demonstrated the utility of implementation of AAC by primary caregivers (Nunes & Hanline, 2007).

Few studies involving interventions for people with ASD have reported treatment fidelity. Treatment fidelity is collected throughout a study as a measure of its quality and accuracy in the implementation of evidence-based interventions (Kaderavek & Justice, 2010). It verifies the effectiveness of the intervention by measuring how accurately the independent variable is delivered to the participant (Meadan, Ostrosky, Zaghlawan, & Yu, 2009). Meadan and colleagues (2009) found that only two of the 12 studies reported information on treatment fidelity. Although the importance of collecting treatment fidelity has been emphasized in applied behavior analysis (ABA; Gresham, Gansle, & Noell, 1993), McIntyre and colleagues (2007) found that only 30% of 152 studies on school-based intervention published in the *Journal of Applied Behavioral Analysis* reported treatment fidelity. Furthermore, 45% of those studies demonstrated inaccurate intervention implementation protocols, suggesting that treatment fidelity may be a major issue in ABA. Thus, more research needs to be conducted to determine how to ensure high treatment fidelity, particularly when caregivers, who typically have limited training, are implementing interventions.

The previous literature indicates a need for continued research that includes young adolescents and adults with ASD and investigates the efficacy and accuracy of

primary caregivers' implemented AAC systems to promote communication and language skills. This study examined the accuracy of primary caregivers' AAC intervention implementation to an adult with ASD. Furthermore, the participant's independent use of AAC mode was investigated. The research questions included: (a) would the primary caregivers implement AAC intervention to an adult with ASD accurately after instructional coaching; and (b) as a result of instructional coaching with caregivers, would the adult with ASD independently use AAC system to make a request for his preferred items?

Method

Recruitment and Participants

Participants were recruited through an online database at a local university, into which family members had input information about their children with ASD and indicated their interest in participating in research. Participants were considered for the study if they were adults and had autism and complex communication needs; only one potential participant appeared to meet these criteria. One of the investigators contacted the potential participant's parent via email to notify them of the study and seek consent. One adult, Ryan, a 32-year-old male with autism, severe intellectual disability, and CCN and his four primary paid caregivers participated in this study. Ryan had a visual impairment due to his self-injurious behaviors, including poking and hitting his eyes and head. However, due to Ryan's intellectual functioning level, his ophthalmologist was not able to test how well Ryan could see. According to an interview with Ryan's mother, his eyesight seemed to have been recovering gradually. It was apparent throughout the study, however, that Ryan preferred using one side of his face over the other. Ryan was able to

choose an item that he preferred among two or three items and to pick up a small snack item from a plate. Although Ryan correctly matched colors and shapes (1 by 1 inches in size), he had difficulty with fine motor skills including pointing his finger to touch an icon on iPad™. Ryan had no functional speech skills. When requesting items, Ryan typically grabbed the hand of someone and guided him or her to the item. Although he had used a picture-based communication system when he was in a high school, he had not continued to use this system recently and had no history of using any other modes of AAC.

Ryan had four caregivers who had been working with him, with two on duty at all times, 24 hours per day, seven days a week. None of them had received any training related to applied behavior analysis. Table 1 displays the caregivers' information including age, sex, race, maximum level of education, and previous experience working with individuals with special needs and with Ryan.

Table 1

Characteristics of primary caregivers

Participant(s)	Age/Sex	Education level	Experience working with individuals with disabilities	Length of time worked with Ryan
Carol	51/Female	High school	Over 15 years working with individuals with ID	7 years
Troy	23/Male	Associate degree	None	1 year, 3 months
Jared	22/Male	Associate degree	None	1 month
Joshua	27/Male	High school	Worked with individuals with TBI	9 months

Note. ID = intellectual disability; TBI = traumatic brain injury.

Setting and Materials

This study was conducted in a one-on-one private therapy room (8 by 8 feet) at a university-supported autism intervention clinic. Two tables and two chairs were present in each session. All of the reinforcing materials that were used were presented on one of the tables at the corner of the room and available throughout the study. None of the materials were within arms-reach of the participant. On another table, an Apple iPad™, which had the Tap to Talk™ application installed, was present and available throughout baseline and intervention sessions. Six pictures of items were presented on the tablet at the beginning of the study and fewer items were presented as the study proceeded since Ryan appeared to have difficulty discriminating among more than two pictures. Only

two pictures were presented on the tablet from the mid-point of the study. On a screen of the iPad™, there were three icons presented including *FOODS, GAMES, and ACTIVITIES*. Under each icon, items that were identified through interviews with Ryan's mother and the caregivers were depicted. The food icons included snacks, drink, and fruit. The activity icon included balls and walking. The game icon included Colorama™ and Connect 4™. Since more edible items were identified as Ryan's preferred ones, under each icon of *SNACK, DRINK*, and *FRUIT,* there were different types of snacks (i.e., potato chips, pretzel, trail mix), drinks (i.e., coke, juice, water), and fruits (i.e., apple, raspberry, grapes) contained. Those items were frequently modified according to Ryan's preference throughout the study. Once an icon was touched, the iPad™ generated speech, including a name of the selected icon and then *"please"* (e.g., *"Snacks please"*). In addition to the first author, one to three observers collected data in the room throughout the study. Only one of Ryan's caregivers was present at a time in the room. The study was conducted for approximately one hour per day, twice weekly for two months.

Design

A single subject, multiple-probe design (Kazdin, 2011) was conducted across the participants' (caregivers) behaviors to evaluate the effects of instructional coaching regarding implementation of an AAC system (Fossett & Mirenda, 2005). Each level included a baseline and an intervention phase.

Procedure

Preference Assessment. Tangible and edible items Ryan preferred were identified through a reinforcer checklist competed by his mother and through interviews with his caregivers. Preferred items included large balls; games (i.e., checkers, Colorama™, Connect 4™); fruits (i.e., grapes, apples, and raspberries); snack foods (cookies, pretzels, trail mix, cereal); and drinks (soda and juice). These selections were consistently requested by Ryan through behavioral indication (e.g., reaching for items, consuming or manipulating them when offered) throughout the study.

Baseline. The caregivers were instructed to interact with Ryan in the way she or he typically interacted. No instructions or prompts were given to the caregivers about how to implement Tap to Talk™ with Ryan, though it was turned on and placed within reach of Ryan and the caregiver. The caregivers were told that they could give an item that Ryan asked for. When Ryan attempted to access any of the items by showing any behaviors including pulling his caregiver's hand, challenging behaviors, or using Tap to Talk™, the caregiver provided him with the item. After a certain period time, the caregiver took the item back and offered Ryan something new. If Ryan did not show any interest in the items presented, the caregiver presented something else.

Instructional Coaching. After collecting baseline data, instructions were provided to each caregiver on how to teach Ryan to use AAC system. Depending on each caregiver's skill acquisition, the length of time each training session took was varied. First, the first author described steps verbally. Then, using a variety of items, the first author and a graduate student demonstrated some possible scenarios that the

participant might face to while delivering each step to Ryan. Last, the caregiver had opportunities to practice steps with a first author. If the caregiver demonstrated the steps 100% correctly for three consecutive practice trials out of four trials, he or she met the mastery criteria. If the caregiver did not correctly follow steps, the first author reintroduced the steps verbally and let him or her practice it again until he or she met the mastery criteria.

Step I: Entice and provide full-physical prompt. The first author provided each caregiver with one-on-one instructions on how to entice Ryan with the items to draw his attention by presenting no less than two items to Ryan at the same time while asking him which one he wanted to have. The first author also provided each caregiver with instruction on how to provide a full-physical prompt to Ryan to teach him to make a request using Tap to Talk™. The first step comprised of the caregiver enticing with two to three items to Ryan while asking what he wanted. While presenting items, the caregiver also said "what do you want?" When Ryan reached out his hand for his preferred item, a full-physical prompt was provided to him to encourage his use of Tap to Talk™. In providing a full-physical prompt, the caregiver put his or her hand over Ryan's hand and helped him point with one or two fingers to touch the correct icon on the iPad™.

Step II: Verbal model and social praise. Once a caregiver participant mastered the first step of enticing and providing full-physical prompts to use Tap to Talk™, the next step was taught in a similar manner. The first author provided the caregiver with instructions on how to verbally model the name of the item (e.g., "Snack, you want

snack.") requested by Ryan following the provision of a full-physical prompt. Also, the first author provided each individual caregiver with instructions to provide social praise (e.g., "Nice asking" or pat Ryan's shoulder) when Ryan made a request using Tap to Talk™, either independently or prompted. Instructions were given to each caregiver in a sequential manner, covering the components from both the first and second steps.

Step III: Time delay. The first author provided each caregiver with instructions on how to fade to a less intrusive prompt level. This consisted of the caregiver verbally prompting Ryan to touch the icon on Tap to Talk™, saying, "Use your words," or, "touch the picture you want," while pointing the icon. After providing a verbal prompt, the caregiver was instructed to provide a physical prompt to Ryan after a delay of approximately 5 seconds. Because Ryan had difficulties with fine motor skills, such as pointing his finger to contact the icon, the caregivers often needed to continue providing physical prompts.

Post-Instructional Feedback. After data collection sessions were conducted with each caregiver, post-session instructions were provided if needed. If the caregiver did not meet 75% (3 out of 4 trials) correct implementation in a session, instructions were provided to him or her again before the start of a subsequent session.

Dependent Variables and Data Collection

Each caregiver's correct implementation of every procedural step was measured during each trial. A list of each component of procedural steps is provided in Appendix 1. The components of the first procedural step included enticing and providing a full-physical prompt. The components of the second procedural step included verbal

modeling and social praise. The third procedural step was time delay. Four trials were given to each caregiver per session. If Ryan was given access to an item, whether he had used the AAC system correctly or not, it counted as one trial. If the caregiver implemented all components of the step correctly, "+" was scored. If a caregiver did not follow all the components of a step correctly, "-" was scored. Trial by trial data were collected for each session. Every component of the step had to be implemented correctly for 3 of 4 trials to meet a mastery criterion during post-instructional phases. Furthermore, data on Ryan's independent use of the AAC system were collected throughout the study. Ryan's use of the AAC device was considered independent if Ryan touched an icon of item that he wanted without any prompts by primary caregivers.

Analysis

The effects of training caregivers in implementing intervention to Ryan were evaluated through both visual and statistical analysis. Mean, range, and trend for each condition and caregiver were also calculated to determine whether there was a functional relation between the dependent variables and intervention (Horner et al., 2005). As a statistical analysis, Tau-U nonparametric effect size was calculated (Parker & Vannest, 2012).

Fidelity of Implementation of Instructional Coaching

Treatment fidelity was collected on the first author's correct implementation of instructional coaching to the caregivers for 100% of instructional coaching sessions. One or two independent observers marked whether or not each step was completed on the checklist after a session was completed. The number of steps implemented correctly was

divided by total number of possible steps, and calculated as a percentage. A list of the steps is provided in Appendix 2. Treatment fidelity of instructional coaching sessions was obtained for 100% of all the instructional coaching sessions across all primary caregivers.

Reliability

Inter-observer agreement (IOA) was collected for a minimum of 60% of all sessions, for each dependent variable, throughout each phase of the study. It was computed by two independent observers. Point-by-point agreement was used to calculate IOA. Agreement was scored if both observers recorded the same response of each participant for a given trial. A disagreement was coded if either "+" or "-" was marked in a given trial for one observer and not the other. IOA on treatment fidelity of instructional coaching was analyzed for 87% of overall sessions. Data were collected at least on 60% of all baseline conditions and 85% of all intervention conditions. For treatment fidelity, the average IOA for baseline sessions was 100% and the average IOA for intervention sessions was 99.8% (range 99-100%). IOA on Ryan's independent use of Tap to Talk™ was collected on 100% of all baseline conditions and at least on 80% of all intervention conditions. Ryan's average IOA for independent use of Tap to Talk™ was 100% across the caregivers.

Social Validity

Following intervention, the caregivers were asked to complete a brief survey to assess satisfaction with the instructions provided. The questions in the survey were adapted from the Client Satisfaction Questionnaire (CSQ; Larson, Attkisson, Hargreaves,

& Nguyen, 1979). The caregivers rated satisfaction with the quality of training, preference of training, their likelihood of recommend training to other personnel, and overall satisfaction with training. Ratings were made on a 1-4 Likert scale, with 0 being not satisfied and 4 very satisfied. The average social validity rating was 3.5, ranging from 3 to 4.

Results

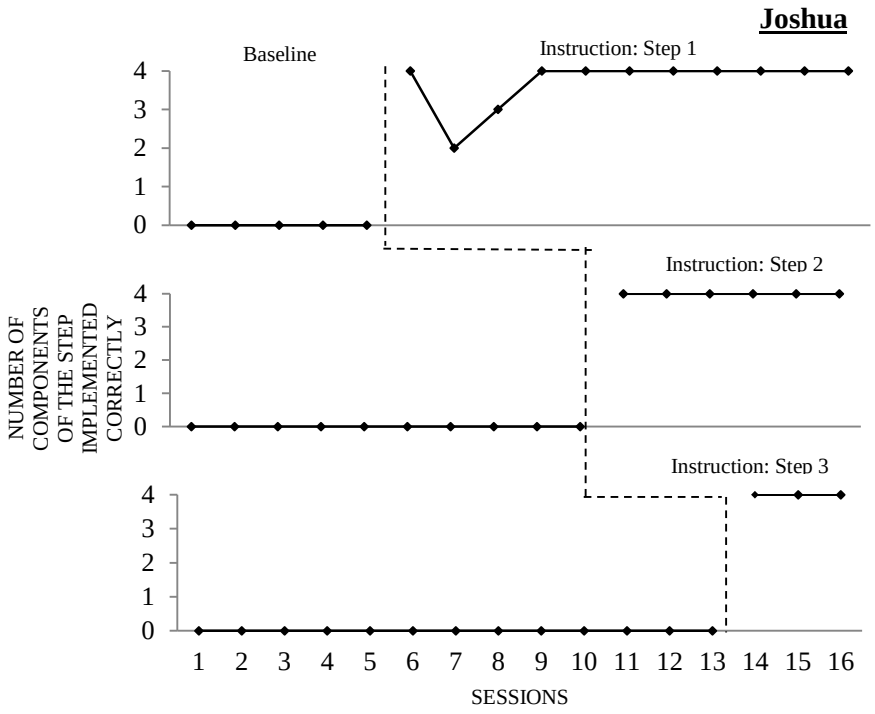
Overall, all of the participants implemented the instructional coaching steps using Tap to Talk™ with high fidelity throughout the study. The omnibus Tau-U effect size for caregivers' correct implementation was 0.998 indicating there was statistical significance. Each caregiver's intervention results are shown in Figure 1a to 1d. Results of Ryan's independent use of AAC are depicted in Figure 2a to 2d.

Joshua

Joshua did not implement any of the instructional coaching steps correctly during any baseline session. His mean during the first intervention phase increased to 3.73 correct steps (range 2-4). During the intervention phase for the second step, Joshua obtained a mean of 4 indicating he correctly implemented all components of the step each time. While participating in the intervention phase for the third step, Joshua maintained a mean of three steps performed correctly. There was no variation or trend in baseline or intervention while there was a significant change in level from baseline to intervention.

Figure 1a

Results: Number of components of the step implemented correctly by Joshua, trial by trial



Carol

Carol did not implement any of the instructional coaching steps correctly during any baseline session. Her mean during the first intervention phase increased to 4 correct steps (range 3-4). During the intervention phase for the second step, Carol obtained a mean of 3 (range 1-4). There was a steep upward trend and variability in the intervention data and a considerable change in level between baseline and intervention. During intervention for step 3, Carol performed the 4 correctly for every session. There was no

trend or variability in the intervention data, but there was a major change in level between baseline and intervention. Overall, Carol's data demonstrate a significant change in level between baseline and intervention for each of the three steps.

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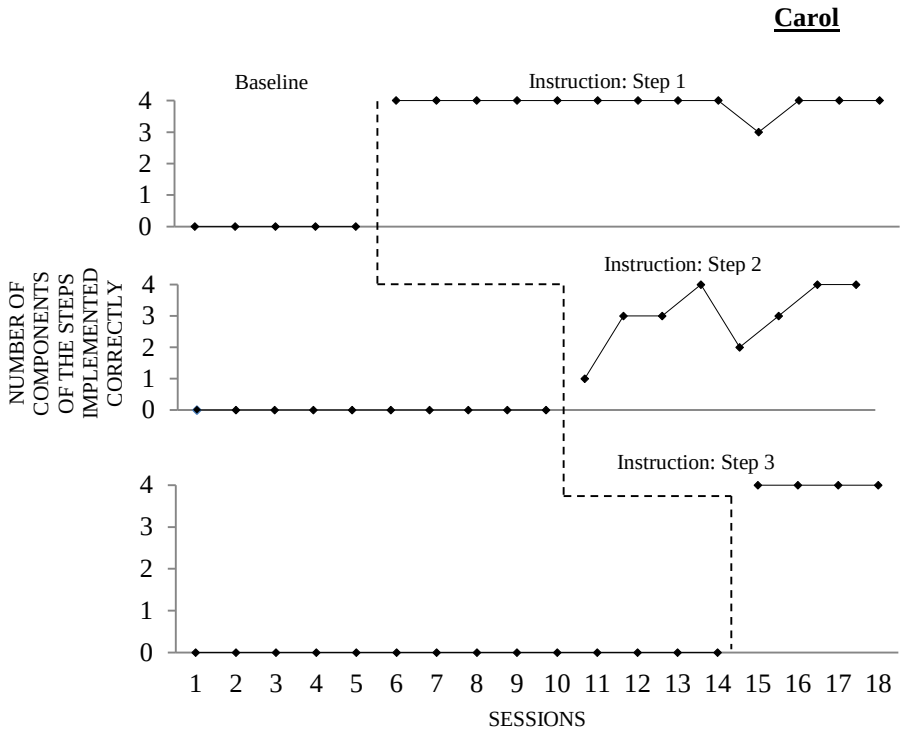
Figure 1b

Results: Number of components of the step implemented correctly by Carol, trial by trial



Jared

Jared did not implement any of the instructional coaching steps correctly during any baseline session. His mean during the first intervention phase increased to 3.8 correct steps (range 2-4). During the intervention phase for the second step, Jared

obtained a mean of 2.9 (range 1-4). There was a steep upward trend and variability in the intervention data and a considerable change in level between baseline and intervention. During intervention for step 3, Jared performed the 4 correctly for every session. There was no trend or variability in the intervention data, but there was a major change in level between baseline and intervention. Overall, Jared's data demonstrate a significant change in level between baseline and intervention for each of the three steps.

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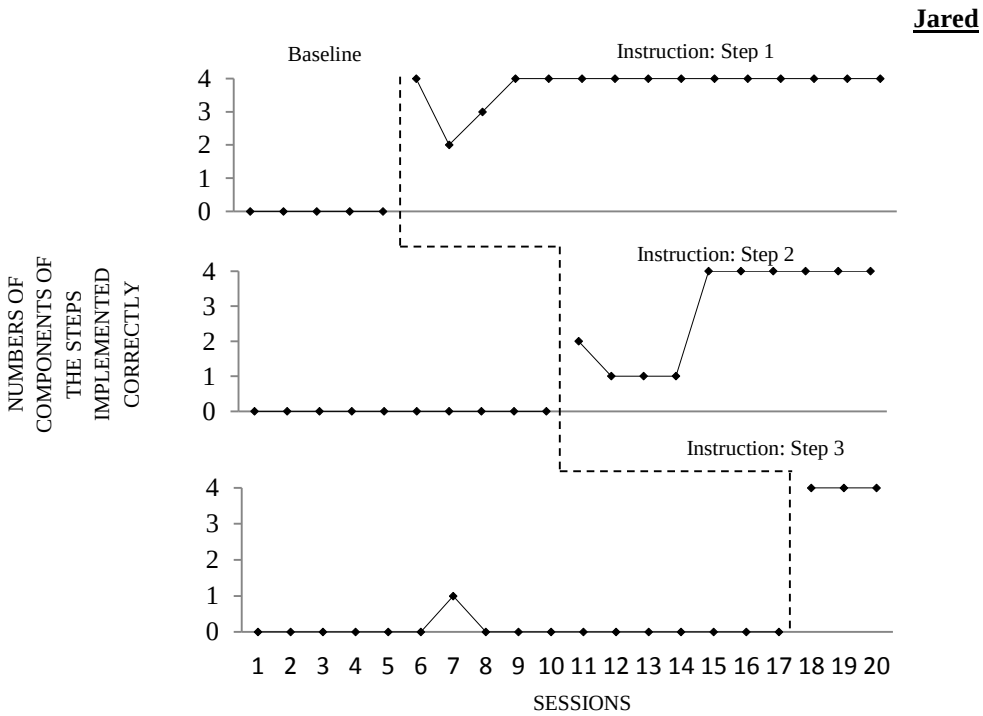
Figure 1c

Results: Number of components of the step implemented correctly by Jared, trial by trial

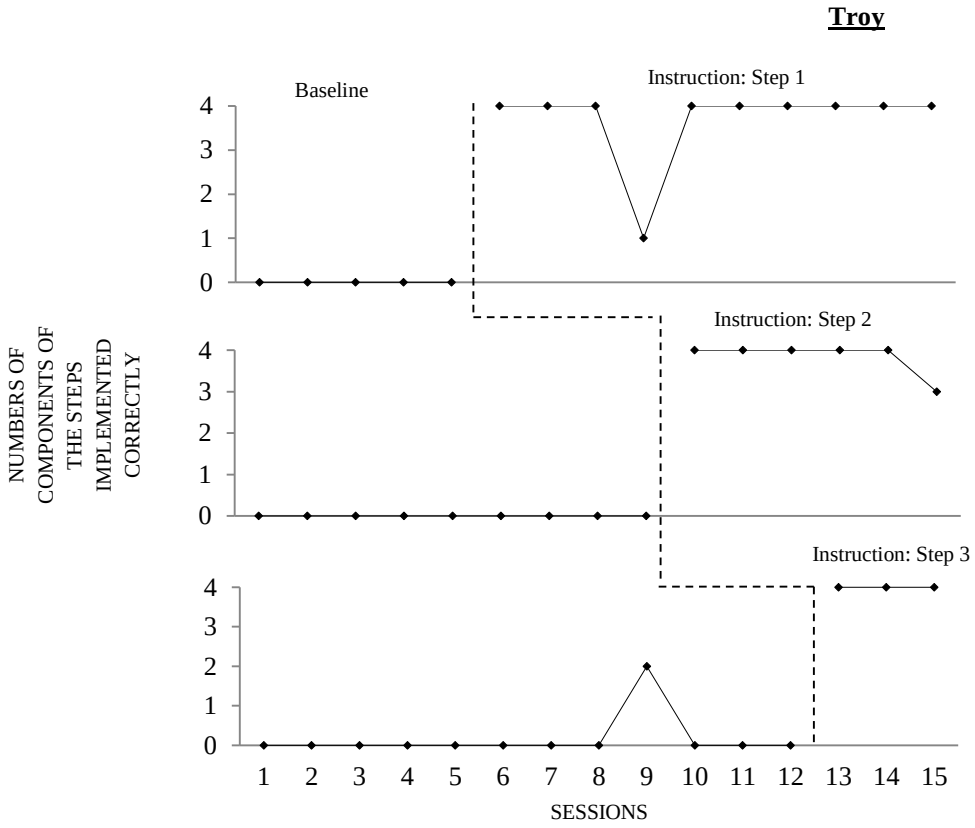


Troy

Troy did not implement the first and second instructional coaching steps correctly during baseline session. During the baseline phase of the instructional coaching step 3, Troy's average was 1.7 (range 0-2). His mean during the first intervention phase increased to 3.7 correct steps (range 1-4). During the intervention phase for the second step, Troy obtained a mean of 3.8 (range 3-4). There was a steep upward trend and variability in the intervention data and a considerable change in level between baseline and intervention. During intervention for step 3, Troy performed the 4 correctly for every session indicating he correctly implemented all components of the step each time. There was no trend or variability in the intervention data, but there was a major change in level between baseline and intervention. Overall, Troy's data demonstrate a significant change in level between baseline and intervention for each of the three steps.

Figure 1d

Results: Number of components of the step implemented correctly by Troy, trial by trial



Ryan's Independent Use of AAC App

Because the study was designed to evaluate the efficacy of instructional coaching related to treatment fidelity for caregiver implementation of AAC, the study was not designed in a manner that allowed us to evaluate whether or not there was a functional relation between the instructional coaching and Ryan's independent use of AAC. However, we collected data on his AAC use as a collateral effect. Although Ryan did not

appear to significantly improve he did use the AAC app independently more often during intervention phases than during baseline. Ryan did not attempt to use Tap to Talk™ during baseline phases with Joshua; however, he did try to use it independently twice during intervention sessions. With Carol, Ryan did not attempt to use Tap to Talk™ during any baseline phases; however, he did attempt to use Tap to Talk™ independently twice during the intervention for Step 1 with Carol. With Jared, Ryan did not attempt to use Tap to Talk™ during baseline phases; however, he did use Tap to Talk™ during the intervention phases for the second step. Although Ryan did not use Tap to Talk™ during any of the baseline phases with Troy, he did attempt to use it independently during the intervention phases for steps 2 and 3.

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Figure 2a

Ryan's independent use of AAC device with Joshua

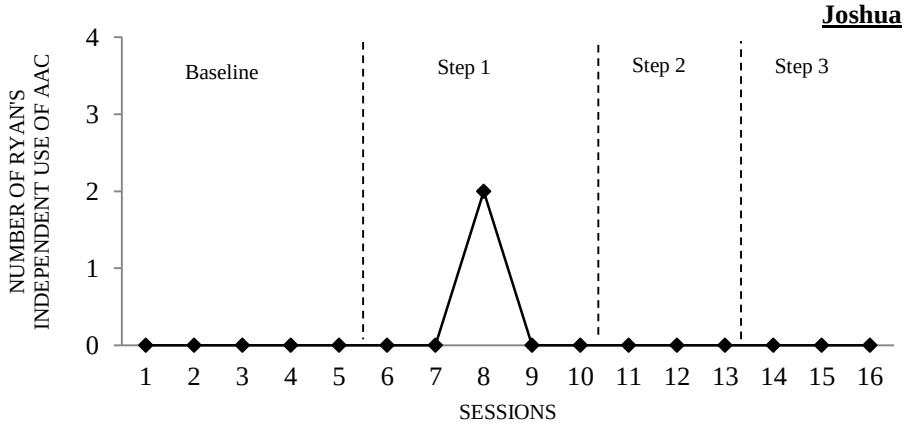

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Figure 2b

Ryan's independent use of AAC device with Carol

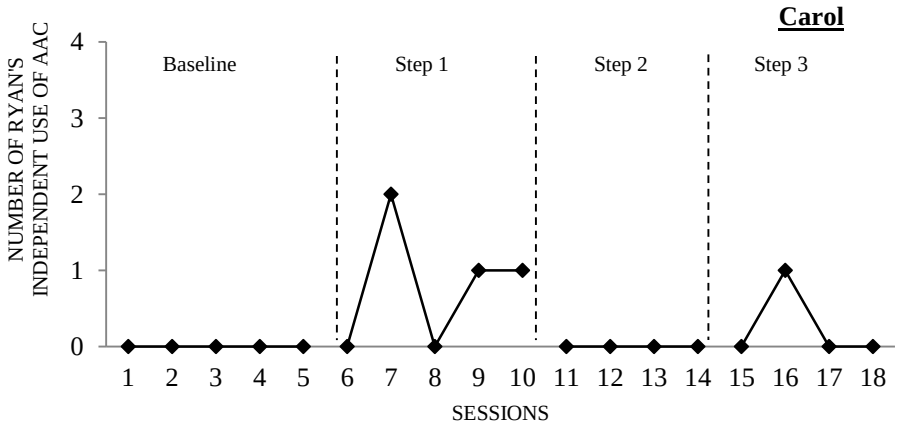

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Figure 2c

Ryan's independent use of AAC device with Jared

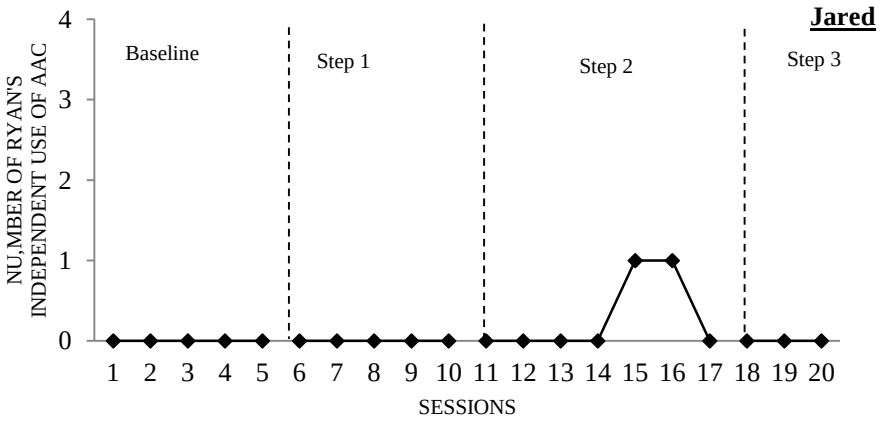
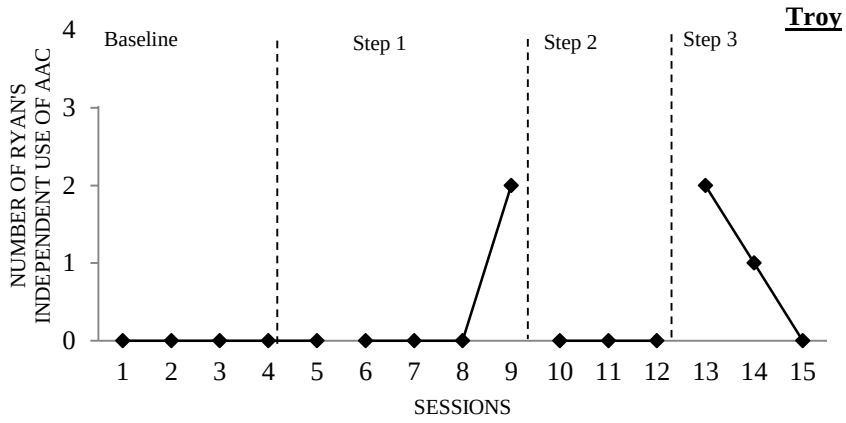


Figure 2d
Ryan's independent use of AAC device with Troy



Discussion

We investigated the accuracy of primary caregivers' AAC implementation with an adult with ASD to teach him to make a request via an AAC app. As depicted in Figure 1, all of the caregivers correctly and quickly learned to implement each step of AAC instruction following instructional coaching. Each caregiver was responsive to instructional coaching throughout the study. Furthermore, they often provided the first author with some feedbacks and comments on utilizing the device more adequately for Ryan, such as the size or number of pictures depicted on iPad™.

While the caregivers implemented the AAC system correctly, Ryan only occasionally infrequently used it independently throughout the study. It may be that this was due to Ryan's vision impairment. Ryan also may have become too dependent on his caregivers' prompts; therefore, he was less likely to independently use Tap to Talk™. Caregivers may have been too quick to give prompts, without giving Ryan an

opportunity to independently respond. Future research should focus on fading prompting when providing instruction to caregivers.

These results confirm and extend previous research. As demonstrated by Meadan, Ostrosky, Zaghlawan, and Yu (2009), the primary caregivers in this study were able to implement the AAC system with the participant accurately throughout the study. Furthermore, in a meta-analysis (Ganz et al., 2012), only 10% of the participants' ages were over 15 years old. By including an adult with ASD, this study extended the literature on AAC by including an adult with ASD and ID.

There are some practical implications suggested in this study. Regarding costs and convenience to families of individuals with ASD, primary caregiver AAC implementation may be beneficial both to individuals with ASD and their families. Services provided by behavior analysts and educational professionals cost more than services provided at home by primary caregivers (Sallows & Graupner, 2005). Further, providing at-home intervention will reduce costs incurred by families by eliminating travel to and from clinics.

Although primary caregivers' AAC implementation improved in the current study, some limitations must be discussed. One of the limitations of the study is that Ryan's staff members were not taught how to fade prompts soon after Ryan began to acquire skills. Thus, the researchers noted anecdotally that Ryan would begin to independently master a skill, and a staff member would intervene without realizing that he might no longer need to be prompted. Ryan's independence in using Tap to Talk™ decreased as staff members continued to intervene with his requests. A second limitation

to the study included Ryan's fine motor skills and his eyesight, which make it difficult to generalize the results to participants with different characteristics. Ryan was unable to use his index finger to point, which made it difficult for him to clearly specify his preferred object. A third limitation to the study was the level of experience previously obtained by each of the staff members. Three of the young men participating in the study had relatively little experience, whereas the fourth individual had several years of experience. The young men's lack of experience may have contributed to an eagerness to learn new skills more quickly, which may not be true for all paid caregivers. Conversely, caregivers with previous training in ABA may have naturally used prompt fading as needed to promote independent AAC use.

This study suggests several areas of future research on the implementation of AAC by caregivers and with adults with ASD. First, future studies should be conducted on effective ways to instruct caregivers and staff members in prompt fading. This appears to be a critical component in teaching caregivers to provide ABA-based instruction to individuals with ASD. Second, other major health issues, such as level of eyesight, should be taken into consideration prior to and during implementation of these interventions. That is, AAC implementation studies should be conducted with many more individuals with ASD and sensory impairments to investigate adaptations necessary to effectively teach AAC use and answer questions involving why some individuals with ASD are less responsive to AAC interventions (Ganz, Lashley, & Rispoli, 2010). Third, additional studies should include data regarding the level of

training and experience of caregivers so that researchers may determine the differential effects of AAC instructional coaching based on prior caregiver preparation.

CHAPTER III

A REVIEW OF THE QUALITY OF PRIMARY CAREGIVER-IMPLEMENTED COMMUNICATION INTERVENTION RESEARCH FOR INDIVIDUALS WITH ASD AND EXAMINATION OF EVIDENCE-BASED PRACTICE

According to the Centers for Disease Control and Prevention (CDC), the overall estimated prevalence of autism spectrum disorder (ASD) in the United States in 2012 was one out of 68 children (CDC, 2014). ASD is considered a permanent developmental disorder and many individuals with ASD face lifelong challenges related to developmental delays (Volkmar, Stier, & Cohen, 1985). Individuals with ASD share a common set of core characteristics including limited social-communication and interaction skills, repetitive behaviors or activities, and fixated interests (American Psychiatric Association [APA], 2013). It has been shown that approximately 20 to 30 % of individuals with ASD do not develop functional speech (Wodka, Mathy, & Kalb, 2013). Failure to acquire functional speech by age five to six years leads to poor outcomes in future academic performance (Estes, Rivera, Bryan, Cali, & Dawson, 2011), social involvement (Estes, Rivera, Bryan, Cali, & Dawson, 2011), and employment (McNaughton, Bryen, Blackstone, Williams & Kennedy, 2012; McNaughton & Bryen, 2007). Furthermore, those individuals with ASD and complex communication needs (CCN), i.e., those who are unable to use age-appropriate conventional speech (Light & Drager, 2007), show a lack of generalization of communication skills across settings and communication partners (Hong, Ganz, Gilliland, & Ninci, 2014).

Children primarily develop their language skills through daily interactive communication in natural settings (Bohannon & Bonvillian, 2005). Individuals who receive special education services tend to spend many hours at home with their caregivers (U.S. Department of Education, 2014; National Autism Center, 2009); thus, caregivers are the persons with whom individuals with ASD interact with the most frequently in their daily routines. How frequently and actively parents interact with their children with ASD may influence both the quality and quantity of a linguistic input that each child receives (Haebig, McDuffie, & Weismer, 2013). The quality of linguistic input is considered an especially important factor that affects the development of spoken language of children with ASD (Hart & Risley, 1992). Therefore, involving caregivers in efforts at improving the communication skills of individuals with ASD is critical.

Some individual studies have demonstrated that involving parents or caregivers of individuals with ASD in intervention procedures is effective in improving the communication skills of those individuals with ASD (Elder et al., 2005; Kaiser, Hancock, & Nietfeld, 2000; Koegel, Symon, & Koegel, 2002; Symon, 2005; Vismara & Colombi, & Rogers, 2009; Vismara & Rogers, 2008). While types of communication interventions vary across studies, primary caregiver-implemented communication interventions tend to share common instructional approaches; one is an adult-led didactic instructional approach and another is an individual with disabilities-led instructional approach (Ganz et al., 2012). An adult-led didactic instructional approach often utilizes one-on-one instruction and is carried out in a contrived setting (e.g., Lafasakis & Sturmey, 2007; Crockett et al., 2007). While providing this type of instruction, a child's responses are

initiated by an adult's prompt (Ganz et al., 2012). In an individual with disabilities-led instructional approach, an adult follows interests of an individual with disabilities and the individual initiates interaction with others, verbally or via behavior indications, such as pointing or looking (Dunst, Raab, & Trivette, 2012). Individual with disabilities-led instruction is often implemented in a naturalistic setting (e.g., Coolican et al., 2010; Gillett & LeBlanc, 2007; Randolph et al., 2011). However, both approaches appear to utilize common behavioral techniques, including modeling, fading, prompt, reinforcement, and time delay (Leach, 2010; Reichow & Volkmar, 2010; e.g., Vernon et al., 2012; Tomaino, 2011; Singh, 2012). While involving parents or caregivers of children with ASD in communication activities is considered to be important to promote language and communication acquisition of those children with ASD, the quality of research designs and quality of the evidence from studies on primary caregiver-implemented communication interventions have not been investigated with regard to currently recommended standards.

Previous literature on communication interventions reviewed treatment effectiveness of various types of primary caregiver-implemented communication interventions for individuals with ASD (Lang, Machalicek, Rispoli, & Regester, 2009; Meadan, Ostrosky, Zaghlawan, & Yu, 2009). In spite of the overall positive communication outcomes demonstrated in the reviewed studies, the previous reviews excluded unpublished studies (e.g., theses, dissertations) in their analyses and only included published journal articles, and this may lead to publication bias (Easterbrook, Berlin, Gopalan, & Matthews, 1991). In addition, prior studies on primary caregiver-

implemented communication interventions have had some limitations since those studies included all articles regardless of the quality of the design and none of the previous reviews have examined the quality of the studies on primary caregiver-implemented communication interventions; that is, those factors may create doubt about whether the primary caregiver-implemented interventions may be considered evidence-based practices, or EBPs (Horner et al., 2005). Therefore, it is imperative to evaluate the quality single-case experimental research design (SCED) of studies on primary caregiver-implemented communication interventions.

SCEDs are often considered appropriate to utilize in special education research (Horner et al., 2004), particularly given the low incidence of disabilities such as ASD and the heterogeneity of characteristics across individuals. In special education, an individual student is often considered as the unit of analysis since characteristics of every student vary from each other (Odom et al., 2005). Further, educational contexts in special education are more complex than in general education (Odom et al., 2005). Most of the previous reviews on primary caregiver-implemented communication interventions reviewed studies that utilized randomized controlled trials (Buschmann et al., 2008; Drew et al., 2002), eliminating a large segment of the evidence base, those which involved implementation of SCED, and none of the reviews evaluated design quality of those studies. Therefore, it is important to review SCED research in primary caregiver-implemented communication interventions and evaluate a design quality of those studies to determine whether the primary caregiver-implemented communication intervention is EBP.

Educational legislation in the U.S., including the No Child Left Behind Act of 2001 and the Individuals with Disabilities Education Improvement Act of 2004, require researchers and practitioners to utilize scientifically proven practices. Thus it is critical to assess and evaluate whether the primary caregiver-implemented communication intervention is an EBP (Horner et al., 2005). To determine this, design quality of each study must be evaluated, and poor quality studies must be excluded from further review, prior to determining whether or not a study and a body of literature meets evidence standards (Odom, Collet-Klingenberg, Rogers, & Hatton, 2010). Then, based on results of the evaluation, it is determined whether or not the primary caregiver-implemented communication intervention can be considered an EBP based on the following criteria outlined by Kratochwill, Hitchcock, Horner, Levin, Odom, Rindskopf, and Shadish (2010). First, at least five single case studies on the primary caregiver-implemented communication interventions either meet the evidence standards or meet them with reservations. Second, the studies must be conducted by different investigators at a minimum of three different sites with no overlapping authorships. Third, there should be a minimum of 20 experiments across the studies.

The paucity of literature on procedural fidelity for caregiver-implemented communication interventions for people with ASD points to the need to investigate the circumstances under which parents and caregivers correctly or incorrectly implement these strategies. It is critical to collect procedural fidelity to affirm that the results of the intervention can be accurately attributed to the intervention in question (Gresham, Gansle, & Noell, 1993; Meadan, Ostrosky, Zaghlawan, & Yu, 2009). Previous research

has found that high levels of procedural fidelity are correlated with intervention effectiveness (Gearing et al., 2011; Grow et al., 2009; DiGennaro, Martens, & Kleinmann, 2007; Noell, Gresham, & Gansle, 2002). Although collecting data on procedural fidelity is considered important in terms of research methodology and quality of the research designs, the current *Single-Case Design Technical Documentation* proposed by What Works Clearinghouse (WWC; Kratochwill et al., 2010, 2013) did not include procedural fidelity as a threat to internal validity of SCED (Wolerly, 2013). Excluding procedural fidelity from SCED standards may lead researchers to exclude data on procedural fidelity in their SCED research. Much of the SCED research on primary caregiver-implemented communication interventions has not reported procedural fidelity measures (e.g., Aldread et al., 2004; Baxendale & Hesketh, 2003; Buschmann et al., 2008; Drew et al., 2002; Van Balkom et al., 2010; Fey et al., 1993; Gibbard, 1994; Gibbard et al., 2004). The lack of procedural fidelity measures on those studies leads to questions regarding whether or not an intervention was implemented as intended and, thus, whether or not it is the sole factor that affected improvement of behavior and communication skills of individuals with ASD. That is, there may be other variables, such as supplementary strategies (e.g., reinforcement, instructor feedback) that may have impacted the results as much as, or more than the intended intervention. Additionally, since procedural fidelity affirms the treatment effects (Gresham, Gansle, & Noell, 1993; Meadan, Ostrosky, Zaghlawan, & Yu, 2009), the lack of procedural fidelity of those studies leaves doubt about whether those interventions can truly be considered an EBP (Horner et al., 2005; Kratochwill et al., 2010).

The lack of participant descriptions in literature on caregiver-implemented language and communication interventions for individuals with ASD also points to the need to investigate the generalizability of a study procedure with different individuals with ASD. In SCED research, to enable other researchers to replicate a study and to determine for whom the results may be applicable, it is necessary to provide adequate descriptions of participants' diagnoses and how the participants were diagnosed with disabilities (Horner et al., 2005; Wolery, 2013). For example, participants' diagnoses should be described by including the specific diagnosis and instruments or assessment tools used to assess the participants. In addition, language and communication characteristics and any symptoms of the participants should be described. Since every individual with ASD shows different language and communication characteristics, the paucity of descriptions regarding such information may lead to doubt about whether caregiver-implemented interventions are effective in improving those skills of individuals with ASD overall.

The purpose of the current review of SCED research is to evaluate the quality of research on primary caregiver-implemented communication interventions for people with ASD. The following question was addressed: (a) does the body of literature on primary caregiver-implemented communication interventions meet the criteria for evidence-based practices as outlined by Kratochwill et al. (2010)?; and (b) the body of literature on such interventions was evaluated to determine whether the primary caregiver-implemented communication interventions for individuals with ASD can be

considered an EBP, based on the WWC standards (Kratochwill et al., 2010), with the addition of design standards to evaluate participant descriptions and procedural fidelity.

Method

Article Identification

The search procedures used in this review are a subset of the other search conducted by Hong (2015). A subset of the articles included in that search was selected to include in this review. That is, the prior work evaluated both caregiver- and peer-implemented interventions for individual with any developmental disability, while this review only includes those studies that reported implementing caregiver-implemented intervention for individuals with ASD.

Search Procedures. Peer-reviewed and non-peer reviewed papers including journal articles, books, dissertations, and other publications were included for this review. Publication year was not restricted. *ERIC, PsychINFO, Academic Search Complete, Professional Development Collection,* and *Social Science Full Text* were used to search for literature. Keywords included: *autis*, ASD, pervasive developmental disorder*, PDD*, Asperger*, development* disab*, low-incidence dis*, intellectual* disab*, mental* retard*,* and *multiple disab** were each combined with the terms, *parent* training, parent education, primary caregiver* training, caregiver* education, sibling training, famil* training, langu*, play*, communic*, langu*, social*,* and *social communic*.* In addition, the reference lists of studies meeting inclusion criteria and the publications of the authors of the studies meeting inclusion criteria were reviewed to identify additional studies for possible inclusion. Initially, a total of 1998 documents

were identified. If a document did not have an author or was duplicated, it was excluded resulting in a number of 1740 documents.

Inclusion and Exclusion Criteria. Initially, the abstract and full text of each article were evaluated regarding whether or not the document included participants who had been diagnosed as having an ASD. Then, the documents identified to have participants with ASD were assessed to determine whether or not it met all of the following inclusion criteria: (a) at least one of those participants' primary caregivers (e.g., parent, other relative, paid in-home caregiver) must have played a role as an intervention implementer; (b) as an outcome measure, language and communication skills must have been targeted, such as any verbal or recognizable words, use of augmentative and alternative communication (AAC; Ganz et al., 2011) system, use of expressive or receptive language, and use of linguistic structures or grammatical forms; (c) the article must have assessed the efficacy of any type of educational intervention; (d) the article must have conducted an experimental research design including a group design or single-case design, such as AB, alternating treatment, reversal, changing criterion, or multiple-baseline design; (e) in case of a group design, the paper must have reported time-series data for individual participants; (f) the article must have presented data in graphical displays that presented individual data points; and (g) the article was excluded if primary caregiver data and outcome measures were not differentiated from other participants (such as paraprofessionals, teachers, researchers, etc.) or other outcome measures (such as behaviors, academic skills, etc.). In the case that a

dissertation was included and a corresponding article was published, the published article was excluded.

Inter-Rater Reliability: Inclusion/Exclusion Criteria. To determine whether an article meets inclusion criteria, two raters independently applied the initial inclusion/exclusion criteria to 60% of the articles found in the initial search (*N*=1052). Two raters reviewed the abstract of each study and determined whether the study included at least one participant with ASD. If there was a disagreement on included and non-included articles between two raters, the final determination to include or exclude articles was made by a third independent rater or the two reviewers discussed the discrepancy until they came to consensus. A total of 110 articles were identified that met the initial criterion. *Chi-Squared* was calculated to compute IRR on the initial inclusion/exclusion criteria. As a result of the calculation, IRR on the initial criterion was 1.000, indicating that there was a high agreement between the raters. After the initial screening, two raters reviewed a full text of remaining documents to ensure all identified studies met rest of the inclusion criteria. A total of 40 articles met the inclusion criteria. One article (Bryson et al., 2007) was a group study and did not report data for an individual participant, and therefore, was excluded from further analysis. No other group studies were identified for inclusion. A *Chi-Squared* statistic (Cohen, 1976) was calculated to compute IRR (see Table 2). As a result of the calculation, IRR on the inclusion/exclusion criteria ranged from .978 to 1.000.

Application of Basic Design Standards

After the initial screening, articles were reviewed based on basic design standards developed by the WWC (Kratochwill et al., 2010), and adapted by Maggin, Briesch, and Chafouleas (2013). Six design standard indicators must be met to meet the design standards. An overall score of 0, 1, or 2 was assigned for each design standard based on whether the article overall met the standards, met the standards with reservations, or did not meet the design standards (Kratochwill et al., 2010; Maggin et al., 2013).

WWC Design Standards. Design Standard 1 evaluated whether the independent variable or intervention was systematically manipulated (Kratochwill et al., 2010; Maggin et al., 2013). Rather than considering naturally occurred events, the independent variable was introduced and changed, that is, the study had to document manipulation of the independent variable (Kratochwill et al., 2010; Maggin et al., 2013). If the design met this standard, a score of 1 was given. If the design did not meet this standard, then a score of 0 was given.

Design Standards 2A-2C and 3 were scored as 1 if the standard was met and 0 if the standard was net met. Design Standard 2A evaluated whether the inter-observer agreement (IOA) data were collected (Kratochwill et al., 2010; Maggin et al., 2013). IOA was calculated by measuring dependent variables by two or more than two evaluators over time. If the article included IOA data, it indicated that the design met this standard. Design Standard 2B evaluated whether or not the IOA was collected and reported on at least 20% of the data points in each condition (Kratochwill et al., 2010;

Maggin et al., 2013). The condition referred either to a baseline, intervention, generalization, or maintenance condition. Design Standard 2C evaluated whether or not IOA averaged .80 or higher measured by percentage agreement or at least .60 by *Cohen's kappa* coefficient (Kratochwill et al., 2010; Maggin et al., 2013).

Design Standard 3 evaluated whether the article includes at least three attempts of demonstration of an intervention effect at three different points in time or with three different condition changes (Kratochwill et al., 2010; Maggin et al., 2013). Designs including ABAB designs, multiple baseline or multiple probe designs with at least three baseline and intervention conditions, and changing criterion designs with at least three different attempts, and alternating treatment designs with five attempts to demonstrate an intervention effect met this standard and received a score of 1. If multiple baseline or multiple probe designs only included two legs, it did not meet the standard, and therefore AB, BAB, and ABA designs did not meet this standard.

Design Standard 4 evaluated whether each condition, except for generalization and maintenance condition, had at least three data points (Kratochwill et al., 2010; Maggin et al., 2013). If a reversal and withdrawal design had four conditions per design while including five data points per condition, it met standards and received a score of 2. If there were four conditions with at least three data points per condition, a score of 1 was given (met with reservations). If there were fewer than four conditions and three data points per condition, a score of 0 was given (did not meet standard). In a case of a multiple baseline or a multiple probe design, to meet standards, it had to have six conditions while including at least five data points per condition. If there were at least

six conditions with at least three data points per condition, it met standards with reservations. If there were any conditions with fewer than three data points, the article did not meet this standard. For an alternating treatment design, to meet standards, it must have had five attempts of the condition changes. If there were four attempts, it met standards with reservations. If there were fewer than four, it did not meet standards.

Each article was then given an overall score of 0, 1, or 2 (Kratochwill et al., 2010; Maggin et al., 2013). If all the design standards were scored with the highest score, indicating that the article met the standards (score of 2). If any of those standards was not scored with the highest score but not assigned a score of 0, the article met the standards with reservations (score of 1). If any of the standards were scored with 0, the article did not meet the standards (score of 0). Articles that did not meet either the standards or the standards with reservations were excluded from further evaluation (*N*=28). A total 12 articles met the design standards or met them with reservations and were evaluated for evidence standards.

Additional Design Standards: Procedural Fidelity and Participant

Descriptions. In this review, as recommended by Wolery (2013), while evaluating each article with the design standards, researcher's procedural fidelity in implementation of the intervention with the caregiver was also assessed. A score of 1 was assigned if the article included, at a minimum, a description of how the intervention was evaluated for procedural fidelity of implementation, at least 20% of intervention data points were evaluated for procedural fidelity of implementation and procedural fidelity of

implementation was at least 80% accurately implemented. If not, a score of 0 was assigned.

In SCED research, to enable other researchers to replicate a study and to determine for whom the results may be applicable, it is necessary to provide adequate descriptions of participants' diagnoses and how the participants were diagnosed with disabilities (Horner et al., 2005; Wolery, 2013). For example, participants' diagnoses should be described by including the specific diagnosis and instruments or assessment tools used to assess the participants. In addition, behavior characteristics and any symptoms of the participants should be described. If a study provided such information, a score of 1 was given; if not, a score of 0 was given to the study. Based on evaluation with this additional standard, an overall rating was assigned to each article. Because these standards exceed the current standards of the field (e.g., Kratochwill et al., 2010; Maggin et al., 2013), we did not include these as exclusionary criteria, but provide those results for informative purposes.

Application of Evidence Standards. After evaluating the basic design quality of each article, the quality of the evidence for each experiment within the remaining articles was evaluated based on visual analysis criteria developed by the WWC (Kratochwill et al., 2010), and adapted by Maggin et al. (2013). The remaining articles included a total of 39 experiments. A definition for what was considered to be an experiment is described below.

By applying four steps of visual analysis, each article was examined to determine whether a functional relation existed between manipulation of the independent variable

and dependent variables and the strength of that relation was also evaluated (Kratochwill et al., 2010; Maggin et al., 2013). When changes in dependent variables are caused only by manipulating an independent variable and not by other variables, it indicates that there is a functional relation between the independent and the dependent variables (Horner et al., 2005). In an article utilizing an ABAB or alternating treatment design, an inference can be drawn about the functional relation if the behavior changes in response to the implementation and removal of the intervention (Kadzin, 2011; Horner et al., 2005). If an article utilized a multiple baseline design, an inference can be drawn about the functional relation only when behavior changes are observed across all the subjects, behaviors, or settings only after implementing the intervention (Horner et al., 2005; Watson & Workman, 1981). In a case of an article using a changing criterion design, an inference about the functional relation can be drawn if the performance level meets each pre-determined criterion over the course of intervention implementation (Hartman & Hall, 1976). If there was more than one participant included in an article that utilized a design other than a multiple baseline or multiple probe design across participants (e.g., within-participant designs, such as several MBDs across behaviors, several ABAB designs), each experiment per participant was evaluated separately. A visual analysis to determine the strength of the evidence was conducted on each experiment and included the following indicators. Most of the steps included sub steps scored as meeting, the indicator (score of 1) or not meeting it (score of 0). Those that had three possible scores (0, 1, or 2) are described below. In those cases, a score of 1 indicated meeting the indicator with reservations and a 2 indicated meeting the indicator. The first step of

visual analysis was an evaluation of predictability and stability of data pattern in baseline and consisted of four indicators (Kratochwill et al., 2010; Maggin et al., 2013). *Baseline Change* evaluated whether or not the data pattern appeared to be in need of change, which means data in baseline were flat at expected levels or were moving away from the therapeutic direction. *Baseline Predict* evaluated whether or not the data pattern was predictable, which means, if there was no phase change, the data pattern within baseline was consistent so we could predict how the data pattern would look. *Baseline Variability* evaluated whether or not the data had little variability, or little variance within baseline. *Baseline Trend* evaluated whether or not the trend was stable or moving away from the therapeutic direction.

The second step of visual analysis was an evaluation of the data pattern within intervention conditions and consisted of four indicators (Kratochwill et al., 2010; Maggin et al., 2013). *Within Points* evaluated the number of data points in each phase. If each condition, except for generalization and maintenance, included at least five data points, a score of 2 was given the indicator met the standard. If each condition included at least three data points, it met the standard with reservations. If any condition included less than three data points, it did not meet the standard. *Within Predict* evaluated the predictability of the data pattern. If the data pattern was predictable, which means the data pattern within non-baseline was consistent and improving or maintaining an improved level, it met the standard. *Within Variability* evaluated the data variability; low variability met the standard. *Within Trend* evaluated whether or not the trend was stable or moving towards the therapeutic direction.

The third step of visual analysis was an evaluation of the data pattern between conditions and consisted of seven indicators (Kratochwill et al., 2010; Maggin et al., 2013). *Between Basic Effect* evaluated whether or not there was the presence of basic effects between baseline and intervention condition. If less than half of data points in baseline did not overlap with data in an adjacent phase, it met the standard. *Between Level Immediacy* evaluated the level change between phases. If there was a significant level change between the first three data points of the intervention condition and last three data points of the baseline condition, it met the standard. *Between Level Change* evaluated whether or not there was an overall level change between the conditions. *Between Trend Change* assessed the overall change in trend between phases. If the overall change in trend between the conditions was significant, which means the trend in baseline remained at low and stable rate but there was a significant level change, this standard was met. *Between Variability* evaluated whether the overall variability between the conditions was significant. If data variability in baseline was similar to that in the non-baseline condition (i.e., low variance vs. low variance, high variance vs. high variance), a score of 1 was given; and if not, a score of 0 was given. *Between Overlap* evaluated whether a degree of the non-overlap gap between the conditions was significant, which means there were few data points overlapped between baseline and non-baseline phase. If so, a score of 1 was given; and if not, a score of 0 was given. *Between Similarity* assessed whether or not the data patterns in similar conditions resembled each other (i.e., baseline vs. baseline, intervention vs. intervention).

The fourth step of visual analysis was an evaluation of overall effectiveness and consisted of three indicators (Kratochwill et al., 2010; Maggin et al., 2013). First, *Overall Data Points* evaluated how many data points were collected in each condition of an experiment, except for generalization and maintenance condition. If all conditions in an experiment included at least five data points, the experiment met the standard. If any condition included 3-4 data points, and the rest of the conditions included 3 or more data points, the standard was met with reservations. If any condition included less than three data points, a score of 0 was given. Second, *Overall Treatment Effects* evaluated whether experiments included at least three attempts of demonstration of an intervention effect. If so, it met the standard. Third, *Overall Ratio* evaluated the ratio of effects to non-effects of each experiment. If an article had at least three demonstrations of intervention effect with no case of non-effect, it met the standard, if an article had three demonstrations of intervention effect with one case of non-effect, it met the standard with reservations;, and if an article had three demonstrations of intervention effect with more than one case of non-effect, it did not meet the standard.

Overall Evidence was determined for each experiment based on rating given under each indicator (Maggin et al., 2013). Each experiment was rated either as strong evidence, or moderate evidence, or no evidence. If any step was given a score of 0 then the article was considered as providing no evidence. If any step was given a score of met with reservations, and all other steps were rated as met or met with reservations, then the article was considered to have moderate evidence. If all of the steps were scored as having met the standards, then the article was considered to have strong evidence. If an

article included more than one experiment, each experiment was evaluated separately. For example, if three participants participated in one article and each had an individual experiment, then three participants were evaluated as three experiments.

Inter-Rater Reliability: Design and Evidence Standards. Following the initial determination of whether an article was included, two independent raters evaluated about 60% of the articles (*N*=23) for the design standards and 100% of the experiments (*N*=41) for the evidence standards. IRR was calculated on each of the six basic design standards, and each of the four evidence standards to determine whether two raters agreed on whether each study met standards/met standards with reservations/did not meet standards. If there was disagreement on individual standards between two raters, a third rater reviewed the disagreement or the two reviewers discussed the discrepancy until they came to consensus. IRR for basic design and evidence standards was calculated by using a *Chi-Squared* statistic (Cohen, 1976). IRR was calculated for each article for basic design and for evidence standards and an overall for each article (see Table 2). As a result of the calculation, IRR on the design standards ranged from .634 to 1.000, indicating that there were substantial to high agreements between the raters. IRR on the evidence standards ranged from .717 to 1.000, indicating that there were substantial to high agreements between the raters. Design Standards 4 got a lower IRR. When rating the Design Standard 4, two criteria should have been considered to meet the standard; one was a number of conditions and the other one was a number of data points in each condition should have been considered. However, it was found that one rater sometimes rated this standard by evaluating only a number of data points in each

condition, which made the rater generous on rating. In the meanwhile, the other rater consistently evaluated both of the criteria, which made the rater stricter on rating. For example, a study utilized a multiple baseline design that included less than six conditions but each condition included a minimum of five data points. In this case, one rater gave 0, and the other rater gave either 1 or 2. Given this discrepancy in rating, the two raters discussed this and came to consensus. After then, the second rater reevaluated additional articles for this design standard. Compared to IRR on design standards, some of IRRs on the evidence standards got lower scores. This was because many of the quality of evidence standards are somewhat subjective.

Table 2

Interrater reliability for inclusion and exclusion criteria, design standards, and evidence standards

Inclusion/Exclusion Criteria	Kappa	Design Standards	Kappa	Evidence Standards	Kappa
1st criterion	1.000	Overall Standard	.849	Baseline Change	.844
2nd criterion	1.000	DS#1: Independent Variable	1.000	Baseline Predict	.868
3rd criterion	1.000	DS#2A: [a]IOA Collected	1.000	Baseline Variability	.820
4th criterion	1.000	DS#2B: IOA 20%	.826	Baseline Trend	.795
5th criterion	1.000	DS#2C: Minimum Quality Thresholds of IOA	1.000	Within Points	.741
6th criterion	.978	DS#3: Replication Effects	.919	Within Predict	.854
7th criterion	1.000	DS#4: Number of Data Points	.634	Within Variability	.802
8th criterion	.982	DS#5 Procedural Fidelity	.826	Within Trend	.806
		DS#6 Participant Description	.893	Between Basic Effect	.902
				Between Level Immediacy	.752
				Between Trend Immediacy	.796
				Between Level Change	.739
				Between Trend Change	.851
				Between Variability	.717
				Between Overlap	.852
				Between Similarity	1.000
				Overall Data Points	.889
				Overall Treatment Effect	.927
				Overall Ratio	.802
				Overall Evidence	.768

[a]IOA-interobserver agreement

Study Characteristics

Experiments in the studies included in this analysis were grouped by dependent variables collected with individuals with ASD and caregivers since the studies often targeted either or both of their behaviors. When targeting the caregivers' behaviors, data on the accuracy of the caregivers' intervention implementation were often measured while collecting data on communication skills of individuals with ASD. For example, a study may have demonstrated that it impacted the caregivers' behavior, but not the participants with disabilities. Therefore, the dependent variables were reviewed separately to determine whether primary caregiver-implemented interventions can be an EBP for communication skills for individuals with ASD, which is a purpose of this current analysis.

Evaluation for Evidence-Based Practice: Replication of Effects

To determine whether primary caregiver-implemented communication intervention can be considered an evidence-based practice, the following criteria were examined broken down by caregiver outcomes and outcomes for participants with disabilities, as proposed by Horner et al. (2005) and updated by WWC (Kratochwill et al., 2010):

1. There must be a minimum of five single case design studies on primary caregivers' communication intervention implementation that met evidence standards or met evidence standards with reservations.
2. The studies must be carried out by at least three different investigators with no overlapping authorship at a minimum of three different institutions.

3. There must be at least a total of 20 single-case experiments across the studies.

Results

A total of 40 articles were initially analyzed with the design standards. After evaluating all of the studies for the design standards, studies that met the design standards both with and without reservations were evaluated with the evidence standards. Table 3 provides a summary of dependent and independent variable in each study. Table 4 presents a detailed summary of each article, analyzed for each design standard. The studies that did not meet the design standards were excluded from further analysis of the evidence standards. Table 5-6 provide summaries of whether or not each experiment within each article met the evidence standards.

Overall Study Characteristics: Dependent and Independent Variable

An overall description of each article (N=12) that met the design standards or met them with reservations was summarized by experiment according to dependent and independent variables in each study (see Table 4). A total of 41 experiments across the 12 studies were included that met the design standards or met them with reservations. In terms of dependent variables, 5 of the studies collected data on behaviors of both of individuals with ASD and their caregivers. A total of 26 experiments measured data on communication outcomes of individuals with ASD. Across the 5 studies that collected data both on individuals with ASD and caregivers, a total of 11 experiments measured data on treatment fidelity of the caregivers' correct intervention implementation. Table 3 shows types of the independent variable utilized in each study.

Table 3

Summary of each study that met the design standards or met them with reservations

Study	Participant	Outcome Variables		Independent Variables	
		Individuals with ASD	Caregivers' behaviors	Training caregivers	Training individuals with ASD
Coolican et al. (2010)	8 children with ASD (average age: 3 y 8 m)/ 8 caregivers	Functional verbal utterances/type of utterances	Treatment fidelity of [a]PRT principles	Written instructions, modeling, performance feedback	Pivotal response training principles
Crockett et al. (2007)	One child with ASD (4 y)/ 1 caregiver	Prompted response (label, verbal imitation)/correct response (answer to questions, follow instructions)/ incorrect response (not answer to questions correctly, follow instruction incorrectly)	Treatment fidelity of [b]DTT procedures	Verbal instructions, reviewing videos of intervention procedures being implemented, performance feedback	Discrete Trial Training procedures
Gillett & LeBlanc (2007)	3 children with ASD (average age: 4 y 3 m)/ 3 caregivers	Frequency of vocalization (words or approximations)/ spontaneous vocalization	Not measured	Verbal instructions, reviewing videos of intervention procedures being implemented, performance feedback	Natural Language Paradigm

Table 3 Continued

Study	Participant	Outcome Variables		Independent Variables	
		Individuals with ASD	Caregivers' behaviors	Training caregivers	Training individuals with ASD
Hong et al. (2014)	1 individual with ASD (32 y)/ 4 caregivers	Independent use of [c]AAC (Tap to Talk)	Treatment fidelity of AAC implementation	Coaching, verbal instructions, modeling, role-play, performance feedback	Instructional coaching (use of AAC mode): entice items, modeling, prompts
Mancil et al. (2009)	3 individuals with ASD (average age: 5 y 11 m)/ 3 caregivers	Use the target communication response by labeling an item or activity appropriately	Not measured	Reviewing videos of intervention procedures being implemented, role-play	Modified miliue therapy intervention, Functional communication training
Park et al. (2011)	3 individuals with ASD (age: 2y 6m)/ 3 caregivers	Independent picture exchanges ([d]PECS)/ word vocalizations (word utterances and word approximations)	Not measured	Written and verbal instructions, modeling, reviewing videos of intervention procedures being implemented, performance feedback	Picture Exchange Communication System procedures
Randolph et al. (2011)	3 individuals with ASD (average age: 5y)/ 3 caregivers	Nonverbal responses/communicative initiations/communicative responses/ social-communication	Treatment fidelity of PRT principles	In-vivo practice, performance feedback	Pivotal Response Training

Table 3 Continued

Study	Participant	Outcome Variables		Independent Variables	
		Individuals with ASD	Caregivers' behaviors	Training caregivers	Training individuals with ASD
Reagon et al. (2009)	3 individuals with ASD (average age: 3y 7m)/ 3 caregivers	Unscripted verbal initiations/scripted initiation/direct answers to questions or directions	Not measured	Verbal instructions, modeling, prompts, role-play, performance feedback	Audio Script-fading intervention
Robertson et al. (2013)	2 individuals with ASD (average age: 3y 8m)/ 2 caregivers	Spontaneous requests: all verbal statements	Not measured	Coaching, video feedback	Providing reinforcement contingent on appropriate behaviors
Singh (2012)	3 individuals with ASD (average age: 3y 2m)/ 3 caregivers	Appropriate verbal responses to open-ended questions	Treatment fidelity of PRT principles	Verbal instructions, in-vivo practice, modeling	Typical PRT procedures
Tomaino (2011)	6 individuals with ASD (average age: 7y 6m) / 6 caregivers	Number of correct responses/scripted responses/unscripted responses	Treatment fidelity of intervention implementation	Verbal instructions, modeling, role-play, performance feedback	Visual scripts and script fading
Vernon et al. (2012)	3 individuals with ASD (average age: 2y 9m)/ 3 caregivers	Child eye contact/child verbal initiations	Not measured	Verbal instruction, video feedback	Pivotal Response Training

[a]PRT-pivotal response training, [b]DTT-discrete trial training, [c]AAC-augmentative and alternative communication, [d]PECS-picture exchange communication system

Design Standards Based on the Original Standards

Design standard ratings for each study are summarized in Table 4. A total of 40 studies were evaluated with the design standards; 3 studies met the design standards. Of those 9 studies met them with reservations failure to fully meet standards was often due to phases included 3-4 data points instead of the 5 required to meet standards. A total of 28 studies did not meet the design standards. Those 10 studies that met the design standards with reservations but that were not scored with the highest score of each standard were due to a lack of the minimum number of data points in each condition. The 28 studies that failed to meet the design standards primarily failed to meet one of the following criteria. First, most of the studies did not report collecting IOA data on at least 20% of data points in each condition and several failed to meet the requirement of the minimum quality thresholds (i.e., .80 or higher measured by percentage agreement or .60 by *Cohen's kappa* coefficient). Second, nine studies did not include at least three attempts to demonstrate a treatment effect at three different points in time. Third, 10 studies did not include at least three data points in each phase.

Design Standards with Additional Standards

An overall evaluation with the additional design standards (i.e., procedural integrity and participant descriptions) was also conducted for each study included in this review. Across the 40 studies, 13 studies reported both of procedural integrity and participant descriptions while eight studies did not report any of these standards. After applying the additional standards for the 12 studies that met the original design standards or met them with reservations, only seven studies were found to meet the standards with the additional standards or met them with reservations. Studies that failed to meet the additional standards were not excluded from the evidence standards evaluation.

Table 4

Design standards

Study	Original Standards							Additional Standards		
	Overall Standards	DS#1: Independent Variable	DS#2A: IOA Collected	DS#2B: IOA 20%	DS#2C: Minimum Quality Thresholds of IOA	DS#3: Replication Effects	DS#4: Number of Data Points	Overall Standards with Additional Standard	Procedural Integrity	Participant Description
Met the design standards										
Crockett et al. (2007)	2	1	1	1	1	1	2	0	0	0
Hong et al. (2014)	2	1	1	1	1	1	2	0	1	0
Park et al. (2011)	2	1	1	1	1	1	2	2	1	1
Met the design standards with reservations										
Coolican et al. (2010)	1	1	1	1	1	1	1	0	0	1
Gillett & LeBlanc (2007)	1	1	1	1	1	1	1	1	1	1
Mancil et al. (2009)	1	1	1	1	1	1	1	1	1	1
Randolph et al. (2011)	1	1	1	1	1	1	1	0	0	1
Reagon et al. (2009)	1	1	1	1	1	1	1	0	0	0
Robertson et al. (2013)	1	1	1	1	1	1	1	1	1	1

Table 4 Continued

Study	Original Standards							Additional Standards		
	Overall Standards	DS#1: Independent Variable	DS#2A: IOA Collected	DS#2B: IOA 20%	DS#2C: Minimum Quality Thresholds of IOA	DS#3: Replication Effects	DS#4: Number of Data Points	Overall Standards with Additional Standard	Procedural Integrity	Participant Description
Singh (2012)	1	1	1	1	1	1	1	1	1	1
Tomaino (2011)	1	1	1	1	1	1	1	1	1	1
Vernon et al. (2012)	1	1	1	1	1	1	1	1	1	1
	Did not meet the design standards									
Ben Chaabane et al. (2009)	0	1	1	0	1	1	2	0	1	0
Carr et al. (1999)	0	1	1	0	1	1	1	0	0	1
Carson et al. (2012)	0	1	1	0	0	1	0	0	0	1
Casey (1978)	0	1	1	0	1	0	2	0	0	1
Charlop & Carpenter (2000)	0	1	1	0	1	1	1	0	1	1
Charlop & Trasowech (1991)	0	1	1	0	1	1	1	0	0	0
Elder (1995)	0	1	0	0	0	0	1	0	0	1
Hemmeter & Kaiser (1994)	0	1	1	0	1	1	2	0	1	0
Ingersoll & Wainer (2013)	0	1	1	0	1	1	1	0	0	0

Table 4 Continued

Study	Original Standards							Additional Standards		
	Overall Standards	DS#1: Independent Variable	DS#2A: IOA Collected	DS#2B: IOA 20%	DS#2C: Minimum Quality Thresholds of IOA	DS#3: Replication Effects	DS#4: Number of Data Points	Overall Standards with Additional Standard	Procedural Integrity	Participant Description
Kaiser et al. (2010)	0	1	1	0	1	1	1	0	0	0
Kashinath et al. (2006)	0	1	1	0	1	0	1	0	0	0
Kirby (2013)	0	1	1	1	0	1	0	0	1	0
Koegel et al. (2002)	0	1	1	1	0	1	0	0	1	1
Lafasakis & Sturmey (2007)	0	1	1	0	0	1	1	0	0	1
Laski et al. (1988)	0	1	1	0	0	1	1	0	1	0
Moes & Frea (2002)	0	1	1	0	0	1	0	0	0	0
Mulford (2010)	0	1	1	1	1	0	0	0	0	1
Nordquist & Wahler (1973)	0	1	1	0	1	0	2	0	0	1
Nunes & Hanline (2007)	0	1	1	0	1	0	0	0	0	0
Rocha et al. (2007)	0	1	1	0	1	1	1	0	1	1
Schertz & Odom (2007)	0	1	1	0	1	1	1	0	0	1

Table 4 Continued

Study	Original Standards							Additional Standards		
	Overall Standards	DS#1: Independent Variable	DS#2A: IOA Collected	DS#2B: IOA 20%	DS#2C: Minimum Quality Thresholds of IOA	DS#3: Replication Effects	DS#4: Number of Data Points	Overall Standards with Additional Standard	Procedural Integrity	Participant Description
Stiebel (1999)	0	1	1	0	1	1	2	0	0	1
Strain & Danko (1995)	0	1	1	0	1	1	1	0	0	1
Symon (2005)	0	1	1	0	1	1	0	0	1	1
Vismara et al. (2013)	0	1	1	0	1	0	0	0	0	1
Vismara & Rogers (2008)	0	1	1	0	1	0	0	0	0	1
Vismara et al. (2009)	0	1	1	0	1	0	0	0	1	1
Vismara et al. (2012)	0	1	1	0	1	1	1	0	1	1
Vogler-Elias (2009)	0	1	1	0	1	1	1	0	0	1

Evidence Standards

Studies that met the initial design standards or met them with reservations were included in an analysis of the evidence standards. As a result, a total of 39 single-case experiments were included across the 12 remaining studies and each experiment was analyzed with the evidence standards. Since the studies often measured behaviors of either or both of individuals with ASD or/and caregivers, experiments included in those studies were grouped by outcome measures including the communication skills of the individuals with ASD and the accuracy of intervention implementation of the caregivers (see Tables 5 and 6).

Evidence Standards: Outcome Measures on Behaviors of Individuals with ASD. Among the 12 studies that met the design standards or met them with reservations, there were a total of 28 experiments that measured the communication skills of individuals with ASD. Table 5 summarizes evidence standard ratings for each experiment that measured the communication skills of individuals with ASD.

Most of the experiments met criteria based on the state of the baseline data. Some experiments that failed this standard (e.g., Collican et al., 2010; Crockett et al., 2007; Robertson et al., 2013; Singh, 2012) failed due to the following reasons. First, baseline data were not consistent enough to predict how the data pattern would look if there was no phase change. Second, the data had large variance within baseline. Third, the baseline data trended toward improvement or toward the therapeutic direction. A similar pattern was found in evaluation of data in the intervention phase; three experiments met all the criteria of *Within Phase* evaluation across three studies (i.e., Coolican et al., 2010;

Mancil et al., 2008; Park et al., 2011). More than two-thirds of the experiments failed to meet the intervention phase for the following reasons: data in those experiments' intervention phases were not consistent and predictable, a range of the data in intervention phase had large variance and data trended away from improvement or away from the therapeutic direction. Only six experiments across four studies met all the criteria for *Between Phases* evaluation (i.e., Mancil et al., 2009; Park et al., 2011; Singh, 2012; Tomaino, 2011). Two-thirds of all experiments analyzed with evidence standards failed to meet the following criteria: there was no immediacy of basic effect between phases, there was no substantial level change between phases either immediately or in general, no significant change in trend between phases was found and overall data points in the adjacent phases Had a large degree of overlapped.

To evaluate an overall effectiveness, *Overall Data Points, Overall Treatment Effects,* and *Overall Ratio* were assessed. Most of the experiments either met the criteria or met them with reservations, despite some weaknesses within and between phases. The experiments that met the criteria with reservations had 3-4 data points collected in some phases. Only two experiments in one study (i.e., Mancil et al., 2009) collected at least five data points in each phase. Overall, two experiments had strong evidence of an effect. 15 experiments were found to have a moderate evidence of an effect, and 11 experiments appeared to have no evidence of an effect.

Table 5

Evidence standards: Outcome measures for individuals with ASD

Study	Participant ([a]DV)	[b]BACH	[c]BAPR	[d]BAVA	[e]BATR	[f]WIPO	[g]WIPR	[h]WIVA	[i]WITR	[j]BTBA	[k]BTLI	[l]BTTI	[m]BTLC	[n]BTTC	[o]BTVC	[p]BTOV	[q]BTSI	[r]OVDP	[s]OVTE	[t]OVRA	[u]OV
Coolican et al. (2010)	Child 1-8 (functional verbal utterances)	1	0	0	0	1	1	1	1	1	1	0	1	0	1	0	NA	1	0	1	0
Crockett et al. (2007)	Nevin (correct verbal imitation)	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	NA	0	0	0	0
	Nevin (incorrect verbal imitation)	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	NA	0	0	0	0
	Nevin (prompted verbal imitation)	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	NA	0	0	0	0
Gillett & LeBlanc (2007)	Caleb, Garrett, Marcus (spontaneous vocalization)	1	1	1	1	1	0	0	0	0	1	0	1	1	1	0	NA	1	2	1	1
	Caleb, Garrett, Marcus (prompted vocalization)	1	1	1	1	1	0	1	0	0	1	0	0	0	1	0	NA	1	2	1	1

Table 5 Continued

Study	Participant ([a]DV)	[b]BACH	[c]BAPR	[d]BAVA	[e]BATR	[f]WIPO	[g]WIPR	[h]WIVA	[i]WITR	[j]BTBA	[k]BTLI	[l]BTTI	[m]BTLC	[n]BTTC	[o]BTVC	[p]BTOV	[q]BTSI	[r]OVDP	[s]OVTE	[t]OVRA	[u]OV
Hong et al. (2014)	Ryan-Joshua (use of AAC)	1	1	1	1	1	0	0	0	0	0	0	1	0	1	0	NA	1	2	2	1
	Ryan-Carol (use of AAC)	1	1	1	1	1	0	0	0	0	0	0	1	0	1	0	NA	1	2	2	1
	Ryan-Jared (use of AAC)	1	1	1	1	1	0	0	0	0	1	0	1	0	1	0	NA	1	2	2	1
	Ryan-Troy (use of AAC)	1	1	1	1	1	0	0	0	0	0	0	1	0	1	0	NA	1	2	2	1
Mancil et al. (2009)	Scott, David, Zeb (prompted response)	1	1	1	1	2	0	0	0	1	1	1	1	0	1	1	NA	2	2	2	2
	Scott, David, Zeb (unprompted response)	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1	NA	2	2	2	2
	Scott, David, Zeb (response rate)	1	1	1	1	1	0	1	0	1	0	0	1	1	1	0	NA	1	2	0	0
Park et al. (2011)	Tad (use of AAC)	1	1	1	1	1	1	1	1	1	1	NA	1	1	1	1	NA	0	2	2	0
	Eric (use of AAC)	1	1	1	1	2	0	0	1	0	0	NA	1	1	1	1	NA	1	2	1	1
	Bill (use of AAC)	1	1	1	1	1	0	0	0	0	1	NA	1	1	1	1	NA	0	2	2	0

Table 5 Continued

Study	Participant ([a]DV)	[b]BACH	[c]BAPR	[d]BAVA	[e]BATR	[f]WIPO	[g]WIPR	[h]WIVA	[i]WITR	[j]BTBA	[k]BTLI	[l]BTTI	[m]BTLC	[n]BTTC	[o]BTVC	[p]BTOV	[q]BTSI	[r]OVDP	[s]OVTE	[t]OVRA	[u]OV
Randolph et al. (2011)	Bryan, Wyatt, Kim (nonverbal response)	1	1	0	1	2	0	0	0	0	0	0	0	0	0	0	NA	1	0	1	1
	Bryan, Wyatt, Kim (verbal response)	1	1	1	1	2	0	0	0	0	0	0	0	0	0	0	NA	1	0	1	1
	Bryan, Wyatt, Kim (initiations)	1	1	1	1	2	0	1	0	0	0	0	0	0	0	0	NA	1	0	0	0
Reagon et al. (2009)	Collin, Brandon, Jake (verbal imitation)	1	1	1	1	2	0	0	0	1	0	0	1	1	1	1	NA	1	2	2	1
Robertson et al. (2013)	Nicholas (verbal request)	0	1	0	0	1	1	1	0	0	0	1	0	0	1	0	0	0	2	1	0
	Jeff (verbal request)	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	1	2	1	1
Singh (2012)	Child 1-3 (correct response)	1	0	0	1	1	1	0	1	1	1	0	1	1	0	1	NA	1	2	2	1
	Child 1-3 (overall responsivity)	1	0	0	1	1	1	0	1	1	1	1	1	1	1	1	NA	1	2	2	1

Table 5 Continued

Study	Participant ([a]DV)	[b]BA CH	[c]BAPR	[d]BA VA	[e]BA TR	[f]WI PO	[g]WI PR	[h]WI VA	[i]WI TR	[j]BT BA	[k]BT LI	[l]BT TI	[m]BT LC	[n]BT TC	[o]BT VC	[p]BT OV	[q]BT SI	[r]OV DP	[s]OV TE	[t]OV RA	[u]OV
Tomaino (2011)	Nick, Reid, Jenna (correct response)	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	NA	0	2	2	0
	Lilly, Katie, Jordan (correct response)	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	NA	0	2	2	0
Vernon et al. (2012)	Child 1-3 (eye contact)	1	1	1	1	1	0	0	0	1	0	0	1	0	1	0	NA	1	2	2	1
	Child 1-3 (verbal initiations)	1	1	1	1	1	0	0	0	1	0	0	1	0	1	0	NA	1	2	2	1

[a] DV-dependent variable, [b]BA CH-baseline change, [c] BA PR-baseline predict, [d]BA VA-baseline variability, [e]BA TR-baseline trend, [f]WI PO-within points, [g]WI PR-within predict, [h]WI VA-within variability, [i]WI TR-within trend, [j]BT BA-between basic effect, [k]BT LI-between level immediacy, [l]BT TI-between trend immediacy, [m]BT LC-between level change, [n]BT TC-between trend change, [o]BT VA-between variability, [p]BT OV-between overlap, [q]BT SI-between similarity, [r]OV DP-overall data points, [s]OV TE-overall treatment effect, [t]OV-RA-overall ratio, [u]OV-overall evidence

Evidence standards: Outcome Measures on Behaviors of Primary Caregivers. Among the five studies that met the design standards or met them with reservations, there were a total of 11 experiments that measured caregivers' behaviors including the accuracy of their intervention implementation. Table 6 summarizes evidence standard ratings for each experiment that measured the caregivers' behaviors.

To evaluate an overall effectiveness, *Overall Data Points*, *Overall Treatment Effects*, and *Overall Ratio* were assessed. The patterns for caregiver behaviors were similar to those for behaviors of participants with ASD. All the experiments met the criteria with reservations, primarily due to an insufficient number of data points collected in each phase. As a result, none of the experiments had demonstrated strong evidence of an effect, a total of nine experiments were found to have a moderate evidence of an effect, and four experiments appeared to have no evidence of an effect.

Table 6

Evidence standards: Outcome measures on primary caregivers

Study	Participant ([a]DV)	[b]BA CH	[c]BAPR	[d]BAVA	[e]BATR	[f]WIPO	[g]WIPR	[h]WIVA	[i]WITR	[j]BTBA	[k]BTLI	[l]BTTI	[m]BTLC	[n]BTTC	[o]BTVC	[p]BTOV	[q]BTSI	[r]OVDP	[s]OVTE	[t]OVRA	[u]OV
Coolican et al. (2010)	Caregiver ([v]TF)	1	0	0	0	1	1	1	1	1	1	0	1	0	1	0	NA	1	0	1	0
Crockett et al. (2007)	Jina (TF)	0	0	0	0	2	1	1	0	0	0	0	1	0	1	0	NA	2	0	1	0
Hong et al. (2014)	Joshua (TF)	1	1	1	1	1	1	1	1	1	1	0	1	0	0	1	NA	1	2	2	1
	Carol (TF)	1	1	1	1	1	1	1	1	1	1	0	1	0	0	1	NA	1	2	2	1
	Jared (TF)	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	NA	1	2	2	1
	Troy (TF)	1	1	1	1	1	1	1	1	1	1	0	1	0	1	1	NA	1	2	2	1
Randolph et al. (2011)	Caregiver 1-3 (TF)	1	1	1	1	2	1	1	1	1	1	0	1	1	1	1	NA	1	2	2	1
Singh (2012)	Caregiver 1-3 (TF)	1	1	0	1	1	1	0	1	1	1	1	1	1	1	1	NA	1	2	2	1
	Caregiver 1-3 ([w]NOP)	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	NA	1	2	1	1
Tomaino (2011)	Caregiver (Nick, Reid, Jenna) (TF)	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1	NA	0	2	2	0
	Caregiver (Lilly, Katie, Jordan) (TF)	1	1	1	1	2	1	1	1	1	1	1	1	1	0	1	NA	0	2	2	0

[a] DV-dependent variable, [b]BA CH-baseline change, [c] BA PR-baseline predict, [d]BA VA-baseline variability, [e]BA TR-baseline trend, [f]WI PO-within points, [g]WI PR-within predict, [h]WI VA-within variability, [i]WI TR-within trend, [j]BT BA-between basic effect, [k]BT LI-between level immediacy, [l]BT TI-between trend immediacy, [m]BT LC-between level change, [n]BT TC-between trend change, [o]BT VA-between variability, [p]BT OV-between overlap, [q]BT SI-between similarity, [r]OV DP-overall data points, [s]OV TE-overall treatment effect, [t]OV-RA-overall ratio, [u]OV-overall evidence, [v]TF-treatment fidelity, [w]NOP-number of opportunity provided

EBP Evaluation for Communication Skills of Individuals with ASD

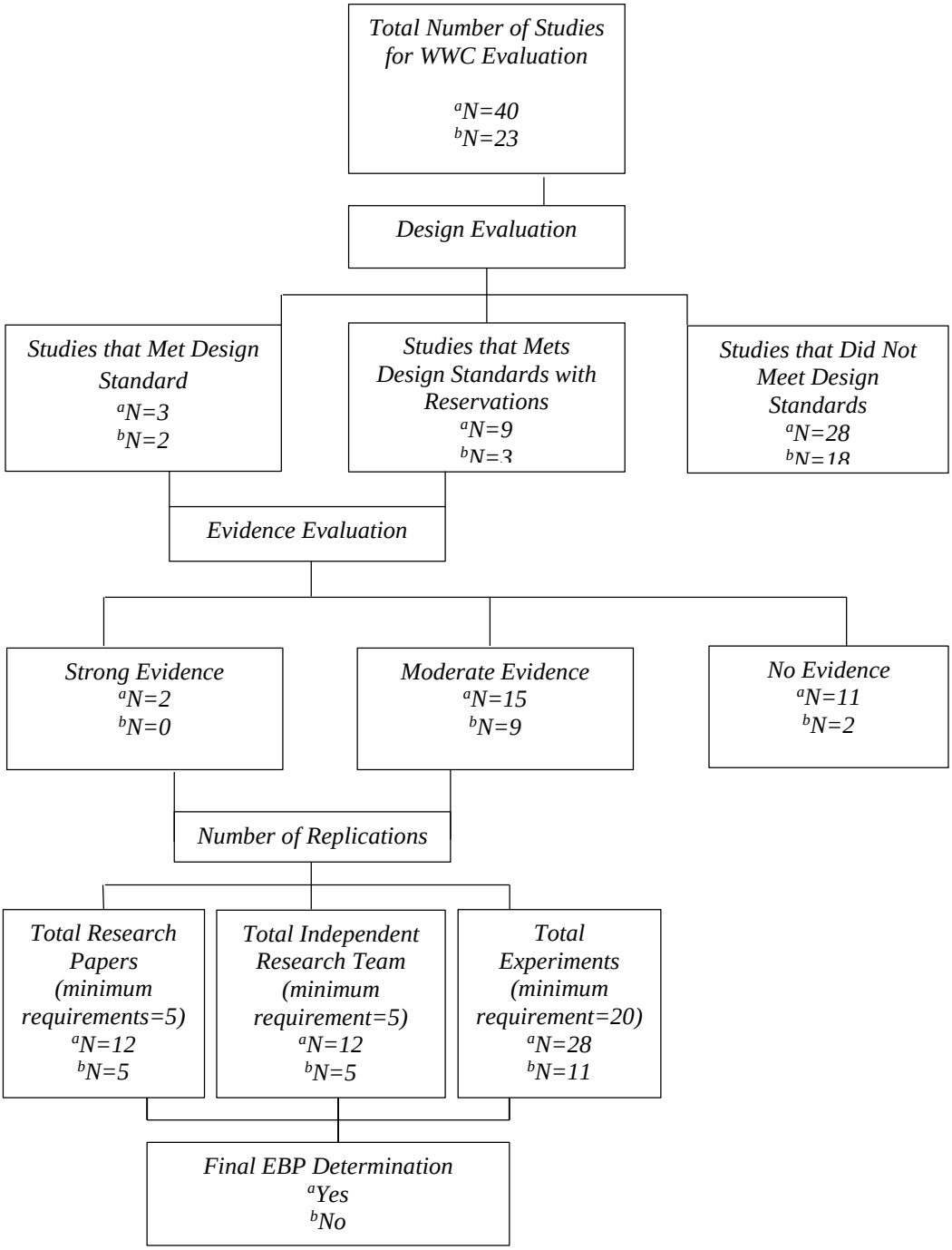
A total of three studies met the evidence standards and nine studies met the standards with reservations (Kratochwill et al., 2010; Maggin et al., 2013) related to communication outcomes for people with ASD. Therefore, primary caregiver-implemented communication intervention meets the first standard for EBP. Across those studies, there is no overlapping authorship, and thus, it meets the second standard for EBP. A total of 28 experiments were included across studies, and therefore, it meets the third standard for EBP. In conclusion, primary caregiver-implemented communication intervention can be considered EBP for communication skills for individuals with ASD (see Figure 3).

EBP Evaluation for Caregivers' Behaviors

A total of two studies met the design standards and three studies met the standards with reservations (Kratochwill et al., 2010; Maggin et al., 2013) related to measurement of caregiver outcomes. Therefore, primary caregiver-implemented communication intervention meets the first standard for EBP. Across those studies, there is no overlapping authorship, and thus, it meets the second standard for EBP. A total of 11 experiments were included across studies, and therefore, it does not meet the third standard for EBP. In conclusion, primary caregiver-implemented communication intervention may not be considered EBP for caregivers' behaviors (i.e., accuracy of intervention implementation) of individuals with ASD (see Figure 3).

Figure 3

Evaluation for evidence-based practice for the primary caregiver-implemented communication intervention



[a] N-evaluation for communication skills of individuals with ASD, [b] N-evaluation for caregivers' behaviors

Discussion

In this review, an analysis of the quality of research of 40 single-case studies was conducted based on the quality indicators developed by WWC (Kratochwill et al., 2010) and adapted by Maggin et al. (2013). As a result of the evaluation, it was found that primary caregiver-implemented communication intervention met the standards for EBP for individuals with ASD in improving communication skills of those individuals, although this cannot be said for the interventions' effectiveness on the behaviors of the caregivers. In addition, the findings in this review suggest issues that need to be addressed in the field related to quality of designs in single-case research.

As identified in this review, more than half of studies that failed to meet the design standards were due to a lack of IOA collected in each condition and not meeting the minimum quality thresholds. To apply SCED methodology appropriately for dependent variables in a study, some aspects should be considered, including whether the variables are repeatedly measured and evaluated by more than one rater in each condition throughout the study (Horner et al., 2005). *Instrumentation*, one of the phenomena that increase the threats to internal validity that refers to any changes in a way to evaluate targeted behaviors, can be prevented by collecting IOA in each condition throughout the study (Campbell & Stanley, 1963; Christ, 2007; Kratochwill et al., 2010). When insufficient measures of IOA of dependent variables are collected, we cannot be confident about results of the studies even when the data indicate that the primary caregiver-implemented interventions were truly effective in improving language and communication skills of the participants (Wendt, Quist, & Lloyd, 2011).

Additionally, many studies in this review failed to include three demonstrations of experimental control leading to a failure to meet the design standards. To reduce a risk of the threats to internal validity in a SCED study, a number of elements of experimental controls should be considered when designing a single-case study (Horner et al., 2005; Christ, 2007). If there are changes in dependent variables only when manipulating independent variables, it indicates that an experimental control is demonstrated in a study (Horner et al., 2005). In a within a participant or across participants SCED study, there should be at least three demonstrations of treatment effects at three different points in time in order to demonstrate an experimental control (Horner et al., 2005; Kratochwill et al., 2010; Maggin, Briesch, & Chafouleas, 2013). By confirming experimental control existed in a study, we can be confident that the manipulation of independent variables is most likely the sole factor that affects changes in dependent variables (Horner et al., 2005). This review evaluated whether the included studies collected data on procedural fidelity throughout their studies. According to Horner et al. (2005) and Wolery (2013), it is critical to collect procedural fidelity to ensure that an intervention utilized in a study is the only factor that impacts outcome variables. More than half of the studies included in this review did not report procedural fidelity or meet minimum quality thresholds. Among the studies that met the design standards, five studies failed to meet the standards for procedural fidelity. Without measures of procedural fidelity for most of the studies that otherwise passed the WWC design quality criteria, it is not clear whether the primary caregiver-implemented

interventions can be considered effective in improving communication skills of individuals with ASD.

Furthermore, this review evaluated how thoroughly the studies provided described the participants. To enhance replicability in an SCED study, it is important to include operational descriptions of participants, such as identification of the specific disability and identification of the specific instrument and process to determine the diagnosis (Horner et al., 2005; Wolery, 2013). Regarding ages and functioning levels, individuals' communicative responses to interventions can be different from each other (Ganz et al., 2011). In SCED studies, a single individual is considered the unit of analysis and the study procedures are developed based on the participant's characteristics (Horner et al., 2005); therefore, providing sufficient information about the participant will enable other researchers to replicate the study procedures and determine for whom the intervention may or may not be effective. Generally, the studies evaluated in this review included participants' ages and diagnoses. However, only one-third of the studies reported how the participants were recruited and diagnosed with disabilities; therefore, there may be difficulties with replicating the study procedures with different individuals and for practitioners to determine whether or not this literature base in applicable to the individuals with whom they work. Consideration of the quality and inclusion of procedural fidelity and participant descriptions is a unique contribution to this literature base.

Implications for Practice

This review has several implications for practice related to efficacy, particularly in terms of the cost and time needed to provide services to individuals with ASD, the instructional approaches for teaching caregivers, as well as skill generalization and maintenance. Generally, individuals with ASD require intensive and long-term services at costs higher than the services for individuals with other disabilities (Wang & Leslie, 2010; Ganz, 2007). Therefore, by involving primary caregivers in communication interventions for their child with ASD, costs of external services to children with ASD may be decreased while communication skills improve (Gibbard, Coglan, & McDonald, 2004).

Regarding skill generalization and maintenance of individuals with ASD, this review provides another potential benefits to individuals with ASD and their families. As shown in previous literature, most of communication interventions for individuals with ASD have been delivered by teachers or researchers in structured settings and the participants in the studies tended to show a lack of skill generalization and maintenance (e.g., Reichle et al., 2005; Johnston, Nelson, Evans & Palazolo, 2003; Ganz & Simpson, 2004). However, by involving parents or families of individuals with ASD in interventions, we can expect to higher rates of generalization and maintenance of language and communication skills of those individuals with ASD across communicative partners and settings.

Limitations and Implications for Future Research

Despite the contributions of this review, some limitations exist. In this review, no analysis was conducted to determine specifically which type of primary caregiver-implemented communication interventions met the standards for EBP. Rather, due to the number of studies that met the inclusion criteria in this review, the primary caregiver-implemented communication interventions were evaluated with the standards as a group. The studies utilized various types of communication intervention for individuals with ASD including pivotal response training (e.g., Coolican et al. 2010; Randolph et al., 2011; Vernon et al., 2012), discrete trial training (e.g., Crockett et al., 2007), augmentative and alternative communication training (e.g., Hong et al., 2014; Park et al., 2011), and visual-based naturalistic intervention (e.g., Gillett & LeBlanc, 2007). Although the communication interventions implemented by primary caregivers were found to be EBP as a group, it may be difficult for researchers and practitioners to select a particular type of intervention for individuals with ASD since various types of primary caregiver-implemented communication interventions have been utilized. Therefore, more research on primary caregiver-implemented communication intervention that utilizes each type of the interventions should be conducted to enable to evaluation of and comparison across individual types of interventions.

Additionally, with the findings in this analysis, we may not be able to confirm that primary caregiver-implemented communication interventions can be considered EBP based on the additional evaluation. As a result of this study, about half of the studies included in this analysis failed to meet the two additional standards (i.e.,

participant descriptions, procedural integrity of caregiver implementation). Given this fact, we cannot determine whether or not the studies were implemented as planned, leading to doubt about findings of those studies (Billingsley et al., 1980). Furthermore, with the lack of participant descriptions and a consideration of a wide range of language and communication characteristics of the participants, we may not be able to advocate that primary caregiver-implemented interventions are effective in improving language and communication skills of individuals with ASD overall. In conclusion, future research should collect and report participant descriptions and procedural integrity of caregiver implementation in their studies.

In terms of the instructional approaches for teaching caregivers, most of the studies included in this review tended to utilize multiple common components. Examples of the components include written and verbal instructions, modeling, role-play, and feedback on caregivers' performances. This finding is consistent with previous literature on investigating training procedures used to train caregivers to implement communication interventions to their children with ASD (e.g., Lang, Machalicek, Rispoli, & Regester, 2009). None of the studies reviewed in the current paper utilized a sole technique to provide training to caregivers; rather, the studies used a combined method when training the caregiver participants in intervention procedures, leading to challenges to determine which component may be more effective in caregivers' intervention implementation. Therefore, to enhance efficiency in training caregivers, future research should be able to analyze a training component or a combination of the components that are more effective than others.

Furthermore, with the results of this review, we cannot determine whether the primary caregiver-implemented communication interventions can still be considered EBP based on particular characteristics of individuals with ASD, such as by ages or language characteristics. Previous literatures have found that individuals with ASD have different responsiveness to interventions based on their ages and functioning levels (Ganz et al., 2011; Odom et al., 2005). Most of the studies in this review, except for Hong et al. (2011), included preschool- or elementary school-aged individuals with ASD in their studies, indicating that the communication interventions implemented by primary caregivers of individuals with ASD may be effective in improving language and communication skills only for young children with ASD. Therefore, researchers and practitioners may not be confident in using these types of interventions for older individuals with ASD. In conclusion, future research should include older individuals with ASD to enable a determination of whether the primary caregiver-implemented communication interventions can be considered EBP for those individuals with ASD.

Lastly, the present study extends previous literature on caregiver-implemented language and communication interventions for individuals with ASD by including unpublished studies (e.g., Kirby, 2013; Mulford, 2010; Singh, 2012; Tomaino, 2011; Vogler-Elias, 2009) to reduce publication bias (Easterbrook, Berlin, Gopalan, & Matthews, 1991). Although none of them have corresponding published peer-reviewed papers, two studies (i.e., Singh, 2012; Tomaino, 2011) met the design standards with reservations. Compared to the fact that only about one-fourth of published peer-reviewed studies included in this analysis either met the design standards or met them with

reservations, about half of the unpublished papers met them with reservations, indicating that the quality of those studies were comparable to others that were peer-reviewed. Therefore, in future research, we should include unpublished papers (e.g., theses, dissertations) when reviewing literature.

CHAPTER IV

A META-ANALYTIC REVIEW OF FAMILY-IMPLEMENTED SOCIAL-COMMUNICATION INTERVENTIONS FOR INDIVIDUALS WITH ASD AND OTHER DD

According to a report of the Centers for Disease Control and Prevention (CDC), the prevalence of developmental disabilities (DD) has increased by 17% over a 12-year time period, from 1997 to 2008 (Boyle et al., 2011). The prevalence of this increasing trend was found to be mainly due to changes in autism and attention deficit hyperactivity disorder (Boyle et al., 2011). Consistent with this finding, the most recent report from CDC on the prevalence of autism spectrum disorder (ASD) shows that approximately 1 out of 68 children in U.S. has ASD (Baio, 2014). Many individuals with ASD and other DDs have impairments in receptive and expressive social-communication skills (van der Meer et al., 2012; Hattier, Matson, Sipes, & Turygin, 2011; Hsieh, 2008; American Psychiatric Association [APA], 2013; American Psychiatric Association, 2000; Ganz et al., 2011). For example, it has been reported that approximately 30-50% of individuals with ASD do not develop functional speech and many of them do not develop age-appropriate speech and communication skills (Light & McNaughton, 2012; Light & Drager, 2007; Lord & McGee, 2001; Tager-Flusberg & Kassari, 2013). Given the social-communication impairments of individuals with ASD and other DD, it may to have poor outcomes in their later lives (Cimera & Cowan, 2009). For example, many of those individuals have low rate of employment, poor social relationships, and poor academic

outcomes (Whitehouse, Watt, Line, & Bishop, 2009; Howlin, Mawhood, & Rutre, 2000; Howlin, 1998).

Various interventions to promote the social-communication skills of individuals with ASD and other DD have been investigated (Kagohara et al., 2010; Achmadi et al., 2012; Flores et al., 2012; van der Meer et al., 2012). For individuals with ASD, a total of 10 types of interventions have been identified as an evidence-based practice (EBP), including antecedent package, behavioral package, comprehensive behavioral treatment for young children, joint attention intervention, modeling, naturalistic teaching strategies, peer training package, pivotal response treatment, self-management, and story-based intervention package (National Autism Center, 2009). For individuals who have complex communication needs (CCN), a variety of augmentative and alternative communication (AAC) systems may be utilized to facilitate the language skills of those individuals (Ganz et al., 2011). Individuals who have CCN have either no speech, speech that is comprehensible, or speech that is not functional or spontaneous (Ganz et al., 2012). Most intervention approaches that have been studies have been teacher- or researcher-mediated (e.g., Buckley & Newchok, 2005; Reichle et al., 2005; Johnston, Nelson, Evans, & Palazolo, 2003; Ganz & Simpson, 2004; Drager et al., 2006). Although some interventions have been shown effective in improving the social-communication skills of individuals with ASD and other DD, it has been noted that the teacher- or researcher-mediated intervention approaches conducted in structured or school settings tend to have a lack of skill generalization for those individuals (Smith, 2001; Crockett, Fleming, Doepke, & Stevens, 2007; McGee, Krantz, Mason, &

McClannahan, 1983). Therefore, considering interventions that train all key social-communication partners may address this issue.

Rich social interaction with caregivers has been considered essential to the development of language skills of young children (Haebig, McDuffie, & Weismer, 2013; McCartney, 1984). Particularly for children with developmental disabilities, learning experiences during the first three years of life play a critical role in developing their brain functions that affect cognitive and language development (National Scientific Council on the Developing Child, 2007; Haebig, McDuffie, & Weismer, 2013). Previous research has shown that delivering social-communication interventions, particularly when delivered by all key social-communication partners, tend to promote improvement of the social-communication skills of individuals with ASD and other DD (Strauss et al., 2012; Reichow, Barton, & Hume, 2012; Vismara, Colombi, & Rogers, 2009). However, given their social-communication skill deficits, individuals with ASD and other DD may have lower than typical amounts of social and communicative interaction experiences with their caregivers during that period of time (Branson & Demchak, 2009). As a result of this lack of interaction experiences, detrimental effects on further development of those individuals with ASD and other DD as well as on their social competence may occur (Cress & Marvin, 2003; Branson & Demchak, 2009). It has been reported that approximately 60% of adult-aged individuals with developmental disabilities live with their families (Braddock et al., 2011); therefore, it is critical for the families to participate in interventions designed to promote the social-communication skills of adults, as well as children with ASD and other DD (Haebig, McDuffie, & Weismer,

2013; McDuffie & Yoder, 2010; Siller, Huntman, & Sigman, 2013; McConachie & Diggle, 2007).

Current legislations including the No Child Left Behind (NCLB) Act of 2001 and the Individuals with Disabilities Education Improvement Act of 2004 mandated that practitioners utilize evidence-based practices (EBPs; Horner et al., 2004). In special education, single-case research is considered a scientific methodology that may be used to establish EBPs (Horner et al., 2004). Although randomized control-group designs are commonly used to develop EBPs in the field of education, single-case research is often more appropriate to utilize in special education (Horner et al., 2004; Odom, Collet-Klingenberg, Rogers, & Hatton, 2010), particularly given low-incidence disabilities such as ASD and significant developmental delay. In single-case research, each individual participant is considered the unit of analysis and participants serve as their own "controls" (Odom et al., 2005). Although it may be difficult to aggregate and analyze varied outcome measures from those single-case studies because different metrics are used in each study (Ganz et al., 2011), meta-analytic techniques allow synthesizing and analyzing the data from different studies and help determine EBP through the use of a single metric applied to all studies (Banda & Therrien, 2008).

Visual analysis is still the most commonly used method to analyze data in single-case research (Brossart, Parker, Olson, & Mahadevan, 2006) and remains the only means of determining whether or not there is a functional relation between the intervention and outcomes in a given single-case study; however, more recently, it has been emphasized that reporting both visual analysis and effect size provides some benefits over visual

analysis alone (Parker & Hagan-Burke, 2007). Effect sizes allow objectivity of measure of intervention effect, increased precision when changes in outcome variables are not large, objectivity and credibility of interpretations of outcome variables, and comparison of intervention effects across single-case experiments (Parker & Hagan-Burke, 2007; Rosnow & Rosenthal, 1989; Mitchell & Hartmann, 1981).

There is still some controversy related to the use of effect sizes. There are a number of nonoverlap effect size metrics commonly used in single-case research, such as percentage of nonoverlapping data (PND; Scruggs, Mastropieri, & Casto, 1987), percentage of data points exceeding the median (PEM; Ma, 2006), the extended celeration line (ECL) method (White & Haring, 1980), percentage reduction data (PRD; O'Brien & Repp. 1990), and percentage of zero data (PZD; Scotti, Evans, Meyer, & Walker, 1991) . These metrics have gained popularity because of their ease of calculation and other strengths (Parker, Vannest, Davis, & Sauber, 2011). These nonoverlap methods do not require interval-level measurement and normal distribution (Armitage, Berry, & Matthews, 2002; Parker, Vannest, & Davis, 2011). In addition, nonoverlap methods are robust to the impact of outliers in analysis (Parker, Vannest, Davis, & Sauber, 2011; Parker, Vannest, & Davis, 2011). However, the nonoverlap effect size techniques include several limitations. First, most of the nonoverlap techniques, except for ECL and Tau-U, do not control auto-correlated data and data trend in phases (Parker, Vannest, & Davis, 2011), so may result in misinterpretations of intervention effect. Second, when utilizing the nonoverlap techniques, it is not always possible to calculate a standard error or confidence intervals (Parker, Vannest, & Davis,

2011). Given limitations of the nonoverlap effect size metrics, some of the metrics are no longer recommended to use for meta-analyses (Allison & Gorman, 1993).

Tau-U is one of the most recent and appropriate non-parametric effect size measures for single-case research (Parker, Vannest, Davis, & Sauber, 2011) because it addresses the aforementioned issues and other issues related to previously used non-overlap methods (Parker, Vannest, Davis, & Sauber, 2011). Tau-U is robust to autocorrelation of data, which indicates the magnitude of Tau-U does not vary in response to a level of autocorrelation (Parker et al., 2011). Tau-U combines non-overlap between phases with trend from within intervention phases and permits controlling an undesirable baseline trend (Parker et al., 2011). Furthermore, Tau-U is a "bottom-up" approach and it has some benefits over top-down procedures (e.g., Hierarchical Linear Modeling, Multiple Regression, and Randomization) (Parker & Vannest, 2012). First, Tau-U can be calculated even when there are few data points and phases in the design. Second, Tau-U can be customized regarding the design and data. Third, Tau-U is in line with visual analysis. Fourth, effect sizes can be calculated using Tau-U analysis. None of the previous reviews that have examined single-case research on primary caregiver-implemented communication interventions for communication of individuals with ASD have utilized modern meta-analytic techniques, such as Tau-U. Therefore, given benefits of use of Tau-U as a measure of effect size, such a meta-analysis may provide objectivity and credibility of interpretations of outcome variables in the studies and allow aggregating and comparing intervention effects across studies and potential moderator variables.

While effects of family-implemented social-communication interventions have been investigated via single-case research and literature reviews, there are no meta-analytic reviews that have provided an overall measure of the effectiveness of those. Furthermore, none of the prior reviews (e.g., Meadan, Ostrosky, Zaghlawan, & Yu, 2009; Roberts & Kaiser, 2011; Lang, Machalicek, Rispoli, & Regester, 2009) investigated how the family-implemented interventions differentially affected the social-communication skills of individuals with ASD and other DD differentially by the characteristics of those individuals (e.g., ages, level of communication and language skills on outset of the study). That is, it may be that individuals' responsiveness to interventions may be related to their ages, or communication/language characteristics (Ganz et al., 2011; Odom et al., 2005). To determine the general effectiveness of the family-implemented social-communication interventions and the differential impact of the interventions across the characteristics of individuals with ASD and other DD, it is necessary to synthesize results of single-case studies conducted on those interventions and make comparisons related to potential moderators such as age and communication/language characteristics through meta-analytic techniques (Scruggs & Mastropieri, 1998; Kavale, 2001).

Various types of family-implemented interventions have been studied to investigate their effectiveness on the social-communication outcomes of individuals with ASD and other DD (National Research Council, 2001; e.g., Elder, 1995; Elder et al., 2005; Hemmeter & Kaiser, 1994; Kaiser et al., 2000; Koegel et al., 2002; Symon, 2005; Laski et al., 1998; Stiebel, 1999; Rocha et al., 2007; Vismara et al., 2009; Vismara & Rogers, 2008). In addition, each intervention includes multiple components (e.g.,

modeling, prompting, fading, reinforcement; Mayer, Sulzer-Azaroff, & Wallace, 2012; Reichle, Drager, & Davis, 2002). While different social-communication interventions and components have been utilized, those can be categorized into two instructional types; one is a type of adult-led instructions and the other is a type of individual with disabilities-led instructions. Adult-led didactic instructions involve one-on-one instructions and are often implemented in a structured setting (Ganz et al., 2012). When utilizing a type of the adult-led didactic instruction, such as discrete trial training (e.g., Lafasakis & Sturmey, 2007; Crockett et al., 2007), an individual with a disability tends to initiate social and communication interactions following an adult's prompts (e.g., Casey, 1978; Tomaino, 2011). Individual with disabilities-led interventions are those initiated by the individual with disabilities via behaviors such as verbalization, gestures, or facial expressions (Ganz et al., 2012). Individual with disabilities-led instructions are usually carried out in a natural environment and designed based on interests of the individual with disabilities (Ospina et al., 2008) and occur during his or her daily routines in his or her natural contexts, such as home or community settings (e.g., Chang, 2009; Laski, Charlop, & Schreibman, 1988). When utilizing an individual with disabilities-led instruction, a social-communication partner follows the individual's lead (Ospina et al., 2008). Examples of the individual with disabilities-led instructions include incidental teaching and pivotal response training (e.g., Wetherby & Woods, 2006; Yoder & Stone, 2006; Sevcik, Romski, & Watkins, 1995; Charlop-Christy & Carpenter, 2000; Hart & Risley, 1978). With the range of intervention strategies, it might be difficult to determine which intervention to use. Thus it may be beneficial for

researchers and practitioners to know whether one type of intervention is more effective in improving the social-communication skills of individuals with ASD and other DD than others.

Given the benefits of including families in education for individuals with ASD and other DD, different social-communication behaviors have been measured including expressive/receptive verbalizations, use of spontaneous communication, mean length of utterances, correct use of grammar or linguistic structures, use of augmentative and alternative communication (AAC) systems, joint attention, social and pretend play, social engagement, social problem solving, and friendship (NAC, 2009; e.g., Elder et al., 2005; Kaiser, Hancock, & Nietfeld, 2000; Koegel, Symon, & Koegel, 2002; Stiebel, 1999; Vismara, Colombi, & Rogers, 2009). Overall, family-implemented interventions appear to have shown positive effects in developing those targeted social-communication skills for individuals with ASD and other DD (Meadan, Ostrosky, Zaghlawan, & Yu, 2009; Simpson, 2001). Furthermore, those interventions have been effective in maintaining and generalizing acquired skills of those individuals (e.g., Schreibman & Stahmer, 2013; Steiner, Gengoux, & Chawarska, 2013; Kaiser, Hancock, & Nietfeld, 2000; Rocha, Schreibman, & Stahmer, 2007). However, no meta-analyses of single-case research on family-implemented social-communication interventions for individuals with ASD and other DD have been conducted; thus, little is known regarding for whom and under what conditions these interventions are most effective and the overall magnitude of effects in each of the social-communication skill targeted of individuals with ASD and other DD.

The purpose of the current meta-analysis of single-case research utilizing family-implemented interventions is to address the following questions: (a) what are the overall effects of the family-implemented intervention on improving the social-communication skills of individuals with ASD and other DD?; (b) would the family-implemented intervention differentially affect the social-communication skills of individuals with ASD and other DD related to the characteristics of those individuals (i.e., age group, communication and language characteristic)?; (c) which type of interventional approach (i.e., individual with disabilities-led instruction, adult-led didactic instruction) produces the largest improvement?; and (d) what are the effects of the family-implemented interventions, differentiated by categories of the social-communication outcomes (i.e., social play behaviors, joint attention, verbal or recognizable words, use of AAC system)?

Method

Article Identification

Search Procedures. Studies included in the meta-analysis were located by conducting a search of peer-reviewed journal articles. Non peer-reviewed articles, including books, dissertations, and other publications, were also included in this review. Publication year was not restricted. Electronic databases utilized for systematic search included *ERIC, PsycINFO, Academic Search Complete*, *Professional Development Collection,* and *Social Science Full Text*. Searches were carried out using a combination of the following terms: *autis*, ASD, pervasive developmental disorder*, PDD*, Asperger*, development* disab*, low-incidence dis*, intellectual* disab*, mental* retard**, and *multiple disab** were each combined with the terms, *parent* training,*

parent education, primary caregiver training, caregiver* education, sibling training, famil* training, langu*, play*, communic*, langu*, social*,* and *social communic*.* In addition, ancestry searches through reviewing reference lists of studies and the publications of the authors of the studies that met the inclusion criteria were conducted to identify additional articles for possible inclusion. Initially, this search yielded a total of 1998 articles. However, documents that did not have an author or were duplicated were excluded resulting in a total of 1740 documents.

Inclusion and Exclusion Criteria. Initially, the abstract and full text of each article were reviewed to determine whether or not the study included at least one participant with ASD or other DD. A total of 172 articles met the initial inclusion/exclusion criterion. The 172 articles were then reviewed to determine inclusion eligibility based on the following six criteria: (a) at least one of those participants' family members must have served as an intervention implementer (e.g., parents, siblings, other relative, paid in-home caregivers); (b) as an outcome measure, social-communication skills must have been targeted; (c) the study had to investigate the efficacy of a type of educational intervention; (d) the study involved the use of an experimental research design including single-case (e.g., AB, alternating treatment, reversal, changing criterion, or multiple-baseline design) or group design research if the study reported time-series data for individual participants; (e) the study must have presented data in graphical displays that presented individual data points; and (f) the family member data and outcome measure data must have been differentiated from other participants (such as paraprofessionals, teachers, researchers, etc.) and other outcome

measures (e.g., challenging behaviors, academic skills, etc.). In the case that both a dissertation and its corresponding published article met the inclusion criteria, the published article was excluded.

One study that was considered (Bryson et al., 2007) conducted group research and, in this study, data points were not reported separately by individual participant. Therefore, the study was excluded from this review. No other group studies were found for inclusion. Thus, this initial screening of inclusion and exclusion criteria of articles resulted in 69 articles for further evaluation. The 69 articles were then evaluated with design standards to determine whether or not the articles met the standards. The design standards are described below.

Inter-Rater Reliability for Inclusion/Exclusion Criteria. To determine whether a study met inclusion criteria, two raters independently applied the initial inclusion/exclusion criteria to 1052 of the 1740 articles reviewed (60%). If there were disagreement on whether or not to include an article, the final determination to include or exclude that study was made by the two reviewers after discussing the discrepancy until they came to a consensus. A *Chi-Squared* statistic (Cohen, 1960) was used to calculate IRR on the determination if they agreed whether the article included at a minimum of one individual with ASD or other DD. As a result of the calculation, the IRR for the initial criterion was .873 indicating there was a high agreement between the raters. A total of 172 articles met the initial inclusion/exclusion criterion. Articles including individuals with ASD or other DD were then reviewed by two raters to determine whether the articles met rest of the inclusion criteria (*N*=146, 84%). *Chi-*

Squared (Cohen, 1976) was calculated to compute IRR on initial agreement (see Table 7). As a result of the calculation, high agreements were yielded values ranging from .944-1.000.

Table 7

Interrater reliability for inclusion and exclusion criteria

Inclusion/Exclusion Criteria	Kappa
1st criterion	.873
2nd criterion	1.000
3rd criterion	.978
4th criterion	1.000
5th criterion	1.000
6th criterion	.985
7th criterion	.986
8th criterion	.944

Application of the What Works Clearinghouse Design Standard

Articles were reviewed based on basic design standards within the study. The coding protocol developed by Maggin, Briesch, and Cahfouleas (2013) and adapted from Kratochwill, Hitchcock, Horner, Levin, Odom, Rindskopf, and Shadish (2010) was used in this study.

Design Standard 1 evaluated whether the independent variable was systematically manipulated (Maggin et al., 2013; Kratochwill et al., 2010). A score of 1 was given if the standard was met, and if not, a score of 0 was given. Design Standard 2A evaluated whether interobserver agreement (IOA) was measured (Maggin et al., 2013; Kratochwill et al., 2010). If the study reported IOA, a score of 1 was assigned, and if not,

a score of 0 was assigned. Design Standard 2B assessed whether IOA was collected on at least 20% of data points in each condition (Maggin et al., 2013; Kratochwill et al., 2010). For the purpose of this study, intermediary rating options were included to the design standards to enable me to conduct a meta-analysis by including enough qualifying studies. If the standard was met, a score of 2 was given (originally a 1; Maggin et al., 2013; Kratochwill et al., 2010). If the study reported that IOA was collected for at least 20% of the sessions overall, but not within each condition, a score of 1 was given (originally a 0; Maggin et al., 2013; Kratochwill et al., 2010). A score of 0 was given if the study measured IOA less than 20% of the sessions overall or in any condition. Design Standard 2C examined whether the IOA met minimum quality thresholds, i.e., .80 for percentage agreement indices or .60 for Cohen's *kappa* measures (Maggin et al., 2013; Kratochwill et al., 2010). If the standard was met, a score of 1 was assigned, and if not, a score of 0 was assigned. Design Standard 3 evaluated whether there were at least three demonstrations of treatment effects at three different points in time (Maggin et al., 213; Kratochwill et al., 2010). An intermediary rating was added to this standard. A score of 2 was given if all experiments in a study met this standard (originally a 1; Maggin et al., 2013; Kratochwill et al., 2010). A score of 1 was given if, not all, but at least one experiment in the study met this standard (originally a 0; Maggin et al., 2013; Kratochwill et al., 2010). If any of the experiments did not meet this standard, a score of 0 was assigned (originally a 0; Maggin et al., 2013; Kratochwill et al., 2010). Design Standard 4 evaluated a minimum number of data points per phase (Maggin et al., 2013; Kratochwill et al., 2010). An intermediary rating option was added

to this standard. If all experiments in a study included at least three data points per phase, a score of 2 was assigned (originally a 1; Maggin et al., 2013; Kratochwill et al., 2010). A score of 1 was assigned if at least one experiment in the study met this standard (originally a 0; Maggin et al., 2013; Kratochwill et al., 2010). If any of the experiments did not meet this standard, a score of 0 was given (originally a 0; Maggin et al., 2013; Kratochwill et al., 2010).

Each article was evaluated by assigning a score of 0, 1, or 2 (Kratochwill et al., 2010; Maggin et al., 2013). If all the standards were scored with the highest score for the whole article, a score of 2 was assigned to the article indicating that the study met the design standards. If any of those standards was not scored with the highest score but not with 0, a score of 1 was given to the article indicating that the article met the design standards with reservations. If any of those standards was scored with 0, a score of 0 was given to the article indicating that the article did not meet the design standards. Articles that met the design standards or met them with reservations were included for further analysis. Articles that did not meet the design standards were excluded from this review. Design standard ratings for each study are summarized in Table 8. A total of 40 studies met the designs standards or met them with reservations. The other 30 studies did not meet the design standards, and, thus, were excluded from further analysis.

Table 8

Design standards

Study	Overall Standards	[a]DS#1: Independent Variable	DS#2A: [b]IOA Collected	DS#2B: IOA 20%	DS#2C: Minimum Quality Thresholds of IOA	DS#3: Replication Effects	DS#4: Number of Data Points
Studies that met the design standards							
Crockett et al. (2007)	2	1	1	2	1	2	2
Fox & Westling (1991)	2	1	1	2	1	2	2
Hong et al. (2014)	2	1	1	2	1	2	2
Park et al. (2011)	2	1	1	2	1	2	2
Powell et al. (1986)	2	1	1	2	1	2	2
Studies that met the design standards with reservations							
Ben Chaabane et al. (2009)	1	1	1	1	1	2	1
Carr et al. (1999)	1	1	1	1	1	2	1
Celiberti & Harris (1993)	1	1	1	1	1	2	1
Charlop & Carpenter (2000)	1	1	1	1	1	2	1
Coolican et al. (2010)	1	1	1	2	1	2	1
Hancock & Kaiser (1996)	1	1	1	2	1	2	1
Ingersoll & Wainer (2013)	1	1	1	1	1	2	1
Gillett & LeBlanc (2007)	1	1	1	2	1	2	1
Kaiser et al. (2010)	1	1	1	1	1	2	2
Kent-Walsh et al. (2010)	1	1	1	1	1	2	1
Lafasakis & Sturmey (2007)	1	1	1	1	1	2	1
Laski et al. (1988)	1	1	1	1	1	2	1
Mancil et al. (2009)	1	1	1	2	1	2	1
Marcus et al. (2001)	1	1	1	2	1	1	1
Meadan et al. (2014)	1	1	1	2	1	2	1
Moran & Whitman (1985)	1	1	1	1	1	2	1
Oppenheim-Leaf et al. (2012)	1	1	1	2	1	2	1
Randolph et al. (2011)	1	1	1	2	1	2	1
Reagon et al. (2009)	1	1	1	2	1	2	1
Reamer et al. (1998)	1	1	1	1	1	2	1

Table 8 Continued

Study	Overall Standards	[a]DS#1: Independent Variable	DS#2A: [b]IOA Collected	DS#2B: IOA 20%	DS#2C: Minimum Quality Thresholds of IOA	DS#3: Replication Effects	DS#4: Number of Data Points
Robertson et al. (2013)	1	1	1	2	1	1	1
Rocha et al. (2007)	1	1	1	1	1	2	1
Russell & Matson (1998)	1	1	1	1	1	1	1
Schertz & Odom (2007)	1	1	1	1	1	2	1
Singh (2012)	1	1	1	2	1	2	1
Stiebel (1999)	1	1	1	1	1	2	2
Strain & Danko (1995)	1	1	1	1	1	2	2
Tait et al. (2004)	1	1	1	2	1	2	1
Tomaino (2011)	1	1	1	2	1	2	1
Trent et al. (2005)	1	1	1	2	1	2	1
Tsao & Odom (2006)	1	1	1	1	1	2	1
Vernon et al. (2012)	1	1	1	2	1	2	1
Vismara et al. (2012)	1	1	1	1	1	2	1
Vogler-Elias (2009)	1	1	1	1	1	2	1
Walton & Ingersoll (2012)	1	1	1	1	1	2	1
Studies that did not meet the design standards							
Alpert & Rogers-Warren (1983)	0	1	0	0	0	2	2
Arnold et al. (1977)	0	1	0	0	0	0	0
Carson et al. (2012)	0	1	1	0	0	1	0
Casey (1978)	0	1	1	0	1	0	2
Charlop & Trasowech (1991)	0	1	1	0	1	1	1
Dodd et al. (2008)	0	1	1	1	1	0	1
Elder (1995)	0	1	0	0	0	0	1
Ferraioli & Harris (2011)	0	1	1	0	1	2	1
Hemmeter & Kaiser (1994)	0	1	1	0	1	2	2
Jull & Mirenda (2011)	0	1	1	2	1	2	0
Kashinath et al. (2006)	0	1	1	1	1	0	1
Kirby (2013)	0	1	1	2	1	2	0

Table 8 Continued

Study	Overall Standards	[a]DS#1: Independent Variable	DS#2A: [b]IOA Collected	DS#2B: IOA 20%	DS#2C: Minimum Quality Thresholds of IOA	DS#3: Replication Effects	DS#4: Number of Data Points
Koegel et al. (1978)	0	1	1	1	1	2	0
Koegel et al. (2002)	0	1	1	2	1	2	0
Koppenhaver et al. (2001)	0	1	1	1	1	0	0
Moes & Frea (2002)	0	1	1	0	0	2	0
Mulford (2010)	0	1	1	2	1	0	0
Nordquist & Wahler (1973)	0	1	1	1	1	0	2
Nunes & Hanline (2007)	0	1	1	1	1	0	0
Radley et al. (2014)	0	1	1	2	1	0	1
Seung et al. (2006)	0	0	1	0	1	0	0
Steiner et al. (2013)	0	1	1	1	1	2	0
Stewart et al. (2007)	0	0	1	1	1	0	0
Symon (2005)	0	1	1	0	1	2	0
Trent-Stainbrook et al. (2007)	0	1	1	2	1	0	0
Vismara et al. (2013)	0	1	1	1	1	0	0
Vismara & Rogers (2008)	0	1	1	1	1	0	0
Vismara et al. (2009)	0	1	1	1	1	0	0
Yang et al. (2003)	0	1	1	0	1	0	0

[a]DS-design standards, [b]IOA-interobserver agreement

Inter-Rater Reliability on Quality of Design Standards. Two independent raters evaluated 38 of the 69 articles (53%) with the Design Standards. IRR was calculated on each of the six Design Standards to determine whether two raters agreed on whether each article met the Design Standards, met them with reservations, or did not meet the standards. Any discrepancies between raters were reviewed and discussed until the raters came up to a consensus. A *Chi-Squared* statistic (Cohen, 1976) was used to calculate IRR on initial agreement (see Table 9). As a result of the calculation, moderate to high agreements ranged from .712-1.000.

Table 9

Interrater reliability for design standards

Design Standards	Kappa
Overall standard	.850
DS#1: Independent variable	1.000
DS#2A: [a]IOA Collected	.803
DS#2B: IOA 20%	.900
DS#2C: Minimum quality thresholds of IOA	.722
DS#3: Replication effects	.827
DS#4: Number of data points	.712

[a]IOA-interobserver agreement

Isolation of Descriptive Information and Potential Moderators Coding

To summarize literature on family-implemented intervention, basic information was extracted about each of the 40 studies that met the design standards or met them with reservations (see Table 10). For each study, information regarding participant's age and communication and language level were summarized. In addition, types of

intervention implemented (i.e., individual with disabilities-led instruction, adult-led didactic instruction) and dependent measures of participants with ASD and other DD (i.e., verbalization, use of AAC, use of linguistic structures or grammatical forms, social behaviors). This process is termed a moderator analysis (Cohen, Cohen, West, & Aiken, 2003). A moderator variable is an independent variable that alters a direction or strength of relation between an independent and dependent variable (Baron & Kenny, 1986). A description of how potential moderators were coded in this study follows.

Participant Characteristics. Since characteristics of each individual with ASD and other DD and family members are not homogeneous, it is essential to evaluate for whom and under what conditions an intervention produces meaningful outcomes in the social-communication skills of those individuals with ASD and other DD. Therefore, as potential moderator variables, the effect of participant characteristics on targeted social-communication skills was analyzed according to participant's age and communication and language level. First, the age variable included five levels: PRESCH (<5), ELEM (5 to < 10), SEC (10 to < 15), ADULT (15 and older), and NP (not provided). Second, communication and language level of participants were coded based on the following five levels: NOSP (no speech, but may have had vocalizations); SPNOTSPON (some speech, but not spontaneous or functional, echolalia or prompted speech); SPSOMESPON (minimal spontaneous speech, large vocabulary, but usually prompted speech); and OTHERS (does not fit any of the categories); and NP (not provided). These communication and language levels of participants were determined by the best fit according to the authors' descriptions of the participants in their articles. For each

moderator, anything categorized as NP, COMB, or OTHERS was excluded from further analysis.

Intervention Variables. Investigation of which type of intervention components is more effective in improving the social-communication skills of individuals with ASD and other DD should be conducted. The types of intervention appeared to fall into two categories which included individual with disabilities-led instructions and adult-led didactic instructions. Adult-led didactic instructions often occur in a structured setting (Ganz et al., 2012) and an individual with disabilities tends to initiate social and communication interactions following an adult's prompts (e.g., Casey, 1978; Tomaino, 2011). Individual with disabilities-led instructions are developed based on interests of individuals with disabilities and occur in those individuals' natural contexts, such as home or community settings (e.g., Chang, 2009; Ospina et al., 2008; Crockett et al., 2007). Based on two categories, the types of intervention included four levels: IWD (individual with disabilities-led instruction); ADI (adult-led didactic instruction); COMB (combination of individual with disabilities-led and adult-directed instruction); and OTHERS (does not fit any of the categories).

Targeted Social-Communication Skills. Investigation of how design quality of each study affects improvement of the social-communication skills of individuals with ASD and other DD should be conducted. Since a level of functioning in the social-communication skills of individuals with ASD and other DD varies from each other (Wilkinson, 1998), each study targeted different communication skills. Therefore, evaluating which type of interventions have been more effective for which social-

communication skill is essential for guiding future adoption of interventions that can be more effective for targeted social-communication skills being taught. Social-communication skills were defined as any social-communication behaviors including verbal or recognizable words (Bruner, 1975), use of augmentative and alternative communication system (AAC), and social behaviors. Verbal or recognizable words indicated both expressive and receptive language behaviors, such as naming objects and people, imitating vocalizations, , and expressing ideas (Shumway & Wetherby, 2009), and using nonverbal cues (e.g., Tomasello, 1992; Fenson et al., 1994; Bloom & Lahey, 1978). AAC use included unaided and aided systems (Ganz et al., 2011). Communication skills also included use of the linguistic structures or grammatical forms, such as the correct use of pronouns (e.g., Laban, 1976). Facial expressions and other non-verbal cues (e.g., eye contact, gestures, body language) were considered communication skills if an article clearly stated that those non-verbal cues are the means of the social-communication. Social behaviors included joint attention, social initiation and response, and understanding referential nature of words or intentions of others (American Psychiatric Association, 2013; Weiss & Harris, 2001; Cappadocia & Weiss, 2011). Targeted skills included seven levels: VOC (vocalization, verbalize target words); NOVOC (nonverbal communication or gestures using a part of body); AAC (use of augmentative and alternative communication systems); SOC (social behaviors, joint attention, social play skills, social interpersonal skills), COMB (combination of two or more skills), and OTHERS (does not fit any of the categories).

Table 10

Moderator coding

Study	Participant	Participant Characteristics		Independent Variable (s)	Dependent Variable (s)
		Age	Communication/Language Level		
Ben Chaabane et al. (2009)	Cliff	[a]ELEM	NP	[i]ADI	[l]AAC
	Myles	ELEM	NP	ADI	AAC
Carr et al. (1999)	Val	[b]ADULT	[e]SPSOMESPON	ADI	COMB
	Gary	ADULT	SPSOMESPON	ADI	COMB
	Juan	ADULT	[f]SPNOTSPON	ADI	COMB
Celiberti & Harris (1993)	Jimmy	[c]PRESCH	SPNOTSPON	ADI	[m]SOC
	Annie	PRESCH	SPNOTSPON	ADI	SOC
	Rick	PRESCH	SPNOTSPON	ADI	SOC
Charlop & Carpenter (2000)	Ron	ELEM	SPSOMESPON	[j]COMB	[n]VOC
	Andy	ELEM	SPONTSPON	COMB	VOC
	Brad	ELEM	SPONTSPON	COMB	VOC
Coolican et al. (2010)	C1	PRESCH	SPONTSPON	[k]IWD	VOC
	C2	PRESCH	SPONTSPON	IWD	VOC
	C3	PRESCH	SPONTSPON	IWD	VOC
	C4	PRESCH	SPONTSPON	IWD	VOC
	C5	PRESCH	SPONTSPON	IWD	VOC
	C6	PRESCH	SPONTSPON	IWD	VOC
	C7	PRESCH	SPONTSPON	IWD	VOC
	C8	PRESCH	SPONTSPON	IWD	VOC
Crockett et al. (2007)	Nevin	PRESCH	NP	ADI	[o]SOC
Fox & Westling (1991)	Dyad1	PRESCH	[g]NOSP	IWD	SOC
	Dyad2	PRESCH	NOSP	IWD	SOC
	Dyad3	ELEM	NOSP	IWD	SOC
Gillett & LeBlanc (2007)	Caleb	ELEM	SPONTSPON	IWD	SOC
	Garrett	PRESCH	SPONTSPON	IWD	VOC
	Marcus	PRESCH	SPONTSPON	IWD	VOC
Hancock & Kaiser (1996)	A	PRESCH	SPNOTSPON	IWD	VOC
	B	PRESCH	SPNOTSPON	IWD	VOC
	C	ELEM	SPNOTSPON	IWD	VOC
Hong et al. (2014)	Ryan	ADULT	NOSP	ADI	AAC

Table 10 Continued

Study	Participant Characteristics			Independent Variable (s)	Dependent Variable (s)
	Participant	Age	Communication/Language Level		
Ingersoll & Wainer (2013)	C1	ELEM	NP	ADI	VOC
	C2	PRESCH	NP	ADI	VOC
	C3	PRESCH	NP	ADI	VOC
	C4	PRESCH	NP	ADI	VOC
	C5	PRESCH	NP	ADI	VOC
	C6	PRESCH	NP	ADI	VOC
	C7	PRESCH	NP	ADI	VOC
	C8	ELEM	NP	ADI	VOC
Kaiser et al. (2010)	A	PRESCH	SPSOMESPON	IWD	VOC
	B	PRESCH	SPSOMESPON	IWD	VOC
	C	PRESCH	SPSOMESPON	IWD	VOC
	D	PRESCH	SPSOMESPON	IWD	VOC
	E	PRESCH	SPSOMESPON	IWD	VOC
	F	PRESCH	SPSOMESPON	IWD	VOC
Kent-Walsh et al. (2010)	Abby	ELEM	[h]OTHERS	ADI	COMB
	Brian	ELEM	OTHERS	ADI	COMB
	Clea	ELEM	OTHERS	ADI	COMB
	Dale	ELEM	OTHERS	ADI	COMB
	Evan	PRESCH	OTHERS	ADI	COMB
	Freddy	ELEM	OTHERS	ADI	COMB
Lafasakis & Sturmey (2007)	George	PRESCH	NOSP	ADI	VOC
	Emmanuel	PRESCH	NOSP	ADI	VOC
	Christian	PRESCH	NOSP	ADI	VOC
Laski et al. (1988)	C1	ELEM	SPONTSPON	IWD	VOC
	C2	ELEM	SPONTSPON	IWD	VOC
	C3	ELEM	NOSP	IWD	VOC
	C4	ELEM	SPONTSPON	IWD	VOC
	C5	ELEM	SPSOMESPON	IWD	VOC
	C6	ELEM	SPSOMESPON	IWD	VOC
	C7	ELEM	SPSOMESPON	IWD	VOC
	C8	ELEM	SPSOMESPON	IWD	VOC

Table 10 Continued

Study	Participant Characteristics			Independent Variable (s)	Dependent Variable (s)
	Participant	Age	Communication/Language Level		
Mancil et al. (2009)	Scott	ELEM	SPONTSPON	ADI	AAC
	David	PRESCH	SPONTSPON	ADI	AAC
	Zeb	PRESCH	SPONTSPON	ADI	AAC
Marcus et al. (2001)	Joel	[d]NP	NP	ADI	SOC
	Joe	NP	NP	ADI	SOC
	Tabbatha	NP	NP	ADI	SOC
	Roger	NP	NP	ADI	VOC
Meadan et al. (2014)	KK	PRESCH	NP	ADI	OTHERS
	JM	PRESCH	NP	ADI	OTHERS
	AH	PRESCH	NP	ADI	OTHERS
	HM	PRESCH	NP	ADI	OTHERS
	GC	PRESCH	NP	ADI	OTHERS
Moran & Whitman (1985)	Dyad1	PRESCH	NP	ADI	COMB
	Dyad2	PRESCH	NP	ADI	COMB
	Dyad3	PRESCH	NP	ADI	COMB
	Dyad4	PRESCH	NP	ADI	COMB
	Dyad5	PRESCH	NP	ADI	COMB
Oppenheim-Leaf et al. (2012)	Eric	PRESCH	SPSOMESPON	ADI	SOC
	Tanner	ELEM	NOSP	ADI	SOC
	Lonny	PRESCH	SPSOMESPON	ADI	SOC
Park et al. (2011)	Tad	PRESCH	NOSP	ADI	COMB
	Eric	PRESCH	NOSP	ADI	COMB
	Bill	PRESCH	NOSP	ADI	COMB
Powell et al. (1986)	F1	ELEM	NP	ADI	SOC
	F2	ELEM	NP	ADI	SOC
	F3	ELEM	NP	ADI	SOC
	F4	PRESCH	NP	ADI	SOC
Randolph et al. (2011)	Bryan	ELEM	NP	IWD	SOC
	Wyatt	PRESCH	NP	IWD	[p]NOVOC
	Kim	PRESCH	NP	IWD	NOVOC

Table 10 Continued

Study	Participant Characteristics			Independent Variable (s)	Dependent Variable (s)
	Participant	Age	Communication/Language Level		
Reagon et al. (2009)	Collin	ELEM	SPONTSPON	ADI	VOC
	Brandon	PRESCH	SPONTSPON	ADI	VOC
	Jake	PRESCH	SPONTSPON	ADI	VOC
Reamer et al. (1998)	Michael	ELEM	NP	ADI	SOC
	Daniell	PRESCH	NP	ADI	SOC
Robertson et al. (2013)	Nicholas	PRESCH	SPSOMESPON	OTHERS	VOC
	Jeff	ELEM	SPSOMESPON	OTHERS	VOC
Rocha et al. (2007)	Lindsay	PRESCH	NP	ADI	NOVOC
	Jacob	PRESCH	NP	ADI	NOVOC
	Adam	PRESCH	NP	ADI	NOVOC
Russell & Matson (1998)	Travis	PRESCH	NP	ADI	COMB
	Edward	PRESCH	NP	ADI	COMB
	Jimmy	PRESCH	NP	ADI	COMB
Schertz & Odom (2007)	A	PRESCH	NP	IWD	NOVOC
	B	PRESCH	NP	IWD	NOVOC
	C	PRESCH	NP	IWD	NOVOC
Singh (2012)	C1	PRESCH	SPONTSPON	IWD	VOC
	C2	PRESCH	SPSOMESPON	IWD	VOC
	C3	ELEM	SPONTSPON	IWD	VOC
Stiebel (1999)	C1	PRESCH	SPONTSPON	OTHERS	AAC
	C2	ELEM	SPONTSPON	OTHERS	AAC
	C3	PRESCH	SPONTSPON	OTHERS	AAC
Strain & Danko (1995)	North	PRESCH	SPNOTSPON	ADI	SOC
	Broderick	PRESCH	NOSP	ADI	SOC
	Jarred	PRESCH	NOSP	ADI	SOC
Tait et al. (2004)	Mary	PRESCH	NOSP	IWD	COMB
	Greg	PRESCH	NOSP	IWD	COMB
	Mark	PRESCH	NOSP	IWD	AAC
	Alex	PRESCH	NOSP	IWD	COMB
	Beth	PRESCH	NOSP	IWD	COMB
	Lisa	PRESCH	NOSP	IWD	COMB

Table 10 Continued

Study	Participant Characteristics			Independent Variable (s)	Dependent Variable (s)
	Participant	Age	Communication/Language Level		
Tomaino (2011)	Lilly	ELEM	SPSOMESPON	ADI	VOC
	Katie	PRESCH	SPSOMESPON	ADI	VOC
	Jordan	ELEM	SPSOMESPON	ADI	VOC
	Nick	ELEM	SPSOMESPON	ADI	VOC
	Reid	ELEM	SPSOMESPON	ADI	VOC
	Jena	ELEM	SPSOMESPON	ADI	VOC
Trent et al. (2005)	DS1	ELEM	SPSOMESPON	IWD	VOC
	DS2	ELEM	SPSOMESPON	IWD	VOC
Tsao & Odom (2006)	Allen	PRESCH	NOSP	ADI	COMB
	Bobby	PRESH	SPNOTSPON	ADI	NOVOC
	Caleb	ELEM	SPSOMESPON	ADI	COMB
	David	ELEM	NP	ADI	NOVOC
Vernon et al. (2012)	C1	PRESCH	SPSOMESPON	IWD	NOVOC
	C2	PRESCH	SPSOMESPON	IWD	NOVOC
	C3	PRESCH	SPSOMESPON	IWD	VOC
Vismara et al. (2013)	C1	PRESCH	NP	IWD	NOVOC
	C2	PRESCH	NP	IWD	VOC
	C3	PRESCH	NP	IWD	NOVOC
	C4	PRESCH	NP	IWD	VOC
	C5	PRESCH	NP	IWD	NOVOC
	C6	PRESCH	NP	IWD	VOC
	C8	PRESCH	NP	IWD	NOVOC
	C9	PRESCH	NP	IWD	VOC
Vogler-Elias (2009)	A	PRESCH	SPONTSPON	ADI	VOC
	B	PRESCH	SPONTSPON	ADI	VOC
	C	PRESCH	SPONTSPON	ADI	VOC
	D	PRESCH	SPONTSPON	ADI	VOC
	E	PRESCH	SPONTSPON	ADI	VOC
	F	PRESCH	SPONTSPON	ADI	VOC
	G	PRESCH	SPONTSPON	ADI	VOC

Table 10 Continued

Study	Participant Characteristics			Independent Variable (s)	Dependent Variable (s)
	Participant	Age	Communication/Language Level		
Walton & Ingersoll (2012)	Ryan	PRESCH	NP	IWD	SOC
	Daniel	PRESCH	NP	IWD	SOC
	Patrick	PRESCH	NP	IWD	SOC
	Chris	PRESCH	NP	IWD	SOC

[a]PRESCH-<5 , [b]ELEM-5 to <10 , [c]ADULT-15 and older , [d]NP-not provided, [e]SPSOMESPON-minimal spontaneous speech, large vocabulary, but usually prompted speech, [f]SPNOTSPON-some speech, but not spontaneous or functional, echolalia or prompted speech, [g]NOSP-no speech, but may have had vocalizations, [h]OTHERS-does not fit any of the categories, [i]ADI-adult-led didactic instruction, [j]COMB-combination of the categories, [k]IWD-individual with disabilities-led instruction, [l]AAC-use of augmentative and alternative communication systems, [m]SOC-social behaviors, joint attention, social play skills, social interpersonal skills, [n]VOC-vocalization, verbalize target words, [o]SOC-social behaviors, joint attention, social play skills, social interpersonal skills, [p]NOVOC-nonverbal communication or gestures using a part of body

Inter-Rater Reliability on Moderator Coding. To determine IRR for the moderator coding, two raters coded each article (*N*=23, 60%) independently based on the six moderator categories. IRR was calculated on agreement of moderator coding for each of the six moderator categories. If there was disagreement on individual category between two raters, the two reviewers discussed the discrepancy until they came to a consensus. IRR for the moderator coding was calculated by using a *Chi-Squared* statistic (Cohen, 1976) (see Table 11). As a result of the calculation, moderate to high agreements ranged from .739-1.000.

Table 11

Interrater reliability for moderators

Moderators	Kappa
Participant age	1.000
Participant communication/language level	.744
Independent variable	.843
Dependent variable	.739

Data Extraction and Analysis

Data Extraction. Prior to calculating effect sizes, graphs of each study were saved using the snipping tool provided by Microsoft Windows and saved into an Excel file. Every study had its own tab in the excel file to save its graphs. Each column on the top of the excel spreadsheet was labeled with the name of each condition of a study. In the case of a reversal design, A1, B1, A2, and B2 were put on the first row on the spreadsheet. On the first column on the spreadsheet, session numbers were coded. The

graph was placed next to those columns. To get a rank order for data points in a graph, a straight horizontal line was drawn through each data point to visually determine rankings of the data points from bottom to top. A data point that was plotted at the lowest level on the graph was ranked number 1. A data point that was plotted at the second lowest level on the graph was ranked number 2. If the data points were tied (i.e., two or more than two data points were plotted at the same spot on the graph), the same rank was given. In case that decreases in behavior were considered an improvement, a horizontal line was drawn through each data point from top to bottom. A data point that was plotted at the highest level on the graph was ranked number 1. A data point that was plotted at the second highest level on the graph was ranked number 2. These procedures continued until the data point plotted at the highest place on the graph was ranked. Ranks were recorded in the order in which they appeared in each phase (refer to Parker, Vannest, & Davis, 2011a). It must be recognized that printing limitations may affect the correct placement of data points compared to their actual values.

Phase Contrasts. After getting a rank order of data points from the graphs, effect sizes for phase contrasts were computed. Only two phases adjacent to each other were contrasted at a time (e.g., A_1 vs B_1 and A_2 vs B_2). In the case of a reversal and multiple baseline design, effect sizes of each phase contrast were aggregated. If there were more than one intervention phase used in one design (e.g., ABC), each adjacent phase was contrasted separately (e.g., A vs B) and then combined to compute an omnibus effect size (see Parker & Brossart, 2006).

Calculation of Effect Size. Tau-U (Parker, Vannest, Davis, & Sauber, 2011) was used to analyze the data. A result of Tau-U can be summarized either as percent of non-overlap data between phases or percent of non-overlap with either or both phase A and phase B trend controlled (Parker et al., 2011). Tau-U software developed through the Maple platform was used to calculate effect sizes (Davis & Davis, 2014). The Tau-U effect size was calculated considering the "percent of non-overlapping data" (as cited in Parker, Vannest, Davis, & Sauber, 2011, p. 6) between baseline and intervention phases. Scores ranged from -1.0 to 1.0. If the analysis yielded a score bigger than 0.0, it indicates there was an improvement in the data between baseline and intervention phases. If the analysis yielded a score smaller than 0.0, it indicates there was a deteriorating data set. Tau-U can be interpreted in terms of size of effect (i.e., small effect = 0 to .62, medium effect = .63 to .92, large effect = .93 to 1.00; Parker, Vannest, & Davis, 2011). If there were more than one effect size computed in one graph, every effect size was combined using an arithmetic mean to get an omnibus effect size. In this meta-analysis, Tau-U scores were calculated for each participant and across all of the moderators coded to evaluate for whom an intervention produces meaningful outcomes and to investigate which type of intervention components was the most effective in improving the social-communication skills of individuals with ASD and other DD.

To evaluate the statistical significance of the results, the Kruskal-Wallis one-way analysis of variance was conducted (Kruskal & Wallis, 1952). Then, if the statistically significance was found for any of the moderator variables, a Dunn post-hoc test was utilized to examine the pair-wise combinations (Dunn, 1964).

Inter-Rater Reliability for Data Extraction. To determine IRR for data extraction, two raters independently coded 26 of the articles (65%) independently based on the nine moderator categories. IRR was calculated on agreement of data extraction for each article. If there was disagreement on data extraction between two raters, the two reviewers discussed the discrepancy until they came to a consensus. IRR for the data extraction was calculated by using a *Chi-Squared* statistic (Cohen, 1976) (see Table 12). As a result of the calculation, high agreements were yielded, ranging from .867-.895.

Table 12

Interrater reliability for raw data

Raw Data	Kappa
Baseline	.869
Intervention	.895

Results

In this study, raw data in a total of 368 separate AB contrasts (i.e., baseline vs. intervention phase) from 40 studies with 156 participants were extracted to calculate effect sizes. As a result, the omnibus Tau-U effect size across all studies included in this analysis was .640 CI_{95} [.617, .663], indicating that family-implemented interventions to improve the social-communication skills of individuals with ASD and other DD have overall moderate effects (i.e., .630-.920). Within all the experiments analyzed, a wide range of Tau-U effect sizes were identified from -1.000 to 1.000 while about two-third of the analyses were found to have moderate to strong effects (i.e., .630-1.000)

indicating that family-implemented interventions might not have been similarly effective for every participant in improving his or her social-communication skills. In addition to the overall effect sizes across the experiments, results of each moderator analysis are presented in Table 13-20.

Age

A total of four variables were categorized within the age category (see Table 13). As a result of the analysis, Tau-U effect sizes ranged from a moderate effect of .659 CI_{95} [.631-.687] for PRESCH (ages <5) to a small effect of .59 CI_{95} [.430-.755] for ADULT (ages 15 and older). More than half of the analyses were conducted with preschool-aged individuals and resulted in a highest Tau-U effect size (*ES*=.659 CI_{95} [.631-.687]) among the age category. No studies analyzed in this study included secondary-aged individuals. The Kruskal-Wallis analysis indicated no statistically significant differences between experiments based on the level of language and communication skill category (p<.0001) (see Table 14).

Table 13

Number of studies, participants, analyses and Tau results: Age

Age	Number of Studies	Number of Study Participants	Number of Analyses	Group Tau [CI_{95}]
[a]PRESCH	33	103	244	0.659904
[b]ELEM	21	45	113	0.604178
[c]SEC	0	0	0	NA
[d]ADULT	2	2	7	0.593097

[a]PRESCH-5<, [b]ELEM-5 to <10, [c]SEC-10 to <15, [d]ADULT-<15

Table 14

Group comparisons in average ranks, Alpha, and significance difference: Dunn Post-Hoc test for age

Group Comparisons	Difference in Average Ranks	Cutoff at Alpha=.05	Significance Difference=**
[c]ADULT-[b]ELEM	26.2769	109.608	
ADULT-[a]PRESCH	17.9333	107.878	
ELEM-PRESCH	8.3436	32.021	

[a]PRESCH-5<, [b]ELEM-5 to <10, [c]ADULT -<15

Level of Language and Communication Skills

Within a category of the level of language and communication skills, a total of three variables were categorized (see Table 15). As a result of the analysis, Tau-U effect sizes ranged from a moderate effect of .733 CI_{95} [.668-.800] for NOSP (no speech, but may have had vocalizations) to a small effect of .594 CI_{95} [.553-.635] for SPNOTSPON (some speech, but not spontaneous or functional, echolalia or prompted speech). The Kruskal-Wallis analysis indicated no statistically significant differences between experiments based on the level of language and communication skill category (p<.0001) (see Table 16).

Table 15

Number of studies, participants, analyses and Tau results: Communication/language level

	Number of Studies	Number of Study Participants	Number of Analyses	Group Tau [CI_{95}]
[a]SPSOMESPON	11	30	52	0.65077
[b]SPNOTSPON	14	42	100	0.594762
[c]NOSP	9	21	62	0.734505

[a]SPSOMESPON- minimal spontaneous speech, large vocabulary, but usually prompted speech, [b]SPNOTSPON- some speech, but not spontaneous or functional, echolalia or prompted speech, [c]NOSP-no speech, but may have had vocalizations

Table 16

Group comparisons in average ranks, Alpha, and significance difference: Dunn Post-Hoc test for communication/language level

Group Comparisons	Difference in Average Ranks	Cutoff at Alpha=.05	Significance Difference=**
[c]NOSP- [b]SPNOTSPON	35.889	48.3986	
NOSP- [c]SPSOMESPON	10.495	56.3023	
SPNOTSPON- SPSOMESPON	25.394	51.1907	

[a]SPSOMESPON- minimal spontaneous speech, large vocabulary, but usually prompted speech, [b]SPNOTSPON- some speech, but not spontaneous or functional, echolalia or prompted speech, [c]NOSP-no speech, but may have had vocalizations

Independent Variable

A total of two variables were categorized within the independent variable category (see Table 17). As a result of the analysis, Tau-U effect sizes ranged from a moderate effect of .676 CI_{95} [.641-.711] for CLI (individual with disabilities-led instruction) to a small effect of 646 CI_{95} [.612-.680] for ADI (adult-directed instruction). The Kruskal-Wallis analysis indicated no statistically significant differences between

experiments based on the level of language and communication skill category (p<.0001) (see Table 18).

Table 17

Number of studies, participants, analyses and Tau results: Independent variables

Independent Variable	Number of Studies	Number of Study Participants	Number of Analyses	Group Tau [CI_{95}]
[a]ADI	23	85	178	0.646182
[b]IWD	14	63	167	0.676521

[a]ADI-adult-led didactic instructions, [b]IWD-individual with disabilities-led instructions

Table 18

Group comparisons in average ranks, Alpha, and significance difference: Dunn Post-Hoc test for independent variables

Group Comparisons	Difference in Average Ranks	Cutoff at Alpha=.05	Significance Difference=**
ADI-IWD	7.242	30.317	

[a]ADI-adult-led didactic instructions, [b]IWD-individual with disabilities-led instructions

Dependent Variable

A total of four variables were categorized within the dependent variable category (see Table 19). As a result of the analysis, Tau-U effect sizes ranged from a moderate effect of .789 CI_{95} [.729-.850] for NOVOC (nonverbal communication or gestures using a part of body) to a small effect of .546 CI_{95} [.500-.583] for VOC (vocalization, verbalize target words). The Kruskal-Wallis analysis indicated no statistically significant

differences between experiments based on the level of language and communication skill category (p<.0001) (see Table 20).

Table 19

Number of studies, participants, analyses and Tau results: Dependent variables

Dependent Variable	Number of Studies	Number of Study Participants	Number of Analyses	Group Tau [CI_{95}]
[a]AAC	6	11	35	0.765988
[b]VOC	18	78	130	0.546551
[c]SOC	11	32	70	0.663016
[d]NOVOC	6	24	36	0.789988

[a]AAC-use of augmentative and alternative communication systems, [b]VOC-vocalization, verbalize target words, [c]SOC-social behaviors, joint attention, social play skills, social interpersonal skills, [d]NOVOC-nonverbal communication or gestures using a part of body

Table 20

Group comparisons in average ranks, Alpha, and significance difference: Dunn Post-Hoc test for dependent variables

Group Comparisons	Difference in Average Ranks	Cutoff at Alpha=.05	Significance Difference=**
[a]AAC-NOVOC	21.726	74.320	
AAC-[c]SOC	23.786	34.815	
AAC-[b]VOC	43.204	59.621	
[d]NOVOC-SOC	2.060	64.212	
NOVOC-VOC	21.478	58.965	
SOC-VOC	19.419	46.415	

[a]AAC-use of augmentative and alternative communication systems, [b]VOC-vocalization, verbalize target words, [c]SOC-social behaviors, joint attention, social play skills, social interpersonal skills, [d]NOVOC-nonverbal communication or gestures using a part of body

Discussion

This study appears to be the first meta-analytic review on single-case research studies that evaluated the overall impact of family-implemented social-communication interventions and differential impacts across the characteristics of individuals with ASD and other DD, the intervention types, and the targeted outcome skills. Furthermore, this meta-analysis is the first review on this topic that only included single-case research studies that met the basic design standards developed by WWC (Kratochwill et al., 2013). In general, results indicate that family-implemented interventions have a moderate effect on improving the social-communication skills among individuals with ASD and other DD.

The second research question addressed by this study was whether the participant characteristics, including ages and language/communication levels, moderate the effectiveness of family-implemented social-communication interventions. Regarding age, as found in previous reviews on studies that evaluated the effectiveness of parent-implemented interventions (e.g., Lang, Machalicek, Rispoli, & Regester, 2009; Schultz, Schmidt, & Stichter, 2011; Roberts & Kaiser, 2011), more than two-third of the studies included in this review included preschool- and elementary school-aged individuals with ASD and other DD. This may be due to the fact that providing early intensive behavioral intervention to young children with ASD has been emphasized for the last few decades (Tzanakaki et al., 2012; Kovshoff, Hastings, & Remington, 2011). Few of the studies included participants in secondary and adulthood age-groups, leaving us unable to draw

conclusion regarding the effectiveness of family-implemented interventions for older individuals.

Overall, moderate effects were found across the language/communication levels of participants. While participants who were categorized in the no speech, but may have had vocalizations group yielded the highest treatment effect, less than one-third of the studies were conducted with these participants, the results for this group were not statistically significantly different from the Tau score for the other groups. Although participants who had no speech appeared to have better outcomes, it might be due to the fact that the studies that included these individuals targeted less complex skills compared to studies conducted with individuals who had at least a minimum of speech. The studies that included individuals who had some speech skills tended to target more complex social-communication skills that consisted of more than one word or required spontaneous use of the skill, which might have led to the lower treatment effect.

The third research question addressed by this study was whether differential effects existed based on the type of intervention. Small to strong effects were found across interventions. More than half of the studies included in this meta-analysis utilized adult-led didactic instructions. In addition, results indicated no statistical significant difference between adult-led didactic instructions and individual with disabilities-led instructions. This could be due to the fact that both types of family-implemented social-communication intervention appeared to share multiple components as documented in previous reviews (e.g., Lang, Machalicek, Rispoli, & Regester, 2009; Mayer, Sulzer-Azaroff, & Wallace, 2012). Both types of the interventions often include several

behavioral techniques, such as modeling, fading, prompt, reinforcement, and time delay (Leach, 2010; Reichow & Volkmar, 2010). Given this fact that no statistically significant difference was found between the two types of interventions, we can assume that either type of the interventions can be utilized for individuals with ASD and other DD. These findings may increase feasibility of utilization of family-implemented social-communication interventions for family members of individuals with ASD and other DD since those family members may be able to select an intervention based on their preferences and resources available.

The fourth research question focused on identifying the variability of effects based on the type of social-communication skills. Overall, moderate effects were found across the type of social-communication skills of individuals with ASD and other DD; however, there were no statistically significant differences between potential moderator levels. While results indicated the nonverbal communication or gestures using a part of body group yielded the highest treatment effect, only a few studies evaluated non-verbal skills making it difficult to have confidence in these results. Further, the lower complexity of the skills might be the fact that the interventions for non-verbal skills resulted in higher treatment effects than verbal behaviors.

Implications for Practice

In addition to providing empirical support for family-implemented social-communication interventions, several implications for practices can be addressed by this review. First, family-implemented interventions may be effective in improving the social-communication skills for early-aged individuals with ASD and other DD. As

found in previous literatures on social and communication interventions for individuals with ASD and other DD, studies included in this review appeared to heavily focus on young individuals with ASD and other DD (Meadan , Ostrrosky, Zaghlawan, & Yu, 2009; Kaiser & Roberts, 2011; Lang, Machalicek, Rispoli, & Regester, 2009; Schultz, Schmidt, & Stichter, 2011). However, in this meta-analysis, there were no statistically significant differences between preschool- and elementary-aged individuals with ASD and other DD in terms of the treatment effect, indicating that the practice of family-implemented interventions can be broadly applied for those aged individuals with ASD and other DD.

With respect to the functioning levels of individuals with ASD and other DD, the second implication for practices related to family-implemented social-communication interventions can be drawn from this review. Results indicated that there was no statistically significant difference between the levels of communication/language skills of individuals with ASD and other DD. Although the interventions for individuals who had no speech showed slightly higher treatment effects relative to individuals who had some speech skills, there were no statistically significant differences across the level of communication/language skills of individuals with ASD and other DD. Therefore, findings from this analysis may indicate that the practice of family-implemented interventions can be utilized for individuals with ASD and other DD regardless of their level of communication/language skills.

Limitations and Implications for Future Research

There are some limitations to this meta-analysis. In addition, results of this study suggest several implications for future research. First, to include more studies in this meta-analysis, some of the basic design standards were slightly modified when analyzing each study with the standards. Compared to studies analyzed in prior reviews on family-implemented social-communication interventions, studies in this meta-analysis met relatively high quality. This leads to a direction for future research by indicating that more studies that have high quality designs should be conducted across the moderator levels.

Second, the current study did not analyze data in generalization and maintenance condition, leading to doubt whether the interventions may result in positive long term and generalized effects on the social-communication skills of individuals with ASD and other DD. Therefore, future research is recommended for evaluating data in generalization and maintenance conditions to investigate whether the targeted skills were maintained and generalized across setting, behaviors, and people. Furthermore, at the beginning of a study, future research should plan for collecting generalization and maintenance data more frequently throughout phases.

Third, no studies included in this review evaluated the treatment effects for secondary-aged individuals and only two adult participants with ASD and other DDs were included making it impossible to evaluate these interventions for individuals over elementary ages. In addition, this may weaken the conclusion indicating that the interventions were effective in improving the social-communication skills of individuals

with ASD and other DD overall. In order to add more empirical support to findings from this review, more research on family-implemented social-communication interventions should be conducted with older-aged individuals with ASD and other DD.

Fourth, several moderator levels included only a few studies. The uneven number of studies across each category within moderator variables may make it difficult to make solid conclusions based on the findings for moderator effects of each variable. Therefore, it is recommended that more studies be conducted with each category within the moderator variables to add empirical support to the findings from this review.

CHAPTER V

SUMMARY AND CONCLUSIONS

This dissertation aimed to investigate the effects of family-implemented interventions on the social-communication skills of individuals with autism spectrum disorder (ASD) and other developmental disabilities (DD). To do so, this dissertation included three articles. The first article reported the results of a single-case research study. This single-case experimental design (SCED) project examined the effects of instructional coaching on treatment integrity on primary caregiver-implemented augmentative and alternative communication (AAC) intervention for an adult with ASD and independent use of AAC mode of the adult with ASD. The second article reported the results of an evaluation of the quality of research on primary caregiver-implemented communication interventions for individuals with ASD to determine whether or not primary caregiver-implemented communication intervention could be considered an evidence-based practice (EBP). The third article reported the results of a meta-analysis on family-implemented social-communication interventions for individuals with ASD and other DD.

The first article utilized a single subject, multiple probe design across three instructional coaching steps to examine the accuracy of caregivers' AAC implementation. One adult with ASD and complex communication needs participated in this study along with his four caregivers participated in this study. Two research questions were addressed. First, this study evaluated whether or not the instructional

coaching was effective in improving treatment fidelity of the caregivers' intervention implementation to the adult with ASD. Second, it was investigated whether or not the adult with ASD showed an improvement in his independent use of AAC mode. As a result of this study, all the caregiver participants showed high treatment fidelity after receiving training in the AAC intervention procedures. However, throughout the study, the adult with ASD infrequently used the AAC mode independently.

The second article involved determination of whether or not primary caregiver-implemented communication interventions could be considered an EBP for the communication skills of individuals with ASD. In addition, the interventions were evaluated to determine whether or not they could be considered an EBP for caregivers' intervention implementation. Findings in this analysis indicated that the primary caregiver-implemented interventions can be considered an EBP for the communication skills of individuals with ASD. However, because of the few experiments in the analysis included measures evaluating the performance of the primary caregivers, caregiver-implemented communication interventions were not found to be an EBP for caregiver's dependent variables.

In the third article, four research questions were addressed. First, the overall effects of family-implemented intervention on improving the social-communication skills of individuals with ASD and other DD were evaluated. Second, the differential effects of the family-implemented interventions on the social-communication skills related to the characteristics of individuals with ASD and other DD were investigated. Third, the types of intervention approach (i.e., individual with disabilities-led instruction,

adult-led didactic instruction) was examined to determine if any produced significantly larger effects on the social-communication skills of individuals with ASD and other DD. Fourth, the effects of the family-implemented interventions differentiated by categories of the social-communication outcomes (i.e., social-play behaviors, joint attention, verbal or recognizable words, use of AAC mode) were evaluated. To analyze the moderators (i.e., age, communication and language characteristic, intervention type, dependent variable), Tau-U effect sizes (Parker et al., 2011b) with Kruskal-Wallis (Kruskal & Wallis, 1951) and the Dunn post-hoc tests (Dunn, 1964) were calculated. Result of this analysis indicated that family-implemented interventions have a moderate effect on the social-communication skills of individuals with ASD and other DD. Furthermore, the results indicated no statistically significant differences between studies based on all the moderator variables.

Implications for Practice

These findings have several implications for practitioners. The findings in the first study extend the existing evidence on communication interventions for individuals with ASD, demonstrating that primary caregivers may be able to implement the AAC intervention procedures with high treatment fidelity. Regarding cost and time efficiency, primary caregiver-implemented communication intervention can provide some benefits to individuals with ASD and their families. Furthermore, the SCED project extends the existing evidence on the communication interventions by including an adult-aged individual with ASD. Further, by determining that the family-implemented social-communication interventions are an EBP, the findings of the second article help

researchers and practitioners select an evidence-validated practice for individuals with ASD and other DD to improve the social-communication skills of those individuals. Moreover, the family-implemented interventions have positive effects on improving various types of the social-communication skills of individuals with ASD and other DD across the participants' ages, communication and language characteristics, types of intervention, and the targeted social-communication skills.

Limitations

Aside from the limitations noted in each individual study, some additional limitations should be considered. First, only one adult individual with ASD participated in the first article. Although the participant infrequently used AAC mode independently, if implemented with additional participants, researchers may find that participants with different characteristics may be more responsive than others.

An additional limitation to be considered is that although family-implemented social-communication interventions were found to be effective for individuals with ASD and other DD, many of these studies do not inform the reader of the intensity of training needed to facilitate intervention implementation of families while others provided inconsistent information, such as number of sessions and length of training duration. Providing information about training duration in a consistent manner is important because it may moderate accuracy of families' intervention implementation, and therefore, it may also affect intervention effects on the social-communication skills of individuals with ASD and other DD.

Implications for Future Research

By expanding upon these studies and addressing the abovementioned limitations, future research may further emphasize the importance of family involvement in education for their children with ASD and other DD. First, regardless of research design, conducting more studies that include young adolescent- or adult-aged individuals with ASD and other DD would support the findings of the first article. The first article utilized a single-case research design. Since there were only a few individuals who met the inclusion criteria for the study, this type of design appeared to be appropriate for the participants, leading to exclusion of other types of research designs, such as group designs. Although results of the study were shown to be effective in improving the caregiver participants' intervention implementation for the adult-aged individual with ASD, it is unclear whether the training provided to the caregivers were truly efficient in terms of cost and time. Future research should strive to include more families of those aged-individuals with ASD and other DD to enhance the practical implementation of family-implemented social-communication interventions and further revision of the training methods to determine means of affecting both the caregivers' behaviors and the communication skills of the participants with ASD and DD.

Additionally, the second article evaluated whether or not primary caregiver-implemented communication intervention could be considered an EBP for communication skills for individuals with ASD as well as for caregivers' behaviors (i.e., accuracy of intervention implementation). Results indicated that primary caregiver-implemented communication intervention can be considered an EBP for individuals with

ASD while it may not be for caregivers' behaviors. It was because only 11 experiments across five studies measured caregivers' behaviors, resulting in that the second standard for EBP was not met. Previous literature have found that studies involving caregivers as intervention implementers often did not report procedural fidelity on the caregivers' behaviors, leading to doubt about whether the intervention was the sole factor that affected language and communication outcomes of individuals with ASD. With the findings in the second article, it is suggested that future research on primary caregiver-implemented interventions should include measures for caregivers' behaviors to ensure the treatment effects of their intervention implementation on improving language and communication skills of individuals with ASD.

Furthermore, as indicated in the third article, intensity of training provided to families of individuals with ASD and other DD was not reported in a consistent manner, leading to difficulties to determine the number of or the length of training sessions that would produce the highest treatment fidelity for the families' intervention implementation. Research that evaluates the required number of and the length of training sessions needed to achieve maximum effects should be investigated. Providing specific information regarding the minimum number of or the length of training sessions that produce the effects found in the third article may help researchers and practitioners provide training to families of individuals with ASD and other DD in the most efficient manner possible.

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APPENDIX A

Dependent Variable Data: Implementation of Required Components for Procedural Steps
Primary Caregiver's Name:

Circle one on condition and Mark + or - on each trial

Response definitions: Primary Caregiver's accurate AAC implementation
If the participant accessed any item, it should be counted as a trial.

Step	**Components**	**Condition (circle)**	**Trials**				**Total +**
			1 (+/-)	**2 (+/-)**	**3 (+/-)**	**4 (+/-)**	
I	Entice with at least 3 items. Each item was presented and actively enticed no less than 5 seconds. If the participant attempted to access any of those items, using full prompt, physically prompted him to use Tap to Talk.	BL IV					
II	Once the participant touched an icon of the item, verbally labeled a name of the item and handed over the item to him. Provided social praise, such as ″good asking."	BL IV					
III	If the participant attempted to access any of those items, using partial physical or verbal prompt, prompt him to use Tap to Talk.	BL IV					
Ryan's Independent Use of Tap to Talk		BL IV					

APPENDIX B

Steps of the instructional coaching provided to the primary caregivers.

Step / **Procedures**	**Baseline**	***Step I: Entice and provide full-physical prompt.***	***Step II: Verbal model and social praise.***	***Step III: Prompt fading.***
1	Tap to Talk program on iPad was presented on the table.	Tap to Talk program on iPad was presented on the table.	Tap to Talk program on iPad was presented on the table.	Tap to Talk program on iPad was presented on the table.
2	The participant's preferred items were presented in his sight but out of his reach.	The participant's preferred items were presented on the table.	The participant's preferred items were presented on the table.	The participant's preferred items were presented on the table.
3	If the participant attempted to access any of those items, handed over the item to him.	Enticed with at least 3 items. Each item was presented and actively enticed no less than 5 seconds.	Enticed with at least 3 items. Each item was presented and actively enticed no less than 5 seconds.	Enticed with at least 3 items. Each item was presented and actively enticed no less than 5 seconds.
4	No prompts or instructions were given to the participant.	If the participant attempted to access any of those items, using full prompt, physically prompted him to use Tap to Talk.	If the participant attempted to access any of those items, using full prompt, physically prompted him to use Tap to Talk.	If the participant attempted to access any of those items, using partial physical or verbal prompt, prompt him to use Tap to Talk.
5	If the participant did not show any interest in the presented items, presented other items.	Once the participant touched an icon of the item, handed over the item to him.	Once the participant touched an icon of the item, verbally labeled a name of the item and handed over the item to	If the participant did not touch the icon correctly, provided a full physical prompt.

			him.	
6		If the participant did not show any interest in the presented items, presented other items and enticed with them.	Provided social praise, such as “good asking."	Once the participant touched an icon of the item, verbally labeled a name of the item and handed over the item to him.
7			If the participant did not show any interest in the presented items, presented other items and enticed with them.	Provided social praise, such as “good asking."
8				If the participant did not show any interest in the presented items, presented other items and enticed with them.