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Teaching Texting on a Smart Phone to Children and Adolescents with Autism Spectrum Disorder (ASD)

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APPROVAL OF THE DISSERTATION COMMITTEE

This dissertation has been duly read, reviewed, and critiqued by the Committee listed below, which hereby approves the manuscript of Jenna Gilder as fulfilling the scope and quality requirements for meriting the degree of Doctor of Philosophy in Psychology.

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Abstract

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Children and adolescents diagnosed with autism spectrum disorder (ASD) have deficits in social communication (*Diagnostic and Statistical Manual of Mental Disorders*-5th edition, APA, 2013). These deficits are significantly pronounced when individuals with ASD attempt to engage in conversations. Due to advances in technology, children and adolescents are now conversing through computer mediated communication (CMC; Pew, 2015, 2018). Texting in particular is one popular form of CMC that may mitigate the non-verbal social skill deficits seen in individuals with ASD, such as eye contact and tone of voice. Despite the potential of texting and its popularity as a CMC medium among typically developing children and adolescents, no research currently exists on teaching texting to individuals with ASD. The present study therefore aimed to increase the social communication skills of the participants by teaching five children and adolescents with ASD to maintain a back and forth conversation through text. This study was a non-concurrent multiple baseline design across dyads. The study involved two texting interventions; the first focused on the steps needed to send a text and the second examined teaching texting content. The texting step intervention was taught using a total-task chaining procedure to teach each of the steps illustrated in the texting guidebook, which was designed specifically for the current study. The second intervention used a multiple exemplar approach (two conversation samples) that were interspersed across sessions and participants. Both interventions were implemented using the guidebooks combined with prompting. The

participants were paired together, resulting in three dyads. In two of the dyads, both of the participants had an ASD diagnosis. The third dyad included one participant with ASD and one typically developing peer. Training sessions were conducted in a lounge setting at an afterschool behavioral treatment center and in the children's respective homes. Generalization texting partner probes, FaceTime® probes, as well as one-month maintenance probes were also collected. Overall, results demonstrated that during baseline, all five of the children texted appropriately at low rates; in addition, one of the five participants also did not consistently complete all the steps required to send a text. Following the texting content intervention, all five of the participants reached the criterion for appropriate texting content. The one participant, who also received the texting steps intervention, met criterion for both interventions. All five participants also met the fading criterion and continued to demonstrate the two skills on their two weekly independent text conversations. They also all generalized across texting partners (from their peers to their parents/siblings) and maintained the behavior one month following treatment. In addition, the ancillary variable of percentage of appropriate verbal content spoken during FaceTime® was examined. All five children demonstrated low levels of appropriate verbal content in their FaceTime® probes prior to the texting intervention, and all demonstrated an increase in appropriate content following the texting intervention and during follow up. Lastly, strong social validity data was gained through examining pre and post surveys for parents and participants that asked about their current texting habits and their interest in learning to text with more people. Additional, social validity data was gained by having naïve raters score a sample of the conversations to assess the appropriateness of the conversations in terms of replicating the style of conversations typically developing children engage in. The results taken together suggest

the potential benefit of teaching children and adolescents with ASD to communicate through text. Future research should replicate this study to validate and expand upon these findings.

Dedication

This dissertation is dedicated to all of the inspiring children and adolescents with ASD that I have had the privilege to interact with over the years, and to my amazing support system: Mason, Lori, Tom, Jeff, Tiffanie, Gamy & Mandy. Thank you all for providing me with daily inspiration and support that made this dissertation possible.

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Lastly, I would like to thank all of the families that participated in this study. Thank you for taking the time during this pandemic to help make this dissertation a reality. I could not have done this study without the support of the dedicated parents who made it possible for me to conduct sessions over zoom, donated their time, and provided their phones for their children to use. Thank you for your willingness to go above and beyond.

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Introduction to Conversational Skill Development

Conversational skill development in typically developing children and adolescents

Conversational speech. Conversational speech is an essential skill that begins to develop in childhood and continues to evolve and gain complexity throughout the lifespan as individuals age, and their brains develop (Blakemore & Choudhury, 2006; Conti-Ramsden, Durkin, 2012; Hoff, 2013; Nippold, 2000; Tomasello, 2006). For the purpose of this review, conversing will be defined as a verbal exchange of information. Conversational speech involves a back and forth exchange of information between two individuals (Larson & McKinley, 1998). Specifically, conversational speech refers to the social aspect of language (Nippold, 2000). When conversing, each individual takes on the dual roles of listener and speaker (Garfin & Lord, 1986). A few of the many important skills for conversing include identifying a conversation partner and initiating a verbal exchange (Doggett, Krasno, Koegel, Koegel, 2013). It also requires engaging in turn taking (Larson & McKinley, 1998) and perspective taking (Brown-Schmidt & Heller, 2018; Calero, Salles, Semelman, & Sigman, 2013; Devine & Hughes, 2012), interpreting non-verbal social cues and gestures (Doody & Bull, 2011; Driskell & Radtke, 2003; Maricchiolo, Gnisci, Bonaiuto, & Ficca, 2009), and identifying and discussing common interests (Larson & McKinley, 1998).

Childhood. Early signs of language acquisition can be seen in newborns in their ability to distinguish among different sounds (McMurray & Aslin, 2005). By four to six-months, children begin to recognize their names (Hoff, 2013; Mandel, Jusczyk, Pisoni, 1995). Children tend to produce their first words around one (Hoff, 2013; Majorano & D'Odorico, 2011), and

they produce two-word utterances by about 18 months and two years of age (Hoff, 2013; Tomasello, 2006).

It is not until around age two that children start to develop conversational skills (Hoff, 2013). Conversational speech is one way children can engage socially with the world around them (Conti-Ramsden, Durkin, 2012). This is due to the child's increased social engagement, increased vocabulary, and memory of past events (Hoff, 2013). It is around this age that children also begin to understand word order utterances when using familiar verbs (Tomasello, 2006). The length of these early utterances gradually increases until the child is producing complex sentences, which usually occurs around age four (Hoff, 2013). Spontaneous passive language also emerges around age four or five (Tomasello, 2006). Parents are the primary communication partner in the early years for children, but peers begin to also take on this role as the child gets older due to the increased salience of peer relationships (Brown & Larson, 2009; Raffaelli & Ducket, 1989). Typically developing children complete their overall language acquisition by age four (Hoff, 2013). During the years following, the conversations gain complexity as the conversers learn to take turns in conversations, find common interests, and use more complex language patterns. During this time the primary communication partners also expand from parents to also include peers (Brown & Larson, 2009; Raffaelli & Ducket, 1989).

Adolescence. Since peer relationships become more salient in adolescence (Brown & Larson, 2009), peers join parents in becoming primary communication partners for adolescents (Larson & McKinley, 1998; Raffaelli & Duckett, 1989). The brain is still developing during adolescence and this can play a role in the development of important skills for conversing such as perspective taking and selective attention (Blakemore & Choudhury, 2006). Development in the prefrontal cortex during this stage is also important conversationally because of its impact on

reasoning abilities, information processing, and inhibition of inappropriate language (Kuhn & Franklin, 2009). These biological changes may have a social impact by paving the way for more complex verbal conversations.

Gains during adolescence in terms of conversational growth can be seen in the realm of pragmatic and semantic development (Larson & McKinley, 1998; Nippold, 2000). Pragmatics can best be defined as the use of language within a social setting (Nippold, 2000). Semantic development refers to the meaning of words (Nippold, 2000). In terms of the ability to converse, growth in these two areas indicates an increase in conversational speech as well as a greater understanding of the meaning behind the exchange of spoken words. Larson & McKinley (1998) found that when examining adolescent conversations with peers, some common features included engaging in question asking, using figurative language, and going back and forth between multiple conversation topics. Differences were also seen in these three areas when examining adolescents' conversations with peers versus conversations with adults (Larson & McKinley, 1998).

Important social-cognitive skills needed for conversational development.

Other social cognitive skills essential for conversing develop during childhood, adolescence, and even into adulthood (Attardo, Eisterhold, Hay, & Poggi, 2003; Brown-Schmidt & Heller, 2018; Driskell & Radtke, 2003; Farrant, Maybery, Fletcher, 2011; Maricchiolo, Gnisci, Bonaiuto, & Ficca, 2009; Richardson, Dale, & Kirkham, 2007). This includes producing and understanding communicative gestures, engaging in joint attention, understanding paralinguistic cues referencing the intention of the speaker, and perspective taking.

Communicative gestures. Research has suggested communicative gestures can act as a building block needed for development of early language (Goldin-Meadow, Goodrich, Sauer,

and Iverson, 2007; Goldin-Meadow, 2009;). Specifically, research has suggested a connection between children's gestures and early vocabulary. Goldin-Meadow, Goodrich, Sauer, and Iverson (2007) found that children's gestures acted as a signal to mothers to translate the gesture into words. They later found that these words tended to then become a part of the child's early spoken vocabulary. This suggests that the power of children's gestures encouraged language modeling by the parent, resulting in greater exposure to language. In conversational speech during adolescence and adulthood, gestural communication continues to be present alongside verbal speech as a means of enhancing the meaning behind the spoken words (Driskell & Radtke, 2003; Maricchiolo, Gnisci, Bonaiuto, & Ficca, 2009). For example, an individual's body language may provide information concerning how the messages are being perceived (i.e. emotional states) and the individual's overall engagement in the conversation. In turn it is suggested that gestures can enhance both speech production and listener comprehension (Driskell & Radtke, 2003).

Joint Attention. Joint attention, which is when two people are focused on a shared item, is another social cognitive skill that plays a role in conversational skill development. Specifically, joint attention has been connected through research to language (Farrant, Maybery, Fletcher, 2011; Morales et al., 2000; Tomasello, 1988) and conversational skill development (Clark, 1996; Farrant, Maybery, Fletcher, 2011; Richardson, Dale, & Kirkham, 2007). In particular, joint attention between a parent and a child on a single item has been demonstrated through research to aid in early development of both lexical (vocabulary; Farrant & Zubrick, 2011; Morales et al., 2000) and conversational skills (Farrant, Maybery, Fletcher, 2011; Richardson, Dale, & Kirkham, 2007).

During adolescence and adulthood, joint attention plays a role in the topic of conversation (Richardson, Dale, & Kirkham, 2007). One example of this can be seen when two individuals engage in a conversation about a common subject, such as football, while currently watching a football game. Clark (1996) termed this form of joint attention seen in conversations as "joint activity," since the individuals are both engaged in a visual scene and in turn coordinating their attention and conversation around it. These studies together suggest the importance of joint attention in the realm of conversational skills both in childhood as well as in adolescence and adulthood.

Paralinguistic cues. Understanding paralinguistic cues is also an essential component of conversational skill development. This term refers to the non-verbal components of speech that can provide additional information to the intended meaning behind the spoken words. For example, this can include tone of voice, volume, rate of speech, and facial expressions (Cambridge Dictionary, 2019). Sarcasm, or verbal irony, (i.e. when a message differs in terms of its figurative versus its literal meaning; Laval & Bert-Eboul, 2005) is one aspect of speech that is dependent on the listener picking up on paralinguistic cues. The paralinguistic cues commonly seen with sarcastic speech involve tone of voice and facial expressions (Attardo, Eisterhold, Hay, & Poggi, 2003). Typically developing children begin to pick up on the paralinguistic cues related to sarcasm as early as 5 years of age (Laval & Bert-Eboul, 2005).

Perspective taking and Theory of Mind. The ability to maintain a back and forth conversation is dependent on perspective taking, which is the ability to consider the conversation from the perspective of a conversation partner (Brown-Schmidt & Heller, 2018). Perspective taking though can only develop after an individual first demonstrates theory of mind (TOM; Brown-Schmidt & Heller, 2018), which is the ability to understand that each individual has their

own knowledge, beliefs, and desires that will impact their behavior (Frith & Frith, 2005). The basic components of TOM usually develop around 3-5 years of age (Flavell, 1999). TOM though can continue to develop and gain more complexity throughout middle childhood and adolescence (Calero, Salles, Semelman, & Sigman, 2013; Devine & Hughes, 2012). In terms of conversing, understanding TOM and taking on the perspective of a conversation partner may help with determining conversation topics based around shared interests and gaining a deeper understanding of the intention and meaning behind spoken words.

Summary

Conversing with another individual involves the coordination of both verbal and non-verbal social skills (Attardo, Eisterhold, Hay, & Poggi, 2003; Brown-Schmidt & Heller, 2018; Driskell & Radtke, 2003; ; Farrant, Maybery, Fletcher, 2011; Maricchiolo, Gnisci, Bonaiuto, & Ficca, 2009; Richardson, Dale, & Kirkham, 2007). The preliminary skills required to engage in conversation begin to develop during childhood, and they continue to develop and evolve throughout the lifespan (Hoff, 2013; Larson & McKinley, 1998; Nippold, 2000). However, not all individuals develop conversational skills following this linear trajectory. One example of this can be seen when examining the conversational skill deficits of both children and adolescents with autism spectrum disorder (ASD) (*Diagnostic and Statistical Manual of Mental Disorders*-5th edition, APA, 2013).

Chapter 2

Children and Adolescents with ASD and conversational skill development

Introduction to Autism spectrum disorder

ASD is a pervasive developmental disorder impacting the lives of 1 in every 59 individuals (*Diagnostic and Statistical Manual of Mental Disorders*-5th edition, APA, 2013). ASD has been diagnosed in individuals across racial, socioeconomic and ethnic groups and is estimated to be four times more common in males compared to females. Deficits associated with ASD involve social and communication skills (APA, 2013). Specifically, individuals with ASD fall along a spectrum ranging from mild/moderate to severe in terms of their deficits. Even children and adolescents with ASD on the higher end of the spectrum, mild/moderate, maintain severe deficits in social skills, especially in the realm of social communication (*APA, 2013*). These deficits include impaired non-verbal skills, as evidenced by the individuals' inability to read body language and social cues, make eye contact, adjust to new social environments, display emotion, and understand emotional expressions produced by peers (APA, 2013). In addition, verbal communication deficits include difficulty maintaining a back and forth conversation and sharing interests, abnormalities in speech production, and inability to initiate and respond to social bids (APA, 2013).

Non-verbal deficits impacting conversational ability

Understanding facial expressions. Interpreting facial expressions conveying emotions is a key non-verbal deficit commonly seen in individuals with ASD (APA, 2013; Eack, Mazefsky, Minshew, 2015; Wallace, Case, Harms, Silvers, Kenworthy, Martin, 2011) that in turn could impact their ability to engage in a conversation (Grossman, Klin, Carter, Volkmar, 2000). Specifically, Wallace and colleagues (2011) showed 42 adolescents with ASD and 31 typically

developing adolescents photographs of faces expressing six emotions (anger, happiness, surprise, fear, sadness, and disgust). Findings indicated that overall the individuals with ASD were less accurate than the typically developing individuals when identifying the emotions (Wallace et al., 2011). Specifically, it was demonstrated that these participants with ASD required a greater degree of intensity in the facial expressions depicted in the picture to accurately identify the emotions. This finding was particularly seen in terms of identifying sadness. This is an important finding since quickly identifying the emotional states of others is an essential component to interacting and conversing with another individual when face to face (Wallace et al., 2011). Grossman, Klin, Carter, Volkmar (2000) also pointed out that even when individual's with ASD could accurately identify emotions from facial expressions when presented on their own, if these expressions were instead paired with conflicting language (i.e. an individual depicting a sad face, but verbal writing that said "happy") the individuals' more often made their decision in agreement with the verbal information. This suggests it could be possible that an individual with ASD could misinterpret the emotional state of their conversation partner if his or her facial expressions differed from his or her verbal language (i.e. girl looks sad but says "I'm fine").

Understanding body language and social cues. Another common non-verbal deficit seen in children and adolescents with ASD that is related to impairments in understanding facial emotional expressions, is the inability to understand body language (APA, 2013; Atkinson, 2009; Doody & Bull, 2011; Hubert, et al., 2007; Libero, Stevens, Kana, 2014). Understanding body language is important when engaging in conversation since it can provide social cues concerning the intentions and emotional states of the speaker (Doody & Bull, 2011). For example, body posture can provide information indicating if the conversation partner is interested in the conversation, board, or disagrees with a statement. Doody & Bull (2011) examined the ability of

individuals with ASD, compared to typically developing individuals, to comprehend body postures when shown computer generated images of individuals engaging in different types of body language (i.e. leaning back or looking away versus leaning in). The participants were asked in this study to imagine these computer generated people were their conversation partner. Findings indicated that the individual's with ASD demonstrated a slower response time, compared to controls, in making decisions about the body postures. In addition, the individuals with ASD made more mistakes when identifying boredom (Doody & Bull, 2011). This finding is important in terms of conversing, since boredom could indicate a need to change a conversation topic or terminate a conversation altogether.

Eye-gaze and joint attention. A third key non-verbal deficit seen in children and adolescent's with ASD's involves lack of eye-contact (APA, 2013; Senju & Johnson, 2009). Specifically, individuals with ASD have been shown to engage in less direct eye gaze (looking someone in the eyes), compared to typically developing individuals (APA, 2013). Eye-gaze directed at another individual can be a social signal indicating their interest in engaging with the individual (Conty, Diaya, Tijus, & George, 2007). In addition, individuals with ASD also show deficits in joint attention which involves coordination of eye-gaze and attention with another individual to social phenomenon in the environment (Baron-Cohen, Baldwin, Crowson, 1997). Eye-gaze directed at the environment can signal to others the person's environmental interests (Conty, Diaya, Tijus, & George, 2007). These are both important skills for conversing since direct eye-contact can indicate an interest to converse and gaze directed at the external environment can play a role in conversational topics (i.e. watching the dance floor and asking someone to dance).

Perspective Taking and theory of mind. Individuals with ASD show deficits in perspective taking abilities as demonstrated by their poor performance on theory of mind tasks (Baron-Cohen, 1989; Senju, 2011). As previously defined, theory of mind refers to the ability to understand another person's motivations, beliefs and values as it pertains to their behavior (Frith & Frith, 2005). In terms of conversing, this means that individuals with ASD cannot see the conversation from another's perspective. This in turn could lead to a disjointed conversation that is one-sided (Nadig, Lee, Singh, Bosshart, Ozonoff, 2010).

Verbal deficits impacting conversational ability

Maintaining back and forth conversation about a common topic. An essential component of conversing involves maintaining a back and forth conversation about a common topic (Larson & McKinley, 1998). Individuals with ASD show a deficit when it comes to these skills. Specifically, individuals with ASD have deficits in turn taking during conversations, and instead tend to engage in a monologue form of speech centering around scripted phrases (APA, 2013; Nadig, Lee, Singh, Bosshart, Ozonoff, 2010; De Villiers, Fine, Ginsberg, Vaccarella, Szatmari, 2007). Nadig and colleagues (2010) found in their study looking at generic conversations and conversations centered around central interests of individuals with ASD, that these deficits were especially prevalent when individuals with ASD discussed a perseverative interest.

Abnormalities in speech production. It has been commonly seen that the intonation (overall melody of the sentence), emphasis of particular words, and the general rhythm of speech differs between typically developing individuals and those with ASD (APA, 2013; Filipe, Frota, Castro,Vicente, 2014). In a typical conversation, questions and statements are spoken differently, and there is a specific rise and fall in the tone of voice at different points that indicates the form

of speech (question or statement). Research demonstrates that for individuals with ASD, these same patterns are not present. Instead, individuals with ASD tend to demonstrate a variety of atypical speech patterns. For example some research has showcased the monotone or robotic style to their speech that is devoid of inflection (Burke, Kraut, & Williams, 2010; DePape, Chen, Hall, & Trainor, 2012), while other research points out that sometimes individual's with ASD exaggerate their phrases (Bonneh, Levanon, Dean-Pardo, Lossos, & Adini, 2011; Sharda et al., 2010). In both cases though, the parsody of their speech differs from typically developing peers (Bonneh, Levanon, Dean-Pardo, Lossos, & Adini, 2011, Burke, Kraut, & Williams, 2010; DePape, Chen, Hall, & Trainor, 2012; Sharda et al., 2010).

Inability to initiate and sustain a conversation. Another key verbal deficit identified in individuals diagnosed with ASD involves difficulty initiating verbal conversations (i.e. asking questions) and responding to the verbal initiations made by conversation partners (APA, 2013). This deficit can in turn make it a challenge for individuals with ASD to converse, since conversation is made up of a combination of both initiations and responses (Doggett, Krasno, Koegel, Koegel, 2013). Specifically, without this essential skill, a back and forth exchange of information that defines a conversation, cannot occur. Together these verbal deficits, combined with the previously described non-verbal deficits, can negatively impact the ability of children and adolescents with ASD to socially converse with peers, and are therefore the focus of many interventions targeted at this population (APA, 2013).

Interventions targeted at teaching conversational skills

Common social skill interventions targeted at increasing conversational skills in children and adolescents with ASD include basic prompting and reinforcement techniques (Endicott & Higbee, 2007; Goldsmith, LeBlanc & Sautter, 2007; Koegel, Koegel, Green-Hopkins & Barnes,

2010; Lechago, Carr, Grow, Love & Almason, 2010; Marion, Martin, Yu, Buhler & Kerr, 2012; Williams, Donley & Keller, 2000), cue cards and scripts (Brown, Krantz, McClannahan & Poulson, 2008; Charlop-Christy & Kelso, 2003; Ganz, Kaylor, Bourgeois, & Hadden, 2008; Pollard, Betz, & Higbee, 2012; Reagon & Higbee, 2009), and video modeling (Boudreau & Harvey, 2013; Charlop, Dennis, Carpenter & Greenberg, 2010; Charlop, Gilmore & Chang, 2008). These interventions have been successfully used with children and adolescents with ASD ranging in diagnosis from mild/moderate to severe.

Prompting and reinforcement. One intervention that has commonly been used to teach children with ASD the early components that make up conversational speech skills, question asking and responding, involves basic prompting and reinforcement (Endicott & Higbee, 2007; Goldsmith, LeBlanc & Sautter, 2007; Koegel, Koegel, Green-Hopkins & Barnes, 2010; Lechago, Carr, Grow, Love & Almason, 2010; Marion, Martin, Yu, Buhler & Kerr, 2012; Williams, Donley & Keller, 2000). In terms of question asking specifically, Koegel, Koegel, Green-Hopkins & Barnes (2010) demonstrated the promise of basic prompting and reinforcement when they taught three children with ASD to ask for the location of hidden items. Specifically, in this multiple baseline across participants design, the experimenter provided a prompt (i.e. "Can you say, where is it?") to the child so that they could ask where hidden items were located. When the child successfully repeated the prompted phrase (i.e. "Where is the car?") the therapist revealed where the item was hidden, and the child was given access to it. This verbal prompt was then faded, in turn resulting in all three children independently asking for the item's location and then later generalizing this skill to the home environment (Koegel, Koegel, Green-Hopkins & Barnes, 2010).

Marion, Martin, Yu, Buhler & Kerr (2012) conducted a similar study, involving a modified multiple baseline design across three participants with ASD. The focus of this study was also on teaching the children to ask where hidden items were located using prompting (Marion, Martin, Yu, Buhler & Kerr, 2012). The study results also demonstrated promise with all three children learning to request for the item "Where is the ball?" and generalizing the learned skill across novel activities and to the natural environment. The new skill was also maintained during follow up (Marion, Martin, Yu, Buhler & Kerr, 2012).

When engaging in conversational speech it is important that children and adolescents are not only taught to ask questions but also to appropriately respond to them. Goldsmith, LeBlanc, & Sautter (2007) examined how prompting and reinforcement could be used to teach intraverbals (i.e. responses) to children with ASD. Specifically, this was examined using a multiple probe design across behaviors (conversational categories) with three children with ASD. The primary goal of the study was to teach children to respond to category specific questions (i.e. Animal Question: "Can you name some animals?"). Prior to teaching intraverbals, the therapist first assessed the participant's overall knowledge of appropriate labels for items using a picture assessment (Goldsmith, LeBlanc, & Sautter, 2007). The items identified through this assessment as unknown items were then taught using a verbal prompt (i.e. showing a picture of a dog, waiting 3 seconds, and then prompting "say dog"). Appropriate child responses were immediately reinforced with praise and edible reinforcement. Prompting and the schedule of reinforcement were then thinned as the child's rate of production of appropriate responses increased. All three children learned to independently respond to the questions concerning items from categories that were taught. The experimenter's found though that little generalization to untaught categories was present and that there was limited evidence of maintenance of the skill

overtime (Goldsmith, LeBlanc, & Sautter, 2007). Overall this study demonstrates that prompting and reinforcement may be a useful intervention strategy to use to increase general vocabulary needed to maintain back and forth conversations, but that limitations may exist concerning generalization and maintenance.

These studies together demonstrate the potential of this intervention for teaching the early skills required to engage in a back and forth conversation. (Koegel, Koegel, Goldsmith, LeBlanc, & Sautter, 2007; Green-Hopkins & Barnes, 2010; Marion, Martin, Yu, Buhler & Kerr, 2012). Specifically, maintenance of a back and forth conversation is dependent of the conversers having a sufficient vocabulary and being able to alternate between asking and responding to questions. Despite the promise of this intervention in teaching early conversational skills, one limitation that can arise is that a child may become overly prompt dependent (Hume, Loftin, Lantz, 2009). To avoid this problem, it is important that prompts are properly faded when used. Another limitation of this instructional approach is that it primarily involves teaching single phrases rather than back and forth speech (Endicott & Higbee, 2007; Goldsmith, LeBlanc & Sautter, 2007; Koegel, Koegel, Green-Hopkins & Barnes, 2010; Lechago, Carr, Grow, Love & Almason, 2010; Marion, Martin, Yu, Buhler & Kerr, 2012; Williams, Donley & Keller, 2000). Therefore, it is important to examine interventions that specifically have focused on teaching back and forth conversations to children and adolescents with ASD.

Cue cards and scripts. A large collection of studies aimed at increasing back and forth conversations in children and adolescents with ASD have involved the use of cue cards and scripts (Brown, Krantz, McClannahan & Poulson, 2008; Charlop-Christy & Kelso, 2003; Ganz, Kaylor, Bourgeois, & Hadden, 2008; Pollard, Betz, & Higbee, 2012). Brown, Krantz, McClannahan & Poulson (2008) demonstrated, in their multiple baseline design across settings

study, the promise of scripts presented on cue cards in teaching three participants with ASD (one adolescent and two children) to engage in verbal conversation during community shopping outings. Specifically, the experimenters introduced the scripts in classrooms that's were decorated to resemble three different mock-stores. These scripted phrases were written on cue cards and placed, prior to the participants entering the stores, on the item that corresponded to each phrase (Brown, Krantz, McClannahan & Poulson, 2008). When the participants entered the store, a prompting procedure was initiated to teach them to read the scripted phrases. Once the participants were reading the cue cards independently, the prompting procedure was systematically faded using a seven-step procedure. Once stable responding was noted in all three settings, the participants were taken to three local community shops in order to assess generalization.

The results from the study demonstrated that all three participants were able to learn the scripted phrases, and an additional increase in unscripted phrase was also seen (Brown, Krantz, McClannahan & Poulson, 2008). Generalization from the mock-shops to the real shops also occurred for all of the participants. This results from this study as a whole adds to the research literature by demonstrating the promising gains that can occur in unscripted language when using cue cards and scripts (Brown, Krantz, McClannahan & Poulson, 2008). This is important since participants need to be able to use a variety of language concerning different topics when engaging in conversational speech.

Pollard, Betz, & Higbee (2012) also found promising results with their study, in turn providing further support of the potential for scripts in teaching conversational speech. In their study they used cue cards to teach three children with ASD to engage in bids for joint attention. Following fading of the cue-cards, all three children were able to independently initiate bids and

generalize the skill across conversational partners and settings and to new stimuli (Pollard, Betz, & Higbee, 2012).

Despite the promise of these studies, a key limitation is that they are only teaching single lines of speech. While teaching appropriate phrases and varied speech is important, an additional step that still needs to be taken to fully teach conversational speech involves teaching multiple lines of speech allowing for a back and forth conversation to occur.

Charlop-Christy & Kelso (2003) addressed this limitation in their study by teaching three child participants with ASD to read three related lines of conversation that were crafted for each conversational topic and presented on cue cards. Specifically, in this multiple baseline design across participants, with an additional multiple probe with-in participant design across conversations, three children were prompted to read from the cue cards, in turn allowing for them to maintain a brief back and forth conversation (Charlop-Christy & Kelso, 2003). Similar to the other studies involving cue cards, the cards were then faded resulting in independent conversing. The results demonstrated that once the cue cards were removed, the effects on speech production were maintained and that the participants were able to generalize the skill across settings and persons (Charlop-Christy & Kelso, 2003).

Ganz, Kaylor, Bourgeois, & Hadden (2008) expanded on previous script-based studies by utilizing a ten-line script written on cue cards to teach three participants (one adolescent and two children) to converse with a play partner. Their findings were similar to Charlop-Christy & Kelso (2003) in that all three participants increased their independent production of the scripted phrase following intervention and were able to reduce their overall preservative speech (Ganz, Kaylor, Bourgeois, & Hadden, 2008). Together this study, along with the previously described studies examining the use of cue cards and scripts, provide promising results and together

provide support for the usefulness of this intervention (Brown, Krantz, McClannahan & Poulson, 2008; Charlop-Christy & Kelso, 2003; Ganz, Kaylor, Bourgeois, & Hadden, 2008; Pollard, Betz, & Higbee, 2012).

The studies that have been conducted using cue cards or scripts as a medium for teaching conversational speech have produced largely successful results, and together demonstrate its usefulness (Brown, Krantz, McClannahan & Poulson, 2008; Charlop-Christy & Kelso, 2003; Ganz, Kaylor, Bourgeois, & Hadden, 2008; Pollard, Betz, & Higbee 2012; Stevenson, Krantz & McClannahan, 2000; Wichnick, Vener, Pyrtek, & Poulson, 2010). The one downside identified with this intervention though is the lack of naturalization that occurs when using the cue cards (Charlop-Christy & Kelso, 2003).

Social communication interventions for children and adolescents with ASD that incorporate technology

Cue cards presented using a tablet. One way to combat the lack of naturalization when using cue cards is by presenting a visual script on a common technological device. For example, the visual script could be presented on an iPad®. It would be contextually appropriate for children and adolescents to have an iPad® with them while they converse. Ganz, Boles, Goodwyn, Flores (2014) conducted an alternating treatments design study examining the efficacy of using a visual script, presented on a tablet, in an effort to increase the overall vocabulary of three individuals with ASD (two children and one adolescent). Specifically, this study involved the use of picture cards depicting nouns and verbs with labels underneath (i.e. picture of a man card and a picture of a car with a man in the driver's seat card represented the phrase "The man is driving"). All of the participants were taught to read the scripted phrases in the treatment condition (in the non-treatment condition the tablet was placed on the table but was

turned off). The participants were presented with the visual scripts while participating in an activity. Following intervention, the participants were able to verbally produce the appropriate phases without verbal or physical prompting. In this study the script was not faded but was rather described as a visual prompting tool that the child or adolescent could keep with them. Not fading the script though does create some naturalization problems. This study suggests the potential of integrating technology into already beneficial intervention strategies, such as cue cards and scripts, in turn helping to make these interventions as naturalistic as possible.

Video modeling. Another popular intervention, involving technology, for teaching conversational speech to children and adolescents with ASD has involved video modeling. Video modeling has been used with children and adolescents with ASD to teach overall acquisition, generalization, and maintenance of conversational speech (Charlop & Milstein, 1989; Charlop, Gilmore & Chang, 2008; Sherer et al., 2001).

Charlop and Milstein (1989) were the first in the field to examine the use of video modeling to teach back and forth conversation to children with ASD. They specifically used a multiple baseline design across participants to examine using video modeling as an intervention to teach three children with ASD conversational speech. Two adults acted as the video models (Charlop & Milstein, 1989). In the videos they modeled five scripted conversations. Stimuli generalization videos were also included (Charlop & Milstein, 1989). Videos were also made demonstrating abstract conversations, unrelated to the stimuli currently present in the room. The results from the study, for all three participants, demonstrated acquisition of conversational speech, maintenance at 15-months following intervention, and generalization across all probes (stimuli, abstract topics, settings, and partners) (Charlop & Milstein, 1989).

Charlop, Gilmore, and Chang (2008) added to the research by examining the effect of video modeling on expanding the conversational topics of children with ASD beyond their preservative interests using a multiple baseline across participants, and supplementary with-in participant design. In this study, multiple videos were made on four conversational topics related to a toy that the child preferred (Charlop, Gilmore & Chang, 2008). Five different scripts were also created for each conversational topic. Adults were used as the models in the videos. Prior to video instruction, the children were also given practice test conversations (Charlop, Gilmore & Chang, 2008). The participants then viewed the videos and were again presented with conversational practice tests. The results from this study indicated that the two participants were able to increase the variation in their conversational speech following video modeling (Charlop, Gilmore & Chang, 2008). Generalization probes were also taken across persons and settings in which the two boys conversed with each other or with a typically developing peer in a different setting. Generalization across stimuli and topic probes were also taken. The generalization findings for this study were mixed and no maintenance data was presented (Charlop, Gilmore & Chang, 2008).

Sherer et al. (2001) also added to the video modeling research by examining different types of video models. This study was a combination of an alternating treatments design and a multiple baseline design across five participants (children and adolescents) with ASD (Sherer et al., 2001). The primary focus of the study was looking at the effect of peer versus self-modeling on the acquisition of conversational skills by the participants. For this study, twenty questions were created that directly related to the children and adolescent's daily lives (Sherer et al., 2001). From these twenty questions, the experimenter randomly selected sixteen questions to be presented in each of the two video modeling conditions (eight questions per condition). When

creating the self-modeling tapes an additional therapist was present in the video to provide prompting to the participant with ASD (Sherer et al., 2001). Since the participant took part in making the videos, the participant was asked the list of questions following video production to assess whether any skills were gained from that process. Following this step, the self versus peer modeling videos were presented on alternating days to the participant (Sherer et al., 2001). The day after a participant watched the video; he was then asked the list of questions presented in the video. In terms of general acquisition of the skills the results were variable across participants. The interesting finding from the study though was that acquisition of skills did not seem to differ based on who played the model in the video (Sherer et al., 2001). This suggests potential versatility in teaching with video modeling.

In addition to teaching general conversational skills, video modeling has also been used to teach specific aspects of social conversational skills to children and adolescents with ASD including: giving compliments (Apple, Billingsley, Schwartz, 2005), demonstrating appropriate socially expressive behaviors (i.e. intonation of speech, facial expressions, verbalizations and gestures) (Charlop, Dennis, Carpenter & Greenberg, 2010), and initiating social interactions (Boudreau & Harvey, 2013; Nikopoulos & Keenan, 2003). These studies add to the research literature by providing information concerning the versatility of forms of video modeling. Specifically, these studies used a variety of different models, including familiar adults (Charlop, Dennis, Carpenter & Greenberg, 2010; Nikopoulos & Keenan, 2003), unfamiliar adults (Nikopoulos & Keenan, 2003), peers (Apple, Billingsley, Schwartz, 2005; Nikopoulos & Keenan, 2003) and the participant themselves (Boudreau & Harvey, 2013; Nikopoulos & Keenan, 2003). Since full acquisition of all targeted behaviors occurred in the majority of these

studies (Boudreau & Harvey, 2013; Charlop, Dennis, Carpenter & Greenberg, 2010; Nikopoulos & Keenan, 2003) they provide support for the use of a variety of video models.

These studies together show the benefits of video modeling as an intervention for teaching conversational speech to children and adolescents with ASD (Apple, Billingsley, Schwartz, 2005; Boudreau & Harvey, 2013; Charlop, Dennis, Carpenter & Greenberg, 2010; Charlop & Milstein, 1989; Charlop, Gilmore & Chang, 2008; Nikopoulos & Keenan, 2003; Sherer et al., 2001). One of the main reasons why this may be a beneficial teaching strategy is based on Bandura's Social Learning Theory (1977) that emphasis the importance of learning through observing others (Bandura, 1986). In particular, video modeling may be beneficial because it capitalizes on the key aspects important to observational learning such as capturing a child's attention, assisting with the retention of learned skills, helping develop the learned skills into actions, and motivating the viewer through visual representations of reinforcement (Bandura, 1977; Corbett & Abdullah, 2005).

The one negative factor of video modeling is the lack of naturalization in the majority of studies. Specifically, children or adolescents are typically taken out of their natural environment to watch the videos (Apple, Billingsley, Schwartz, 2005; Boudreau & Harvey, 2013; Charlop, Dennis, Carpenter & Greenberg, 2010; Charlop & Milstein, 1989; Charlop, Gilmore & Chang, 2008; Nikopoulos & Keenan, 2003; Sherer et al., 2001). One way to combat this is by bringing the video modeling presentation directly into the individual's natural environment through portable video modeling.

Portable video modeling. Two studies have examined portable video modeling as an intervention for teaching conversational speech, which adds a more naturalistic component to video modeling (Grosberg & Charlop, 2014; Macpherson, Charlop, & Miltenberger, 2015). The

videos were viewed in these studies on an iPad® (Macpherson, Charlop, & Miltenberger, 2015) and iTouch® (Grosberg & Charlop, 2014) in the children and adolescent's natural environment. These two studies both demonstrated promising findings in terms of acquisition (Grosberg & Charlop, 2014; Macpherson, Charlop, & Miltenberger, 2015). Maintenance was only assessed in Grosberg & Charlop (2014)'s study, but in terms of that study all of the children maintained the skill. The findings from Grosberg & Charlop (2014) and Macpherson, Charlop, & Miltenberger (2015) together both demonstrate the potential for video modeling, and technology in general, to be adapted to fit more appropriately in the child and adolescent's natural learning environment.

Since learning though technology has shown to be beneficial in teaching new skills to children and adolescents with ASD (Boudreau & Harvey, 2013; Charlop, Gilmore & Chang, 2008; Grosberg & Charlop, 2014; Macpherson, Charlop, & Miltenberger, 2015; Nikopoulos & Keenan, 2003) this teaching modality should be capitalized on with modifications. Specifically, future interventions should examine technological approaches for conversing between children and adolescents that are already embedded in their natural environment (i.e. texting, email, Snapchat®).

The studies addressed thus far have focused primarily on teaching children and adolescents conversational speech for when they are in the home or community setting directly engaging with another individual (Brown, Krantz, McClannahan & Poulson, 2008; Charlop-Christy & Kelso, 2003; Ganz, Kaylor, Bourgeois, & Hadden, 2008; Goldsmith, LeBlanc & Sautter, 2007; Koegel, Koegel, Green-Hopkins & Barnes, 2010; Pollard, Betz, & Higbee, 2012). It is important to note that now with the expansion of technology, many new communication modalities have been developed, and these are growing increasingly popular. Communicating through these new communication modalities, collectively referred to as computer mediated

communication (CMC), may be a way for children and adolescents with ASD to communicate with peers that mirrors the communication styles naturally occurring in their environment among typically developing individuals.

Chapter 3

Computer Mediated Communication (CMC)

Advances in technology have allowed for variations to the traditional face-to-face communication format. Specifically, these advances have allowed typically developing individuals to socialize both when face-to-face with a peer and when separated, using both verbal and text formats (Chayko, 2002). These new forms of communication, that use technology as a medium, are collectively referred to as Computer Mediated Communication (CMC) (Scott, 2008; Sheeks & Birchmeier, 2007). Current research demonstrates support for CMC on the basis that social relationships can be formed and maintained through its use (Pew, 2015, 2018), in turn suggesting another route towards forming and maintaining social relationships. This in turn introduces a new avenue of communication that can reduce the constraints imposed by time and distance.

History of CMC

In 1870, the first rise in CMC was seen with the use of landline phones (Pool, 1977). The next big advancements in CMC took place in the mid 1960's to 1970's with the first email being sent (Left, 2002), the creation of networking newsletters (Hendricks, 2013), and the invention of the first prototypes of the videophone (Edwards, 2018). Although the first email was sent in 1971, it was not a common form of communication for the general population until the 1990's (Left, 2002). In terms of video calling, the first Picturephone was introduced in 1964 (Edwards, 2018). Around the same time that emails became a popular communication medium, in 1996 Panasonic introduced the first prototype that allowed for video calling between mobile phones (Edwards, 2018). Even though these protypes were made in the 1960's-1990's, video calling between both phones and computers did not become a popular form of CMC until the mid

2000's. This was in some part due to the increased affordability of the technology (Edwards, 2018). Networking and blogging sites also followed a similar trajectory in terms of development with the first networking newsletters being produced in the 1970's and 1980's and the first blogging sites appearing in 1999 (Hendricks, 2013). These original newsletters and blogging sites acted as early prototypes for the traditional networking and social media sites seen today (Hendricks, 2013).

This historical review on the development of CMC suggests the potential use of this medium for communication and socialization between children and adolescents. Next, it is important to examine the popularity of communicating and socializing using each form of CMC today among children and adolescents as well as examining the impact CMC may be having on their development.

Theoretical support for CMC

Proximal processes represent the engines of development among children and adolescents (Bronfenbrenner & Morris, 2006). Specifically, proximal processes refer to the bidirectional relationship between the individual and multiple environmental variables that continues over the individual's lifespan and in turn impacts their development (Bronfenbrenner & Morris, 2006). CMC is one contextual variable that is becoming prevalent in society (Pew, 2015, 2018), and likely with its increase in use is impacting development. One example of how this proximal process is impacting development can be seen in terms of social network expansion and relationship development (Pew, 2015, 2018; Vandewater, 2013). This effect can be seen when examining the current trends and benefits of CMC use among typically developing children and adolescents.

CMC current trends & research with typically developing children and adolescents

Social media. One popular outlet for social communication involves the use of social media. Specifically, 85% of Millennials report using some form of social media. In a 2014-15 study by the Pew Research Center, 71% of 13-17 year old's reported being Facebook® users, 52% used Instagram®, and 41% used Snapchat®. In a 2018 survey, the rate of Facebook® usage decreased to 51% with an increase instead of other social media platforms (Snapchat®, Instagram®, and YouTube®; Pew, 2018). The rates of social media use among adolescents and the changing popularity of some platforms over others suggests the need for continued research. In addition, other popular CMC mediums, such as multi-player videogames, should be examined.

Multi-player videogames. Multi-player videogames represent another popular platform for communication and social engagement. In 2015, 84% of 13-17 year old's reported having access to a game console at home and 90% reported playing videogames. In addition, male respondents also identified videogame communication as a main communication medium for them to use with peers (Pew, 2015) This finding is important because it suggests potential differences in CMC platform use based on gender. Video game communication is also different than the other forms of CMC previously discussed. Similar to the other CMC modalities, communication can occur between two peers who are not currently in the same setting by using headphones and microphones (Pew, 2015). This form though differs from the previously mentioned CMC modalities in the fact that the communication can also occur when the children are present in the same setting. Therefore, multi-player videogames, in addition to allowing for in-person play and communication, also provide adolescents with a means to communicate with peers who are not present in the same room and to foster and sustain these relationships. Specifically, 59% of adolescents who play video games online also use a voice-connecting

device that allows them to communicate verbally with other peers they are playing with (Pew, 2015). These findings are important because they suggest that some CMC platforms support multiple forms of communication (i.e. face to face communication and/or distance communication)

Research benefits for typically developing children and adolescents. In addition to the popularity of these CMC modalities, research also demonstrates the positive benefits they have on socialization and communication. Through these technological modalities involving communication, typically developing adolescents have reported expanding their social network and sustaining previously made friendships (Pew, 2015 & 2018). In addition, research on CMC between typically developing children has proposed several benefits in terms of social communication (Hoffner & Lee, 2015; Pierce, 2009). Specifically, some research suggests that it may be more comfortable for adolescents who have social anxiety to communicate through CMC compared to traditional face-to-face communication (Pierce, 2009). With the popularity of communicating through technology and the benefits seen with typically developing adolescents, the examination of CMC with children and adolescents with ASD is the logical next step.

CMC current trends & research with children and adolescents with ASD

Current trends. Children and adolescents with ASD spend more time engaging in screen-based activities than their typically developing peers (MacMullin, Lunsky & Weiss, 2016). MacMullin, Lunsky & Weiss (2016) conducted a study that compared the responses on a technology-use survey completed by 172 parents of typically developing children and adolescents to surveys completed by 139 parents of children and adolescents with ASD. The researchers found that children and adolescents with ASD demonstrated greater Internet and videogame use than their typically developing peers (MacMullin, Lunsky & Weiss, 2016). These

findings provide important information on the availability of access to technology and the prominent role it already plays in the lives of children and adolescents with ASD.

Research Support for benefits and practicality of CMC. Since social skills are a deficit in individuals diagnosed with ASD (APA, 2013), technology could provide a new outlet in which these skills can be practiced and expanded upon. In the long-term, communicating through technological means could even help children with ASD form new friendships and engage in social interactions outside of the school setting (Scott, 2008).

Communicating through technology also may be a skill that children and adolescents with ASD can pick up with relative ease (van der Aa, Pollmann, Plaat, & van der Gagg, 2016). This could be due to how relatable this form of communication is with many of the characteristics generally seen in individuals with ASD. For example, children with ASD have difficulty making eye-contact (APA, 2013), which is an important component of face-to-face communication. Many forms of CMC (i.e. texting, videogame play, email, virtual reality and social media), take away the face-to face component of communication (Burke, Kraut, & Williams, 2010). Taking away this variable may potentially alleviate one of the challenges children with ASD face in terms of communicating with peers (Burke, Kraut, & Williams, 2010).

Another communication challenge children with ASD have involves the immediacy of responses (Burke, Kraut, & Williams, 2010; van der Aa, Pollmann, Plaat, & van der Gagg, 2016). The individual is expected to respond to a statement in the moment and does not have additional time to process the information and come up with a response. Many forms of CMC do not result in immediate back and forth responses. This potential for greater processing time could be helpful for children and adolescents with ASD when communicating (Burke, Kraut, & Williams, 2010; van der Aa, Pollmann, Plaat, & van der Gagg, 2016; Benford & Standen, 2009).

With certain forms of CMC, such as texting, email or chat rooms, the communication tends to be in written form. This added bonus of having the conversation in writing could be helpful for children and adolescents with ASD to re-read and process each statement and be able to take in the conversation as a whole (Benford & Standen, 2009; van der Aa, Pollmann, Plaat, & van der Gagg, 2016). Having a conversation in written form also alleviates self-consciousness with issues concerning appropriate tone of voice and lack of inflection children and adolescents with ASD tend to demonstrate (Burke, Kraut, & Williams, 2010). Using technology may also be a beneficial modality for individuals with ASD to communicate through because of the fact that the conversation is visually presented and individuals with ASD are generally considered visual processors (Quil, 1995).

Research support examining CMC use among individuals with ASD. Despite the practicality of teaching children and adolescents with ASD to communicate through technology and the potential benefits that may arise from it, to date there is little research in this applied area of study. Specifically, there are only seven studies that have experimentally examined back and forth communication, using technology as the communication medium, between an individual with ASD and a respondent (Brodhead, Kim, Rispoli, Sipila, & Bak, 2019; Cheng & Ye, 2010; Chung, Vanderbilt & Soares, 2015; Gallup, Serianni, Duff, & Gallup, 2016; Ke & Moon, 2018; Scott, 2008; Shea, 2014). The 24 individuals' with ASD included in this sample of studies ranged in ages from 6-21. The studies also ranged in terms of the technological mediums selected including: collaborative virtual reality environments (Cheng & Ye, 2010; Ke & Moon, 2018), a Massive Multiplayer Online Role Playing Game (MMORPG) (Gallup, Serianni, Duff, & Gallup, 2016), video game play (Chung, Vanderbilt & Soares, 2015), video calling (Brodhead, Kim, Rispoli, Sipila, & Bak, 2019; Shea, 2014), and emails (Scott, 2008).

Collaborative virtual reality environment. Cheng & Ye (2010) and Ke & Moon (2018) both examined communication occurring in the context of a collaborative virtual reality environment. Cheng & Ye (2010) specifically used a multiple probe design across three child participants to examine reciprocal social interaction behaviors and overall social competence during a collaborative virtual reality activity in which the participant, as an avatar, navigated through social problem solving situations while communicating with the other avatars (the teacher/therapist). The results demonstrated that in terms of social competence, all three participants' scores increased during the collaborative virtual environment intervention. In terms of reciprocal social interactions, all three participants also demonstrated increases in their understanding of perceptions, expressions, and non-verbal communication in intervention compared to baseline (Cheng & Ye, 2010).

Ke & Moon (2018) also examined collaborative virtual reality environments. In this study the researcher's used a mixed methods approach to look at responding, initiation, interpersonal negotiation, positive self-identity expression, and cognitive flexibility in eight child and adolescent participants. The collaborative virtual reality game involved competition style games, role playing simulation games, and design themed architecture games. During intervention all eight participants showed improved performance on all five of the targeted skills (Ke & Moon, 2018).

Massive multi-player online role-playing game. Gallup, Serianni, Duff, & Gallup (2016) examined the social identities, interactions, and agendas of three adolescent boys while participating and communicating with peers in a massive multi-player online role-playing game (MMORPG). This information was specifically gained from interviews, focus groups, and observations. During the interviews, four themes were identified: the overall benefits of this type

of communication medium, benefits in both verbal and non-verbal communication, and the transfer effects of learned behaviors to real world settings (Gallup, Serianni, Duff, & Gallup, 2016). Another finding was that participants expressed comfort when communicating through this game and saw it as beneficial for socialization with current friends and as a way to form new friendships. Non-verbal communication benefits were also identified in the interviews related to the participants' feelings of a greater awareness of the emotions of others as well as of their own emotions. Lastly, participants indicated that the game helped them learn to interact with others and that they were able to generalize these learned skills to real-world settings (Gallup, Serianni, Duff, & Gallup, 2016).

Videogames. Chung, Vanderbilt & Soares (2015) examined communication, using an A-B-A withdrawal design, between three child and adolescent male participants and their siblings. The communication was examined while the participants played a sedentary video game (control condition) and an augmented reality video game (intervention condition). They also examined positive affect and aggression while playing the two types of videogames (Chung, Vanderbilt & Soares, 2015). Their findings demonstrated that for the three dyads, across the two conditions, no changes were seen in terms of aggression. In terms of reciprocal communication, they observed decreases in the augmented reality video game condition compared to the sedentary video game condition. For joint positive affect, variable results across the two types of games and the three dyads were observed (Chung, Vanderbilt, & Soares; 2015).

Video calling. Brodhead, Kim, Rispoli, Sipila, & Bak, (2019) employed a non-concurrent multiple-baseline design across participants with an embedded alternating treatments design, to teach three seven-year old males how to engage in a social conversation over video-chat with a familiar adult. A multiple exemplar training (MET) approach was used to teach the

children with ASD to converse over video-chat, while using one of the two scripts provided in the format of a visual guide (similar to a visual activity schedule). The children were taught to converse using the manuals and physical guidance. Following completion of the study, all of the children learned to socially converse over video-chat and this skill was generalized to two unfamiliar adults. The findings also provided support for an increase in unscripted conversational phrases following removal of the scripts. Additionally, the skills were maintained during the two week follow-up.

Shea (2014) also examined the use of video-chat technology with this population. Using an A-B-A withdrawal and a qualitative narrative design, Shea (2014) looked at the occurrence of four social behaviors during video calling sessions between one female non-verbal child and one male non-verbal adolescent and his and her parents. These four social behaviors included joint attention, eye-gaze, gestures, and verbalizations. Specifically, Shea (2014) looked at the amount of times these behaviors occurred in terms of initiations verses responses. This study also looked at the rate the behaviors differed across the three activities (playing games, reading word cards, or discussion) completed with their partner over video calling (Shea, 2014). The findings were variable across all four behaviors. In terms of eye-gaze, the findings indicated that this was impacted positively by communicating over video calling across the three activities and two participants. The other variables: joint attention, gestures and verbalizations resulted in variable results across the two participants and the three activities (Shea, 2014).

Emails. Lastly, Scott (2008) used unstructured interviews and structural and functional assessments of email content to examine the structural and functional patterns of communication in email format and overall perceived social interactions. The email correspondence was between two male adolescents with ASD and thirteen to thirty similar age respondents. The findings

indicated that the two participants with ASD's emails were similar to their peers in terms of structural patterns (length of message, appropriate acronym use, and quantity of emails sent). Differences though were seen, between the participants and their typically developing peers, in terms of the functional patterns of the emails, such as the content of the messages.

Together these studies suggest technology may be a useful way of cultivating conversational skills among children and adolescents with ASD (Brodhead, Kim, Rispoli, Sipila, & Bak, 2019; Cheng & Ye, 2010; Chung, Vanderbilt & Soares, 2015; Gallup, Serianni, Duff, & Gallup, 2016; Ke & Moon, 2018; Scott, 2008; Shea, 2014). Specifically, these studies demonstrated promising findings in terms of social communication skills, such as: initiations and responses, overall social competence, interpersonal negotiation skills and structural patterns of written communication. These findings demonstrating the potential for communication through technological mediums are important since children and adolescents with ASD have difficulty with basic communication skills, that in turn can impact their ability to form social relationships (APA, 2013).

As with all studies, these studies together had unique strengths and limitations that need to be considered in conjunction with their results. In particular, the collective strengths of the studies sampled include the wide number of CMC modalities examined, the wide age range that included both children and adolescent participants with ASD, and the variety of conversational skills examined. Collective limitations involve the fact that these studies showcase the limited number of studies that have been conducted on each type of CMC modality and the gaps in the research literature. Another limitation is that although the focus of these studies is on the benefits of CMC, the majority of them do not touch on how to teach appropriate communication using each type of CMC modality to children and adolescents with ASD. A final limitation concerns

the complete gap in the research literature on texting as a CMC modality that can be taught and used with children and adolescents with ASD.

Chapter 4

Texting

History of the Cell Phone Use

Phones are one form of CMC that have developed considerably over time. The evolution of the landline phone of 1870 to today's smart-phones has been dramatic. In 1983, phone design had a significant advancement with Motorola's creating and releasing the first commercially available cell phone (Motorola, 2019). Following this advancement, in 1993 Bellsouth and IBM created the first smart phone (CBC News, 2013).

Phone use trends & research with typically developing children and adolescents

Trends. Current statistics estimate that 95% of adolescents in America own a mobile phone and 77% own a smart phone (Pew, 2018). In addition, the age range of smartphone ownership is expanding, with an increasing number of children as young as eight reporting owning a smartphone (Rideout & Robb, 2019). When examining of a diverse sample of 1,677 children in the United States ages eight to eighteen, 19% of the eight year old children and 53% of the eleven year old sample reported owning a smartphone (Rideout & Robb, 2019). In addition, it is important to note that smart phone ownership is common across families of various income levels (Pew, 2019). For example, in a 2019 survey, 96% of American adults earning less than $30,000 a year reported owning a cell phone and 71% indicated owning a smart phone (Pew, 2019). These statistics are important because together they indicate the high level of smart phone ownership, of both children and adolescents (8-18) in the United States.

Research benefits. Several research studies have also provided support for the social impact of cell phone use for adolescents (Blair & Fletcher, 2011; Hoffner & Lee, 2015). Hoffner & Lee (2015) indicated the potential benefits of phone use on the quality of life of typically

developing young adults (Hoffner & Lee, 2015). Specifically, this study proposed that phone use might be providing social support to young adults, which in turn can help them handle their own negative emotions (Hoffner & Lee, 2015). Research on early adolescence cell phone use also indicated social benefits. Blair & Fletcher (2011) examined early adolescents' perceptions of cell phone use and found through interviewing twenty seventh graders and their parents that having a cell phone held multiple meanings. Having a cell phone was equated with a higher social status, and it allowed for them to connect with their friends and maintain these relationships, while having the perception of autonomy (Blair & Fletcher, 2011).

Phone use trends & research among children and adolescents with ASD

Trends and research. There is little research currently available on the trends of phone use among children and adolescents with ASD (Durkin et al., 2010). Durkin & colleagues (2010) provided some information to fill this gap, when they found that 65% of their sample of 35 adolescents with ASD reported using a cell-phone. This study was done in 2010, and therefore the percentage has likely risen if it has followed a similar trajectory to that of typically developing children and adolescents cell phone usage (Rideout & Robb, 2019). Therefore, updated research on the current trends are needed.

History of Texting

Around the same time frame that the smart phone was created, in 1992, the first text message was sent (Mobivity, 2012). In 1997, texting became easier with the creation of the first cell phone with a full keyboard (Meyers, 2011). The touch screen was the next major advancement in terms of texting (CBC News, 2013). This was introduced in 2007 with the launch of the first iPhone. During this same year it was also reported that Americans received more text messages per month compared to phone calls (Erickson, 2012). Social texting in

particular became common among children and adolescent peers (Oksman & Turtiainen, 2004; Pettigrew, 2009; Pew, 2015; Tulane & Beckert, 2013)

Texting trends & research with typically developing children and adolescents

Trends. In a sample of 1,009 adolescents ages 13-17, 80% reported that text messaging was one of their top three choices for communicating with friends and 49% stated that text messaging was the most common way they stayed in touch with friends (Pew, 2015). When comparing phone calls to text messages, adolescents in a focus group stated that phone calls were reserved for best friends while text message communication could be used with less close friendships or acquaintances (Pew, 2015). This finding suggests that the format of phone communication, call versus text, may differ based on the perceived strength of the social relationship.

Research benefits. Since text messaging has become a primary communication medium for adolescents (Pew, 2015; Tulane & Beckert, 2013), research has started to examine the benefits of this communication medium. A common finding from these studies is that texting between adolescents can allow for the development of new friendships, as well as the continued maintenance of existing ones (Oksman & Turtiainen, 2004; Pettigrew, 2009). Texting also has been associated with increased autonomy, by providing an outlet for independent communication with peers (Oksman & Turtiainen, 2004; Pettigrew, 2009). These findings together suggest that text messaging may have a positive impact on social relationship development (Oksman & Turtiainen, 2004; Pettigrew, 2009; Tulane & Beckert, 2013).

Texting trends & research among children and adolescents with ASD

Trends and research. Limited research is currently available on the role and overall impact of texting among children and adolescents with ASD (Durkin et al., 2010). Durkin &

colleagues (2010) indicated this gap in the research literature, and in turn conducted a study focused on comparing cell phone among thirty five typically developing adolescents and thirty five adolescents with ASD. In their study they found that the adolescents with ASD indicated that one of their primary uses of their cell-phone was for texting (Durkin et al., 2010). Data was not collected on who the texts were sent to (i.e. peers, parents, siblings) or the frequency with which the texts were sent. This study indicated a need for future research to address these issues.

Research benefits. Overall, there is a lack of research involving teaching children and adolescents with ASD how to engage in back and forth texting. Since CMC is a popular communication medium in its own right (Oksman & Turtiainen, 2004; Pettigrew, 2009; Tulane & Beckert, 2013), it would be beneficial to teach children and adolescents with ASD how to send their own texts and in turn have a back and forth conversation through text.

Glenwright & Agbayewa (2011) shined some light on the positive benefits that may come as a result of teaching children with ASD to communicate through text. In this study the participants consisted of fourteen typically developing children and adolescents and fourteen children and adolescents with high functioning ASD. The study aimed to compare verbal irony comprehension between the two groups when statements were presented through CMC (Glenwright & Agbayewa, 2011). Specifically, an app was installed on the computer that contained speech bubbles. Each participant was then presented with a scenario (i.e. Johnny was in a rush and he parked his car diagonally, taking up two parking spaces. His friend in the passenger seat said “Nice Parking”). The participant was then asked to determine whether the individual in the scenario was giving a literal complement or if it was verbal irony using forced choice answers. They also had the opportunity to write a response to the comment (Glenwright & Agbayewa, 2011).

The findings from the study indicated that the participants with ASD were as accurate as the control group in determining the intention of the speaker (ironic statement or compliment) (Glenwright & Agbayewa, 2011). In addition, they saw that although the participants with ASD did not choose to initially respond to the comment during their first opportunity, when given a second opportunity after more time had passed, the participant's with ASD gave appropriate responses based on the believed intent of the speaker. This finding suggests that communicating through CMC may assist individuals with ASD to better process social information and cues by providing a greater time for information processing (Glenwright & Agbayewa, 2011). In particular, this may be due to the fact that communicating in this manner results in a permanent product of the conversation that can be re-read by the conversers. In addition, there is a reduced need to provide quick responses, since this is not expected when engaging in a conversation through text. Together these facts may allow individuals with ASD an opportunity to better comprehend what their peer is saying and to in turn provide an appropriate response, suggesting that texting could be a beneficial communication medium for this population.

Although this study was conducted using a computer rather than a phone, it provides support for content comprehension by children and adolescents with ASD when the conversation is presented in a written format similar to text messaging (Glenwright & Agbayewa, 2011). Since other formats of CMC, that are similar in format to texting, have been beneficial to children and adolescents' with ASD, it is now important to consider how best to teach children and adolescents with ASD to converse through texts.

Teaching how to text

Language components of texting and rules. When teaching a child or adolescent with ASD how to text, a primary consideration is the type of language used in texts and unspoken

rules around sending and receiving texts. It is therefore important to note that texting language has distinctive features that differ from conventional written language (Thurlow and Brown, 2003). It has been noted that texting may share more features with spoken language than written language (Ling, 2005). For example, text messaging resembles a spoken conversation in terms of the turn taking component and short message length (Kasesniemi & Rautiainen, 2002) that averages around 14 words (Thurlow and Brown, 2003). Texting language is not as strict in terms of grammar and syntax compared to other forms of written language. Specifically, when texting it is considered acceptable to use abbreviations (i.e. TTYL for "talk to you later"), shorten the actual word (i.e., Cuz for because), use letters and numbers together to form a word (i.e. Gr8 for Great), or replace the word with a symbol or picture (Durkin, Conti-Ramsden, Walker, 2011). Due to this shorthand, there have been concerns over how engaging in texting may in turn negatively impact overall language abilities. Research does not support this claim though, and instead argues that texting may have positive effects on both language and literacy skills (Crystal, 2008; Plester, Wood, Joshi, 2009)

Intent of messages. Thurlow and Brown (2003) found when examining 544 text messages obtained from a sample of 149 typically developing adolescents that the type of message that were sent most frequently involved friendship maintenance (Thurlow and Brown, 2003). In addition, two thirds of the text messages were specifically relationship oriented with a focus on friendship maintenance, romantic relationships, and making social arrangements. The researchers also found that overall a primary benefit of text-messaging for participants involved how it met their need for intimacy and social connection (Thurlow and Brown, 2003). This taken together demonstrates the importance of texting in social relationship formation and maintenance.

Chapter 5

Rationale for the Present Study

The research suggests that individuals with ASD have benefited in the past from using forms of CMC to cultivate conversational skills (Cheng & Ye, 2010; Chung, Vanderbilt & Soares, 2015; Gallup, Serianni, Duff, & Gallup, 2016; Ke & Moon, 2018; Scott, 2008; Shea, 2014). In particular, Scott (2008) demonstrated emails produced by adolescents with ASD could mimic the structural patterns (i.e. length, acronym use) of emails sent by typically developing adolescents. In addition, Glenwright & Agbayewa (2011) provided evidence that children and adolescents with ASD may be able to comprehend verbal irony when presented in message format and respond appropriately.

Other potential benefits of teaching children and adolescents with ASD to text can be seen in how the CMC medium aligns with the strengths of individuals with ASD, while also relying less on skills that have been identified as deficits in this population (Benford & Standen, 2009; Burke, Kraut, & Williams, 2010; van der Aa, Pollmann, Plaat, & van der Gagg, 2016; Glenwright & Agbayewa, 2011; Quil, 1995). For example, it uses a visual medium and individuals with ASD are generally visual processors (Quil, 1995). In addition to learning best through visual modalities, individuals with ASD also have shown a preference for training presented on the iPad® compared to traditional instruction (Klein & Charlop, 2018). These reasons may contribute to why video modeling (Apple, Billingsley, Schwartz, 2005; Boudreau & Harvey, 2013; Charlop, Dennis, Carpenter & Greenberg, 2010; Charlop & Milstein, 1989; Charlop, Gilmore & Chang, 2008; Grosberg & Charlop, 2014; Macpherson, Charlop, & Miltenberger, 2015; Nikopoulos & Keenan, 2003; Sherer et al., 2001) and cue cards presented on

an iPad® (Ganz, Boles, Goodwyn, Flores, 2014) and on a cell phone (Grosberg & Charlop, 2017) have produced promising results for children and adolescents with ASD .

In addition to the visual learning benefits that texting may provide, texting also creates a permanent product (the text conversation). The permanent product of the text conversation and the lack of needing to provide immediate responses can help with processing speed (Benford & Standen, 2009; van der Aa, Pollmann, Plaat, & van der Gagg, 2016; Glenwright & Agbayewa, 2011). Other social skills that children with ASD demonstrate deficits in, such as eye contact and tone of voice are not involved in this type of communication (Burke, Kraut, & Williams, 2010).

In spite of all this research support suggesting that texting may be a CMC medium that children and adolescents with ASD could learn to use, no studies to date have taught this population how have a back and forth conversation through text. The present study therefore attempted to do just this as a means of increasing the social communication skills of the participants with ASD.

Purpose of the present study and hypotheses

The present study aimed to teach five children and adolescents with ASD how to have a back and forth conversation with another peer, who also had ASD, through text messaging and then to generalize this skill to other texting partners (i.e. parents, siblings). In particular there were two main hypotheses: 1) the five children and adolescents in the study would learn how to use their phone to both receive and send text messages (i.e. texting steps) and 2) that the participants would be able to maintain a back and forth texting conversation (i.e. texting content). A third hypothesis was that this skill would transfer from the peer with ASD to other texting partners. This is important since the skill needs to generalize across texting partners to allow for texting to be used to develop and maintain multiple relationships. The fourth

hypothesis was that the skill would be maintained one month following treatment. Ancillary data were also collected on whether the back and forth conversation skills taught during texting transferred into verbal face-to-face conversations. In this case, the experimenter's fifth hypothesis was that the conversation skills, taught in the texting intervention, would also be seen following the intervention when the participants communicated face-to-face through Facetime®.

Chapter 6

Method

Participants

The participants were five children and adolescents with ASD between the ages of 8-17. The participants were selected from among the children and adolescents diagnosed with autism spectrum disorder (ASD), according to *The Diagnostic and Statistical Manual of Mental Disorders* (5th ed.; DSM-5, American Psychiatric Association, 2013), who were currently enrolled in a university-based after-school behavioral treatment center. To participate in the study, the child or adolescent had to be literate and demonstrate the basic motor skills needed to use a mobile phone. Reading ability was assessed prior to the study by having the individual read a series of two texts presented on a mobile phone. Spelling was assessed by having the individual write two sentences that were presented to them verbally.

The demographic makeup of the study included two females and three males. The sample was diverse in terms of ethnicities with two of the participants identifying as Mexican-American, two as Caucasian, and one as Korean-American. These participants were placed into three dyads based on age, interests, social skills group placement (whether they both attended the center at the same time on the same day), and whether they indicated that they wanted to communicate with each other on the pre-assessment survey. In two of the dyads, both of the participants had an ASD diagnosis. In the third dyad, the adolescent participant with ASD (17 years old) was paired with a typically developing undergrad (23 years old) who worked with the participant for multiple years and had since graduated. Prior to graduation, he and the participant expressed interest in continuing to maintain the friendship they developed. These pairings therefore resulted in three dyads. A summary of the dyads and their characteristics are presented in Table 1.

Table 1.
Participant Characteristics

Dyad	Participant	Chronological Age	Ethnicity	EVT-III	PPVT-IV	Cars-2
Dyad 1	Bennett	10.9	Caucasian	9.4	8.5	Mild/Moderate
	Milo	8.7	Caucasian	**	**	Mild/Moderate
Dyad 2	Anna	10.2	Korean-American	7.5	7.4	Mild/Moderate
	Veronica	10.8	Mexican-American	**	**	Mild/Moderate
Dyad 3:	Levi	17.1	Mexican-American	5.6	5.1	Severe
	Mick*	23.2	Caucasian	N/A	N/A	Typically Developing

*Typically developing peer **not able to be collected

Dyad 1:

Bennett was 10 years and 9-months old at the start of the study (See Table 1). In addition to his ASD diagnosis, Bennet also had an ADHD diagnosis. Bennett had difficulty maintaining a back and forth conversation. He usually engaged in monologues about inappropriate topics. Bennett and his texting partner Milo were both enrolled in the same social skills session and shared similar interests. Their conversations in the past have been limited and usually initiated by therapist prompts.

Milo was 8 years and 7-months old at the beginning of the study. Milo primarily discussed preferred topics during the social skills session and communicated more with therapists as opposed to peers. During social skills, Milo was working on engaging in activities and conversations with peers and increasing his overall conversational topic repertoire.

Dyad 2:

At the start of the study, Anna was 10 years and two-months old. When engaging in conversations, Anna stood too close to her peers, discussed inappropriate topics, focused

primarily on her perseverative interests when conversing, and had difficulty in engaging in a back and forth conversations.

Veronica was a 10 years and 8-months old. She showed some rigidity in terms of conversational topics and activities, and had difficulty picking up on social cues. Anna and Veronica were in the same social skills group. They had both participated in activities with each other inside the social skills group and had indicated an interest in being friends. When they were paired together in the past during activities, they had difficulty maintaining a back and forth conversation.

Dyad 3:

Levi was 17 years and one-month old when the study commenced. He was echolalic and responded well to scripted speech. Levi was older than the other children and adolescents enrolled in the social skills program. Therefore he was paired with a former undergrad, Mick, he had developed a friendship with and who shared a greater similarity to him in terms of age (23 years old). For the purposes of this study, Mick will not be considered one of the participants, but rather a typically developing communication partner.

Materials

In this study the primary materials consisted of five phones. Specifically, one iPhone® version 5 provided by the behavioral treatment center for use in the study and four Samsung Galaxy phones belonging to the participants' parents or the participants themselves. Additional material included the three guidebooks (See Appendix A for examples). One guidebook was the training manual for sending and receiving texts presented as a visual guide. The other two guidebooks each included a different example of a back and forth texting conversation between two individuals. Additional materials included, a parent and participant survey (See Appendix B

for the surveys), iPads® used to record the texting training sessions, and checklists to record the steps of the behavioral chain and the occurrence of the dependent and ancillary variables. Computers were also used by the children and the experimenter when conducting sessions over videoconferencing software. Lastly the texting intervention was implemented using an application called TextFree®. The steps needed to send a text using this application do not differ from the steps traditionally used to send a text on an iPhone. The only difference is the image of the application that appears on the phone screen (i.e. the traditional texting application is a green box with a picture of a white text bubble, the TextFree® application is a white box with two text bubbles).

Setting

Baseline sessions, intervention training sessions, generalization texting partner probes, and FaceTime® probes were conducted in two different medium lounge settings (1.5m by 3m) at the after-school behavioral program that the participants attended weekly. The participants were exposed to these rooms prior to the study. Each participant was assigned to one of the two rooms through the baseline and training sessions. The first lounge style room contained a couch, a table, and a chair. The second room contained three chairs, a circular table, and a bookshelf. Partway through baseline, for two of the dyads, the setting was moved to the children's respective homes. The third dyad made the switch to the home setting during intervention. The timing of the change in settings from the center to the home environment corresponded with the restrictions put in place by the government in response to an international pandemic.

Design

A non-concurrent multiple baseline design across dyads was used to examine the effect of the texting teaching procedure upon appropriate text exchanges between participants (Watson

& Workman, 1981). In addition, data was collected on any ancillary effects learning to have a back and forth conversation with a peer through text had on verbal conversations over FaceTime®, and text conversations with other individuals (parents, siblings, etc.).

In the present study, prior to baseline, the experimenter created a task-analysis, which is a written checklist of all the steps required to complete the task (See Appendix C for task analysis). Baseline sessions were then collected for each dyad prior to treatment using the task-analysis and the texting content checklists to assess for completion of the texting steps and appropriate message content. The goal here was to determine which participants would receive both the texting step's intervention and the texting content intervention and who would just receive the texting content intervention. Next, the treatment was introduced at different times for each dyad. This staggered pattern of introducing the treatment to each dyad allowed the experimenter to conclude that the change in behavior from baseline to treatment resulted from the intervention (Watson & Workman, 1981; Cooper, Heron & Heward, 2007). The experimenter can conclude this because the staggered design allows the experimenter to control for confounding variables and determine that the change cannot be due to chance (Cooper, Heron & Heward, 2007).

Procedure

Prior to baseline. Prior to taking part in the study, the parents of each participant, as well as the participants themselves, were asked if they wanted their children to learn how to text. They also completed a survey about past texting experience and phone use. If the parents and the child reported that the child was already proficient at texting, then this skill was examined during baseline by scoring for both texting step completion and appropriate content. If the participant met all the criteria identified for both of these variables on two consecutive sessions (See Table

3), they tested out of the study and were no longer considered a participant. During this initial meeting, the participants' and their parents were also asked in the survey to identify potential texting communication partners that the child would likely communicate with in the future. Next, prior to the start of the study the participants were asked to read two different sentences presented on a phone in text format to assess their reading ability (i.e. "I like to play with dinosaurs and talk to my friends about them. I also have a sister named Chloe who sometimes plays with me"). In addition, the participants were asked to write two different sentences that were presented verbally, to access their spelling ability (i.e. "I like playing sports outside. My favorite sport is soccer.").

During this stage the experimenter also created a task analysis of all the steps required to send a text. A second scoring sheet was also created in which the components present in back and forth conversations were identified, the text content. Task-analysis can be created by consulting with experts or skilled individuals, observing competent individuals complete the task, or completing the task yourself (Snell & Brown, 2006). This task analysis for sending a text was created by having the experimenter complete the task while recording each of the steps she took to send a text message (See Appendix C). The scoring criteria for a back and forth conversation was developed through consulting the literature and examining texting conversations of proficient individuals. This task-analysis and content scoring sheets were then used as checklists when collecting baseline probes to assess which components were already in the child's repertoire and what still needed to be taught.

Baseline Probes. During baseline the dyads were initially separated and put in two different lounge style rooms, that simulated typical family rooms seen in the home (i.e. features included a couch, a table, chairs, a bookshelf). They were then each given an opportunity to

complete the task. Each participant was given a phone that had been turned on and given the instruction “send a text to your friend _____.” Each participant’s ability to complete the task was assessed using the task analysis and content checklists. The experimenter employed a multiple opportunity approach to the task analysis for sending a text, which meant that a person’s level of mastery across all the skills in the task analysis was assessed during each opportunity (Snell & Brown, 2006). This means that if a participant incorrectly completed one of the steps in the task sequence, the experimenter would mark that skill as incorrect and would then perform the skills for the individual so that the individual still had an opportunity to perform the steps following the unlearned skill (Snell & Brown, 2006). Their peers phone number was already pre-programed into the phone and could be accessed by typing in their friend’s name and taping the number when it appeared below the name. The number of steps the participant was able to complete in the task sequence was recorded during each session as well as the text content of any messages that they wrote. Dyads that demonstrated the ability to send and receive texts during baseline were able to text each other for ten minutes per session. Probes for the ancillary behaviors were also conducted during baseline. See below for more specific information on this. Following baseline, dyads who tested out of the texting step intervention, by completing all the texting steps at a rate of 100% across two consecutive baseline sessions, moved directly into the texting content intervention. The remaining participant Levi (who had a typically developing texting partner) began intervention one.

Texting Intervention One: Sending a Text. Similar to baseline, the participant was given a phone that was turned on along with the instruction to “send a text to your friend _____.” The participant was then given the texting guidebook that outlines all the steps involved in sending a text. (See Appendix A1). The experimenter then taught the task to the

participant using the guidebook and physical and verbal prompting in a total-task chaining procedure (Cooper, Heron & Heward, 2007). A total task chaining procedure is a variation of forward chaining and involves training on all the steps in the task analysis during each session. Assistance was provided for each step that the individual was not able to complete on their own, until they were doing the task sequence independently (Cooper, Heron & Heward, 2007). For instance, if the participant did not correctly begin to complete a step within five seconds, or was completing the step incorrectly, the experimenter used the guidebook in addition to verbal and physical prompting to teach the step. Completing the task independently was therefore defined as completing each of the seven steps required to send a text without looking at the guidebook or receiving and verbal or physical prompts. Criterion was met when the participant completed all the texting steps at a rate of 100% across two consecutive sessions. Each session lasted a total of ten minutes. Next the dyad was taught how to have a back and forth conversation.

Texting Intervention Two: Text Content. All the dyads received this intervention, which involved teaching them to have a back and forth conversation through text. Once again, the dyads were separated and were taught this skill using the two sample conversations (See Appendix A2). In each of the sample conversations two different individuals, fictional persons created by the experimenter, were conversing: Conversation A was between Brad and Kim and Conversation B was between Claire and Luis. The conversations were presented using multiple pictures of a smartphone with one to two novel lines of text presented on the screen in each picture (See Appendix A2). These sample conversations were centered around two different main topics: Conversation A was about soccer and Conversation B was about movies. In addition, these conversations both began and ended with some form of a greeting (i.e. hi, hello, see you later, bye), they had a central topic, and both of the participants asked and responded to

questions. The two sample conversation books were alternated across the participants. This means that the two participants in each dyad never had the same conversation manual during a single session (Session one: Veronica has book A and Anna has book B; Session two: Veronica has book B and Anna has book A). This was done in an effort to encourage more varied speech.

During intervention both of the participants were handed one of the conversation books and were told to read it. The participants' were given five minutes at the start of each intervention session to read the entire conversation. After reading the sample conversation, the experimenter discussed the characteristics of the conversations with the participants ("In the conversation the friends asked each other questions, responded to their friends' questions and talked about things that they both liked"). The participants were then instructed to have a text conversation with their peer, similar to the one in the book. The experimenter then provided assistance on content as needed during the session. For Dyad 1 and 2 this feedback generally involved asking them if they had any questions for their friend and reminding them to read what their peer wrote before responding. For Levi, his content prompting involved having him use the book to determine what he needed to do to start and end the conversation (i.e. say hi and bye) and potential topics they could discuss. Content prompting was then also provided for him based on his peers responses. Specifically, he was told to first read out loud each line that his peer wrote. Next, the experimenter asked him what he could say in response to the peers question or comment (i.e. "What is your favorite food?"). He was also asked whether he had anything he wanted to ask his peer in return (i.e. "What do you want to ask about? Favorite foods or favorite movies?"). After 10 minutes of conversing, if the participants were still texting, the experimenter told them that it was time to start to end their conversation. Criterion was met when the

participants maintained an appropriate back and forth conversation to 100% accuracy on two separate sessions.

Fading. Fading began after the dyads met criteria for texting intervention one and two. Once criterion was met, the books and prompting were immediately faded (the books were taken out of the room and prompting was no longer given on content or steps). The participants were then given ten minutes to text with each other per session. The fading criterion was set at 80% or above on two consecutive sessions for both the texting steps and content scoring sheets.

Booster Sessions. If a participant's percentage of appropriate texting steps or content regressed back to baseline levels following a single session, two booster sessions were implemented that mirrored the intervention sessions in terms of the treatment implemented and lasted for ten minutes each. The fading was then assessed again across two more sessions.

Fading for Levi. For Levi, who was lower functioning than the other participants included in the study and who also demonstrated high levels of prompt dependency, the book and verbal prompting needed to be faded a third time using a more gradual fading procedure. Specifically, a version of a gradual script fading procedure was implemented using the guidelines provided by McClannahan and Krantz (2005) and demonstrated in Grossberg & Charlop (2017). This process involved fading one word at a time starting with the last word of each phrase (Grossberg & Charlop, 2017; McClannahan and Krantz, 2005). The experimenter also incorporated a modification that Blanco & Charlop (2015) made to the overall procedure in order to make the resulting conversation flow more naturally. In their study Blanco & Charlop (2015) pointed out that the script of a conversation varies based on what the conversation partner adds to the conversation. As a result, they faded the last word gradually from a varied script (Blanco & Charlop, 2015). Similarly, in the current study the experimenter faded the last word in the variety

of phrases previously presented in the guidebook, which were then adjusted based on the conversational content (See Table 2 for examples). In this study, phase one consisted of removing one word from the end of every scripted phrase for the entirety of the ten minute conversation. In the next conversation, the last two words were faded and so on until the script was completely faded. Once the script was fully faded (three phases), the participant needed to reach a criterion of 80% or above on the texting steps and content score sheets across two consecutive sessions. Once the criterion was met, the ancillary measures were assessed (generalization partner probes and FaceTime® probes) and the dyad was instructed to have independent weekly text conversations with each other. A summary of Levi's fading procedure is presented in Table 2.

Table 2.
Levi's Fading Procedure

Fading Level	Procedure	Prompting Example
Level 1	Last word faded	1st text: "Hi ___" 2nd text: "What is your favorite ____?" 3rd text: "My favorite color is _____" 4th text: "Bye ____"
Level 2	Last two words (or phonemes faded if two words are not possible)	1st text: "H_ ___" 2nd text: "How are ____ ____?" 3rd text: I ___ ___" 4th text: "See ___ ____"
Level 3	Last three words faded (or full fade if three words aren't possible)	1st text: "___ ___" 2nd text: "What is ____ ____ ____?" 3rd text: It _____ ____ ____" 4th text: "____ ____"
Level 4	Full Fade	1st text: "___ ___" 2nd text: " _____ _____ ____ ____ ____?" 3rd text: " _____ ____ ____ ____" 4th text: "____ ____"

Independent Weekly Texts. Once the participants reached criterion with the books and prompting faded, a second step toward independent texting was taken by also fading out the experimenter. Specifically, the dyads were instructed to have a conversation with their friend at least once a week independently (the experimenter was no longer present while the children texted, but rather examined the conversation after the fact using the permanent product: pictures of the conversations). The experimenter instructed the parents to help the dyads identify a day each week when they would have a texting conversation. On the selected day the parent was tasked with providing the participant access to the phone and reminding them to text their friend. A screen shot of the texting conversation was taken each week by the parent, and the texting conversation was examined in terms of occurrence, appropriate beginning and end to the conversation, appropriate language, the length of the conversation, staying on topic, and both asking and responding to peer questions.

Generalization Texting Partner Probes. These generalization probes were implemented during baseline, following intervention fading, and during follow-up. They involved the same conditions as in baseline except each participant texted another communication partner that they were likely to text in the future. Specifically, the generalization texting partners were the individuals that the participants' and parents identified as potential texting partners prior to the study (i.e. parents, peers, siblings). Since some parents and participants identified multiple potential communication partners, each dyad differed in the types of generalization texting partner probes (i.e. Dyad 1 and 2: parent probes; Dyad 3: parent and sibling probes).

FaceTime® Probes. These probes also had the same conditions as in baseline, but instead of texting, the participant Face Timed the other participant. Since FaceTime® was not

taught in this study, the steps to making the FaceTime® call were done by the experimenter. Specifically, this probe accessed the ancillary effects texting with a peer has on the verbal conversation skills of the participant when conversing with the same peer. Ancillary measures were taken on whether or not these verbal conversations have an appropriate beginning and end, if appropriate language is used, staying on topic, and both asking and responding to peer questions. FaceTime® probes were taken during baseline, following intervention fading, and during follow-up. In baseline, if neither individual verbally communicated with their peer, then the session was terminated after 10 seconds. The FaceTime® probes concluded when the participants initiated an end to the conversation (i.e. bye) or ten minutes had passed.

Follow-up. Follow-up data was collected one month following treatment. The conditions during follow-up were identical to baseline. The experimenter also collected generalization texting partner probes and FaceTime® probes at this time.

Dependent Measures. The two dependent variables involved acquisition of both the texting steps and content required to maintain a back and forth text conversation. In terms of texting steps, this referred to successful completion of all seven of the steps outlined for sending a text. As for texting content, this included the use of greetings at the beginning and end of the conversation, appropriate language, staying on topic, appropriate length of texts, and both asking and responding to peer questions. The text conversations were scored by examining whether all of the texting steps were completed (were all seven steps completed) and if the conversation as a whole was contextually appropriate (one point for each content variable adding up to a total of 10 points). The experimenter then added up the number of points achieved on each dependent variable and divided the scores per conversation by the total number of points available, resulting

in a percentage of occurrence (_/7, _/10). A summary of the operational definitions for the dependent variables and examples are presented in Table 3.

Table 3.
Dependent Variables

Dependent Measures	**Operational Definition**	**Example**
The participant sent at least one text	The participant completed all seven steps identified in the task analysis	1. Opened the text app 2. Touched the new message or previous message buttons 3. Typed in name 4. Clicked on name 5. Clicked on message box 6. Typed in a message 7. Sent the message
Appropriate beginning to the conversation	The participant said some form of the word hello at the beginning of the conversation	"Hi", "Hi _____", "Hello", "Hey", etc.
Appropriate language	The participant did **not** talk about inappropriate topics	Participant does **not** send a text to his or her peer about their bathroom habits
Length of the conversation and individual texts	• The participant sent at least five texts per conversation and no single text was more than 4 lines • No one word single texts three times in a row • No repeated texts	• Five different texts bubbles in a single color and 1-4 lines of text per each bubble • There were not three same colored text bubbles in a row that contained only a single word: "Yes" "cool" "fine" • No participant sent two texts that were exactly the same: "I like candy" "I like candy"
Staying on topic	The text message the participant sent was related or in some way referenced the texts preceding it	Text from peer: "My favorite sport is baseball!" Response from participant: "That's cool! I like soccer!"
Asking questions	The participant asked his/her peer at least one question per conversation	"What's your favorite sport?" "Do you have any siblings?"

Responding to questions	The participant responded to at least one question of his or her peers per conversation	"I like basketball" "I have three sisters"
Novel response	The participant's texts differed from the texts presented in the sample conversations	"I really love science class" "It was fun chatting"
Appropriate end to the conversation	The participant said some form of the word goodbye at the end of the conversation.	"Bye," "See ya," "See you later," etc.

Ancillary Measures and Social Validity. One ancillary variable that was assessed concerned how the impact of learning to text with a peer subsequently affected the content of verbal back and forth conversions between the peers when communicating over FaceTime® (See Table 4 for operational definitions and examples). The conversational content was scored similarly to that of the dependent variables (points added together and then divided by the total number of points available).

Table 4.
Ancillary Variables

FaceTime® Measures	**Operational Definition**	**Example**
Appropriate beginning to the conversation	The participant said some form of the word hello at the beginning of the conversation	"Hi," "Hi _____," "Hello," "Hey," etc.
Appropriate language	The participant did **not** talk about inappropriate topics	Participant did **not** ask peer about his or her bathroom habits
Staying on topic	Each statement said by a participant was related or in some way referenced preceding statements or questions	Friend says: "My favorite sport is baseball!" Participant says: "That's cool! I like soccer!"
Asking questions	The participant asked his/her peer at least one question per conversation	"What's your favorite sport?" "Do you have any siblings?"
Responding to questions	The participant responded to at least one question of his or her peers per conversation	"I like basketball" "I have three sisters"

Time spent speaking	• No single participant talked for more than 20 seconds straight (no monologues) • No one word responses three times in a row	• Participant did not speak for 20 seconds without stopping to give their friend a turn • Participant did not say "Good" "Yes" "Fine" in three consecutive responses
Appropriate end to the conversation	Participant said some form of the word goodbye at the end of the conversation	"Bye", "See ya" "See you later", etc.

Two additional measures were taken for social validity. Specifically, a social validity questionnaire was administered pre and post intervention to both the participants and parents asking questions concerning the participant's knowledge of how to text, his or her interest in learning to text and his or her overall enjoyment of texting (See Appendix B). In addition, a second measure of social validity was taken in which naïve young adult raters were asked to score a series of eight text conversations sent during baseline and intervention from all three dyads in terms of how appropriate and natural the text conversations seemed.

Inter-rater Reliability and Procedural Fidelity. The primary research observer and one secondary observer were trained on how to score the texting conversations for both steps completed and overall content. They also received training on how to score the ancillary measures as well. To assist with scoring, checklists were provided that contained the observational definitions. If observer drift occurred, the experimenter retrained the secondary observer using booster sessions. The secondary observer reviewed the permanent products of 33% of the texting conversations across conditions, along with 33% of the videotapes of the baseline, intervention training, generalization texting partner probes, FaceTime® probes, and follow-up sessions for each participant. The primary and secondary observers then compared the

scores to each other to determine inter-observer agreement. If scorers disagreed, they re-watched the videotapes and re-examined the permanent product of that session to resolve discrepancies. Interrater reliability was high across both participants and phases of the study, ranging from 88%-100%. A summary of interrater reliability across participants can be seen below in Table 5.

Table 5.
Inter-rater Reliability

	Texting Steps	Texting Content	FaceTime® Content	Gen-Probe Steps	Gen-Probe Content
Bennet	100%	98%	88%	93%	100%
Milo	100%	93%	88%	100%	95%
Anna	100%	95%	88%	100%	90%
Veronica	100%	95%	94%	100%	90%
Levi	99%	93%	94%	100%	95%

Additionally, two observers who did not participate in the texting intervention, assessed procedural integrity in 33% of the sessions across conditions and participants. This was done using the videotapes of the baseline, intervention training, generalization texting partner probes, FaceTime® probes, and follow-up sessions for each participant. The observers received training on how the procedure was implemented and were each given a check sheet to use when scoring the presence and absence of each step in the procedure across sessions and participants. Procedural fidelity for all participants ranged from 94% to 100% on average. Mean procedural fidelity for Bennet was 95%, Milo = 95%, Anna = 94%, Veronica = 94%, and Levi =100% The only error that points were taken off for was the experimenter not ending a few of the sessions at exactly ten minutes.

Inter-informant agreement on social validity surveys. Social validity surveys were given to the participants and their parents prior to and after the study. The percentage of inter-informant agreement between the parent's and their respective children were calculated across the eight questions on the pre-assessment and post-assessment surveys. For each question, the number of agreements were than divided by the total number of informant dyads (five on the pre-assessment and four on the post assessment: due to one parent and her child not being available to complete the post assessment survey) to obtain a percentage of agreement. A summary of the percentage of inter-informant agreement between parents and their children on the questions in the social validity survey is presented below in Table 6.

Table 6.
Inter-informant agreement between parents and children on the pre and post social validity survey

	Pre-assessment	Post-assessment
Question 1: Do you know how to text?	60%	100%
Question 2: Have you sent a text to a parent?	60%	100%
Question 3: Have you sent a text to a friend?	80%	100%
Question 4: Have you sent a text to another individual?	75%	100%
Question 5: How many texts have you sent?	50%	100%
Question 6: Do you like texting?	80%	100%
Question 7: Do you want to text with more people?	100%	100%
Question 8: Who would you like to text with? (fill in the blank)	17%	50%

Chapter 7

Results

During baseline four out of the five participants demonstrated basic texting skills (i.e. the steps required for sending and receiving a text). However, none of the children or adolescents in the study demonstrated the use of appropriate text content during baseline, resulting in texts that did not make sense or one-sided conversations about obsessive interests. Following the interventions, all the participants learned to text appropriately with their peers. Specifically, all five of the participants met the criterion of completing 100% of the steps needed for sending a text and producing 100% appropriate content, across two consecutive texting opportunities. In addition, once the intervention was faded, four participants quickly met the fading criterion of 80% across two consecutive sessions. For Levi, the fading process looked different, as he had two different fading procedures instead of one. Following the second fading procedure he was also able to meet the criterion of 80% across two consecutive sessions. Generalization partner probes were taken following each participant reaching the fading criterion. All five participants generalized to their texting partners (parents and siblings), scoring 80%-100% following the intervention being fully faded. After the experimenter was physically faded from the sessions and the participants' were sending weekly independent texts, all five participants continued to maintain the skills. In addition, the participants continued to generalize to their generalization texting partners. The skill was also maintained at the one month follow-ups. The ancillary measure of the percentage of appropriate content discussed through FaceTime® also increased for all five participants in the probes following intervention compared to the ones taken during baseline. For four of the participants the difference in appropriate content during FaceTime® prior to and following intervention differed by 25% or greater. In addition, this ancillary

variable, verbal content, continued to be present at high rates in the FaceTime® probes taking one month following completion of the study

Texting Steps

Bennet, Milo, Anna, Veronica. Bennet, Milo, Anna, and Veronica tested out of the texting step intervention and therefore went directly to the texting content intervention, by scoring 100% on texting step completion across two consecutive baseline sessions. At first, Milo and Anna did not complete all of the steps correctly at the beginning of baseline. The two steps Milo missed in his first baseline session were step two: touching the new message button and step four: clicking on the name of the person he wanted to text. In his second baseline session he again did not accurately complete step four. Anna missed step two when completing her baseline generalization probe with her mother. Anna also did not complete step two: touching the new message button, step three: typing in a name, and step four: clicking on the name during her first baseline session. In their following baseline sessions, they both joined their partners in meeting the texting step criterion and moved directly to the content intervention.

Levi. Levi demonstrated a low percentage of steps completed during his nine baseline sessions and four generalization partner probes (mother and sister) (mean = 23%). In his baseline probes, he completed 0% to 57% of the steps across sessions. In the nine baseline sessions and four generalization probes he completed 0%, 57%, 43%, 14%, 14%, 29%, 14%, 14%, 14%, 29%, 14%, 29%, 29% of the steps correctly (See Figure 1). During baseline, on average Levi completed two out of the seven steps required to send a text (See Figure 2). The step most frequently completed independently during baseline was step six: typing the message (mean = 92% of sessions). The other step that was consistently completed towards the end of baseline was step three: typing in the texting partners name (mean = 23%). During the first of the text step

intervention sessions, steps three and six were completed independently, 29% of the steps. In the second intervention session, all seven of the steps were independent, 100% of steps. In the third, fourth, and fifth intervention sessions, 43% (three steps), 14% (one step), and 57% (four steps) of the steps were completed independently. In the sixth and seventh intervention sessions, Levi reached the criterion of completing 100% of the steps independently across two consecutive texting sessions.

While completing the texting content intervention, Levi maintained his independence of completing the texting steps scoring 86% (six steps),100% (seven steps), 86% (six steps), 86% (six steps), 100% (seven steps) (See Figure 5). During the second intervention, the one step that was not performed independently on a consistent basis was step 7: sending the text. In the next eleven sessions that made up the fading and booster sessions, Levi scored 100% on independent completion of the steps. Levi also independently completed 100% of the texting steps during the generalization probes with his mother and sister following fading. When completing the two weekly texts, Levi continued to perform 100% of the steps independently. He also continued to generalize this skill to his texting conversations with his sister and mother, 100%, following the weekly texts. Overall, following intervention, Levi reached the texting step training criterion (100%), the fading criterion (80%), and continued to maintain the skills during his independent weekly texts. In addition, he generalized these skills to the conversations with his sister and mom. He also maintained the skills at his one month follow-up, scoring 100%, and continued to generalize this skill to both his mother and sister.

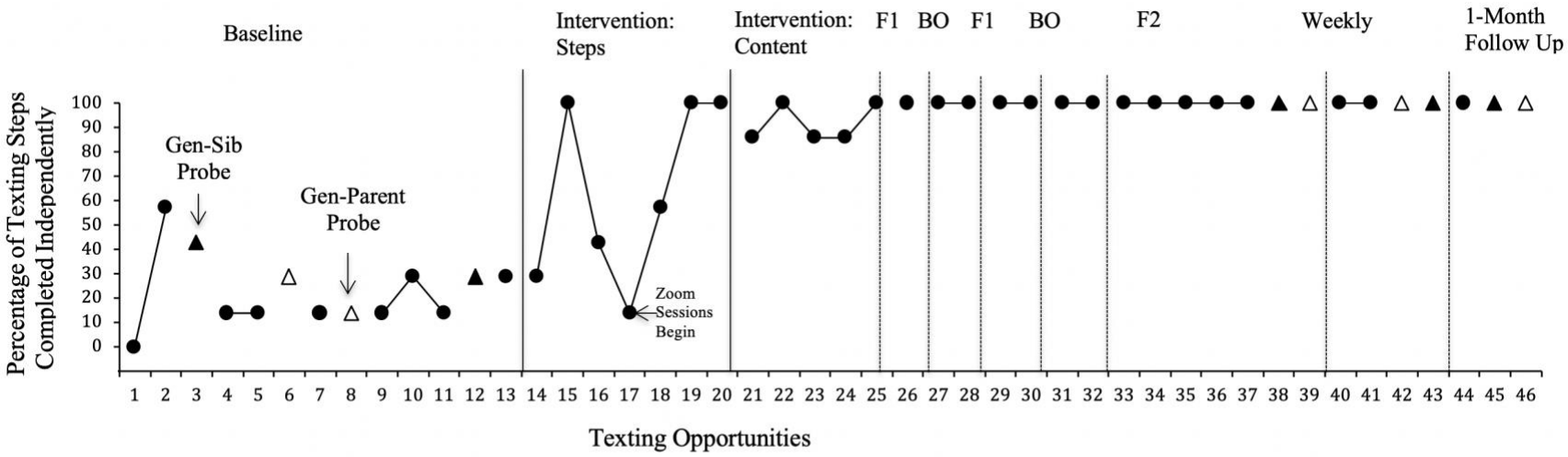


Figure 1. Percentage of Texting Steps Completed Independently by Levi During Baseline, Intervention 1: Texting Steps, Intervention 2: Texting Content, Generalization Partner Probes, Fading Version 1 for Content (F1), Booster Session (BO), Fading Version 2 (F2), the Weekly Texts, and Follow Up.

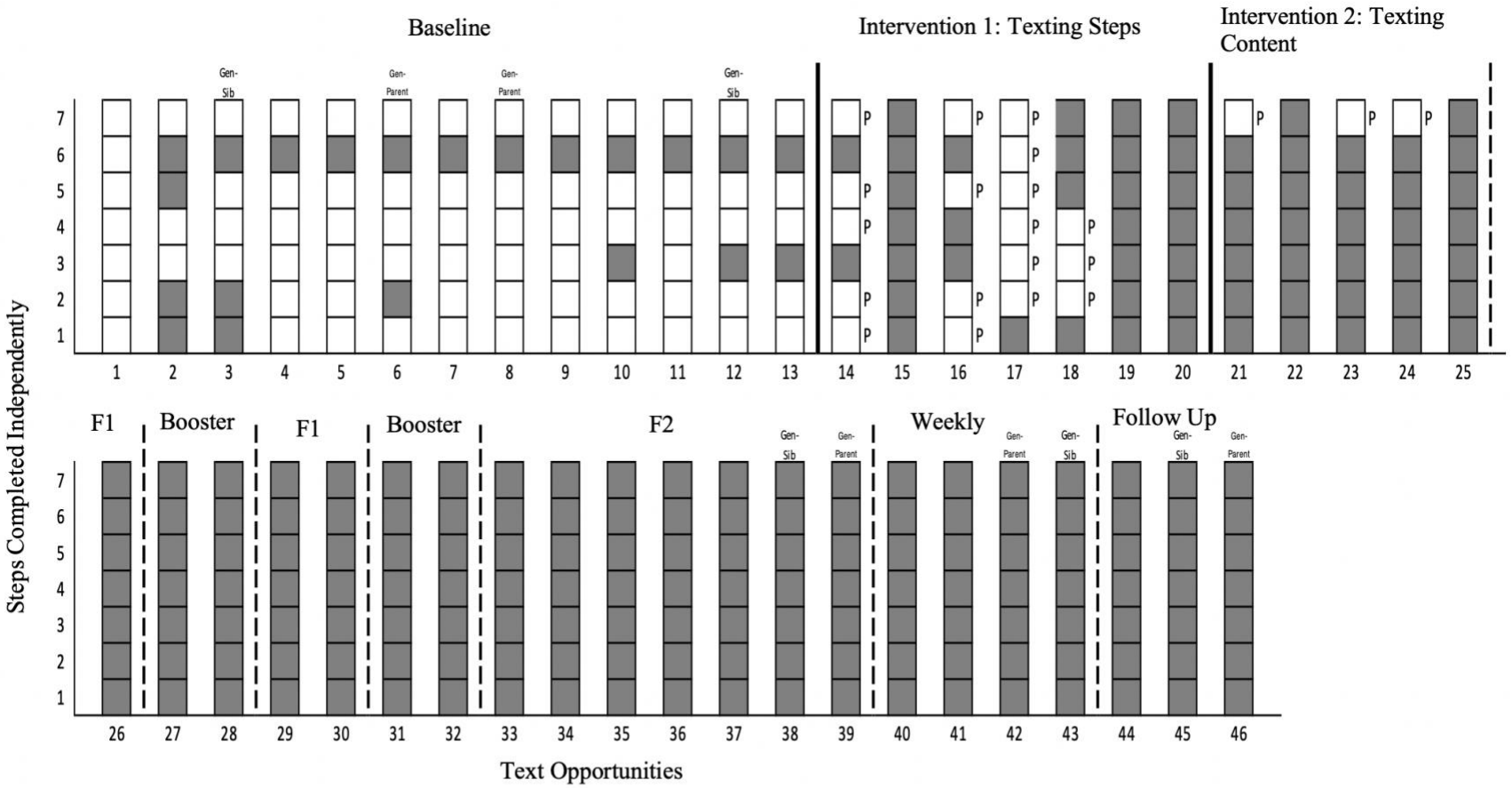


Figure 2. The Steps Completed Independently by Levi when Sending a Text. The numbers on the y-axis refer to each of the seven steps required to send a text. If a box is shaded in grey that means the step was completed independently during that texting opportunity. If the box is shaded in white it means that particular step was not completed. If a P is next to a white box during intervention it means the step was prompted. F1 refers to Fading version 1 and F2 is Fading version 2.

Texting Content

Bennet. In his four baseline sessions and one generalization partner probe (mother), he demonstrated a low percentage of appropriate texting content (mean = 28%; See Figure 3, panel 1). Specifically, during the four baseline sessions, Bennet's percentage of appropriate content per conversational opportunity was 30%, 20%, 30%, 30%, respectively. During his baseline generalization probe his percentage of appropriate text content was 30%. Following baseline, Bennet had the texting content intervention that spanned four sessions. In his first two intervention sessions he scored 100% and 70% on percentage of appropriate text content. When completing his third and fourth intervention sessions, he reached criterion by scoring 100% on both sessions. After reaching criterion, the materials were fully faded. Bennet met the fading criterion by scoring 100% on appropriate content during his two fading sessions (material was fully faded). Next, he demonstrated generalization of the skills across texting partners by scoring 80% on his generalization parent probe. During his two weekly independent texting sessions he scored 70% and 100% respectively. Bennet also demonstrated continued generalization of the skill to his mom, scoring 80% on the generalization texting probe following the weekly texts. Overall, following intervention Bennet reached the texting content training criterion (100%), the fading criterion (80%), and continued to maintain the skills during his independent weekly texts. He also demonstrated generalization of the skills from his peer to his mom. In addition, Bennet maintained the skill one month following treatment and continued to generalize to his mother, by scoring 100% on both sessions.

Milo. During Milo's four baseline sessions and one generalization partner probe (mother), he demonstrated a low percentage of appropriate texting content across sessions (mean = 36%; See Figure 3, Panel 2). In his four baseline sessions, Milo demonstrated low levels of

appropriate text content scoring 30%, 30%, 50%, and 30% during each texting opportunity. Milo's percentage of appropriate text content was 40% during his baseline generalization partner probe (mother). Once the texting content intervention was implemented, his percentage of appropriate texting content increased to 100% on all four intervention sessions. After reaching the texting content criterion, the intervention was fully faded, and Milo continued to demonstrate 100% of appropriate text content across two consecutive sessions. He also demonstrated generalization from his peer to his mom by scoring 90% on his generalization partner probe. During the two weekly independent texting sessions, Milo continued to text appropriately at 90% and 100% respectively. Following the weekly text sessions, Milo also demonstrated a continued generalization of the skill across texting partners by scoring 80% on his generalization parent probe. Overall, Milo reached both the texting content training criterion, the fading criterion, and continued to maintain the skills during his independent weekly texts. He also demonstrated generalization of the skills across texting partners (peer, mother). Lastly, Milo demonstrated continued maintenance and generalization of the skill one month following treatment, scoring 90% on both the follow-up session and the generalization probe.

Anna. During her eight baseline sessions and two generalization partner probes (typically developing peer and mom), Anna demonstrated a low percentage of appropriate texting content (mean = 41%, See Figure 3, Panel 3). Specifically, her percentage of appropriate texting content across her eight baseline sessions was 30%, 50%, 30%, 50%, 40%, 50%, 40%, 40%, respectively. She produced 40% of appropriate texting content during her two baseline generalization texting partner probes (mom and typically developing peer). When completing her four intervention texting sessions, Anna produced 90%, 90%, 100%, 100% of appropriate text content respectively. She reached criterion during her third and fourth intervention sessions.

After the intervention was faded, Anna met and surpassed the fading criterion by continuing to demonstrate 100% of appropriate text content across two more sessions. Anna also generalized across texting partners by scoring 80% on her generalization partner probe (mother). The typically developing peer was not available for a generalization partner probe. While completing her two weekly text conversations, Anna continued to demonstrate skill acquisition by scoring 100% and 80% respectively. Overall, Anna reached both the texting content training criterion, the fading criterion, and continued to maintain the skills during her independent weekly texts. In addition, Anna also showed maintenance of the skill by scoring 90% on her one month follow-up session.

Veronica. Across Veronica's eight baseline sessions and two generalization probes, she produced a low variable rate of text content (mean = 51%; See Figure 3, Panel 4). During the eight baseline sessions, her percentage of appropriate text content was 50%, 40%, 70%, 40%, 70%, 80%, 40%, 40% respectively. Veronica's baseline data was variable with a few high peaks, but in the end, it flattened out at 40%. She scored 50% on her baseline generalization partner probe with a typically developing peer and 30% on her generalization partner probe with her mother. During her four texting intervention sessions she produced 100% appropriate text content across sessions, reaching the criterion. Once the intervention was faded, she met the fading criterion by producing 90% and 100% of appropriate content during two consecutive sessions. Veronica also generalized the skill across texting partners, from her peer to her mother, by scoring 90% on her generalization parent probe. The typically developing peer was not available for a generalization probe. When completing the two weekly texting sessions, she maintained the skill by scoring 100% and 90% respectively. Following the weekly text sessions, Veronica continued to generalize the skill to her parent, scoring 90% on the probe. Overall,

Veronica reached both the texting content training criterion, the fading criterion and continued to maintain the skills during her independent weekly texts and generalize to her mother. Veronica also demonstrated maintenance of the skill by scoring 90% on her one month follow-up session.

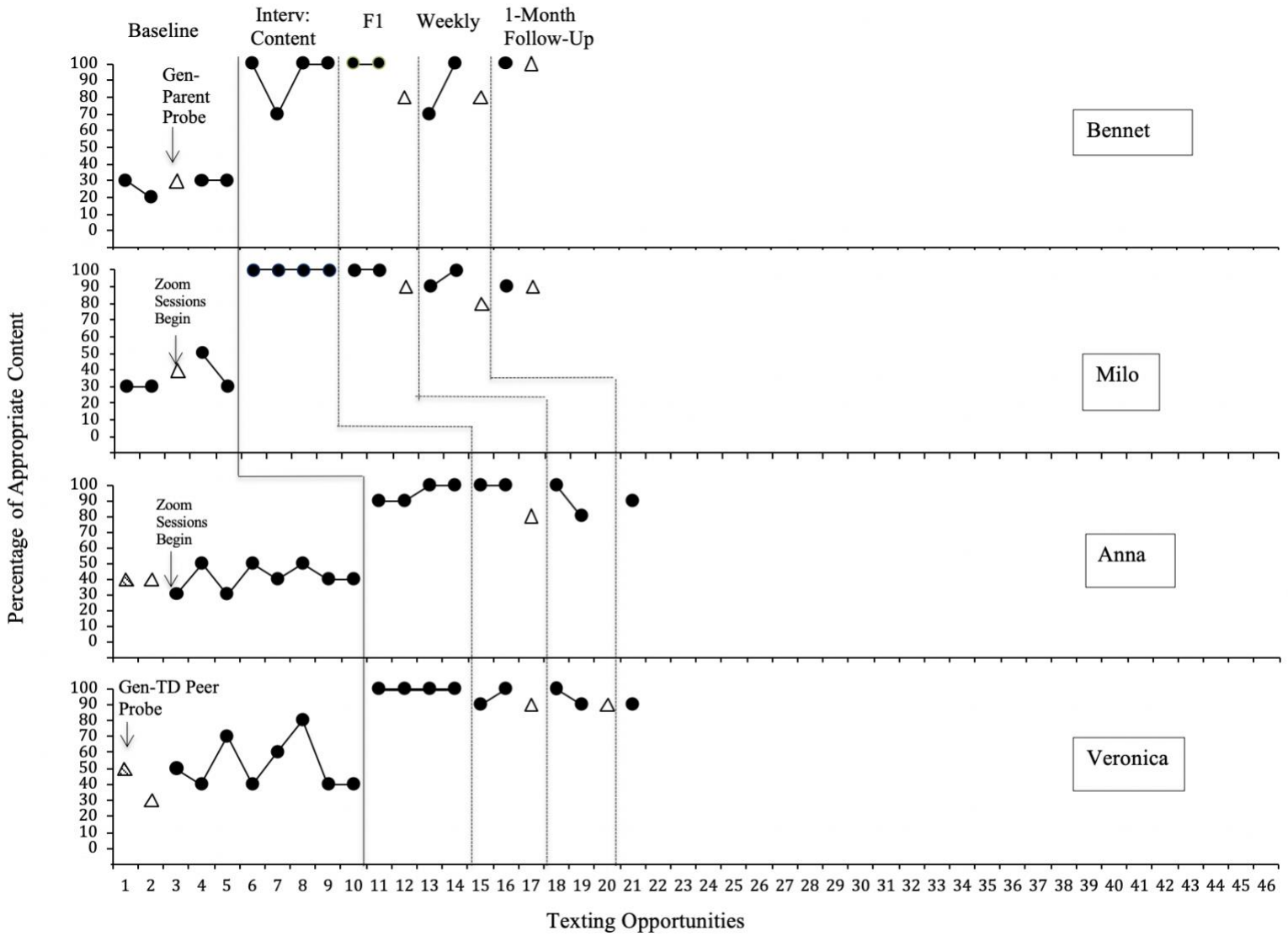


Figure 3. Percentage of Appropriate Text Content for Bennet, Milo, Anna, and Veronica During Baseline, Intervention: Content, Generalization Partner Probes, Fading Version 1, Weekly Texts, 1-Month Follow-Up

Levi. Levi's percentage of appropriate text content during his nine baseline sessions and four generalization partner probes (mother and sister) remained at a consistently low level (mean = 9.2; See Figure 4). In his first baseline session, he produced 0% of appropriate text content. During the following eight baseline sessions, his percentage of appropriate text content was 10%. He also scored 10% on his two baseline generalization partner probes with his mother and his two baseline generalization partner probes with his sister. During the seven sessions that made up the texting steps intervention, his percentage of appropriate text content was 40%, 40%, 40%, 20%, 30%, 20%, 30%, respectively. The texting content intervention was implemented in five sessions. During these five sessions, Levi produced 70%, 90%, 90%, 100%, 100% of appropriate texting content. He reached the texting content criterion in his fourth and fifth sessions. Next, when the books and prompting were fully faded, his percentage of appropriate text content went down to 30%. During his two booster sessions, the percentage increased to 100% across both sessions. The intervention was then faded fully again resulting in two sessions at 50% and 20% respectively. The experimenter implemented two more booster sessions and his scores rose to 90% and 100% respectively. Next the experimenter implemented the fading version two which faded the intervention gradually over three sessions. During the three partial fading sessions, Levi produced 100%, 100%, 80% appropriate text content respectively. Once the intervention was fully faded, he reached the fading criterion by continuing to demonstrate 80% and 90% of appropriate text content. Levi also demonstrated generalization of the skills across texting partners (mother and sister), scoring 100% and 90% respectively. When engaging in the weekly independent texts with his peer, Levi increased his percentage of appropriate content to 100% across both sessions. Following the weekly texts, he also continued to generalize the skills from his peer to his sister and his mother, scoring 90% on both sessions. Overall, Levi reached both

the texting content training criterion, the fading criterion and continued to maintain the skills during his independent weekly texts. Levi also demonstrated generalization of the skills across texting partners (from his peer to his mother and sister). In addition, he maintained the skills at his one month follow-up by producing 100% of appropriate texting content and continued to generalize this skill to both his mother and sister.

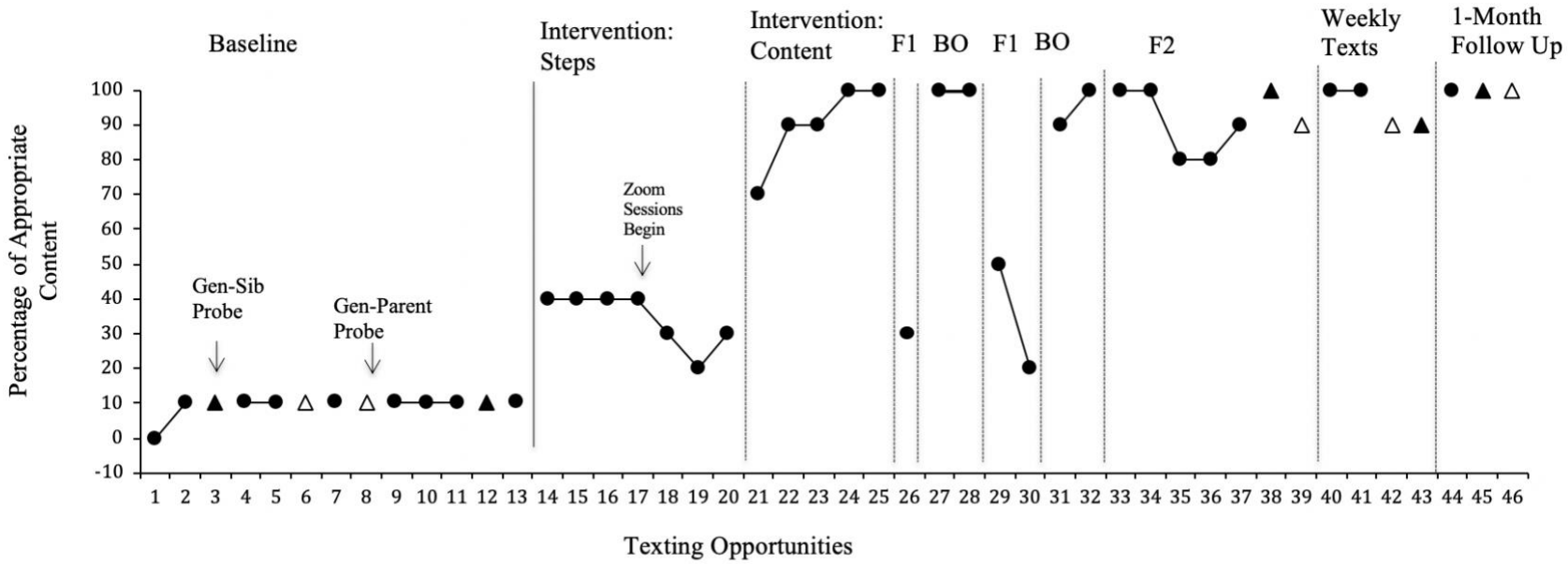


Figure 4. Percentage of Appropriate Text Content for Levi During Baseline, Intervention: Content, Generalization Partner Probes, Fading Version 1, Weekly Texts, 1-Month Follow-Up

Novel Content

Bennet and Milo. Dyad one increased the variety of novel topics discussed (topics not discussed in the sample conversations) during baseline versus intervention. Specifically, they increased from two topics to seventeen topics (See Figure 5 for a visual depiction of the difference, See Table 7 for the list of topics discussed).

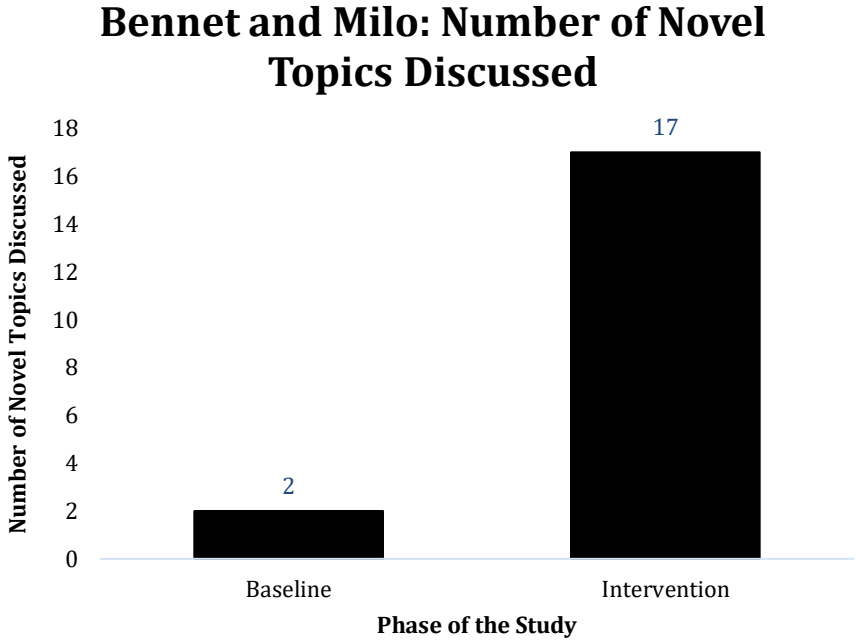


Figure 5. Number of Novel Topics Discussed by Bennet and Milo in Baseline Compared to Intervention

Baseline	Content Intervention
• Applications on the phone • Favorite foods	• Favorite countries • Favorite types of dinosaurs • Favorite videogames • Favorite states • School subjects • Favorite types of soda • Favorite foods • Television shows • Pets • Things they are allergic to • Favorite songs • Favorite ice cream flavors • Favorite pizza toppings

	• Favorite cities • Activities they want to do before they turn 18 • Rules they would make if they could be a parent • Favorite fast-food places

Table 7. Novel Topics Discussed by Bennet and Milo in Baseline Compared to Intervention

Anna and Veronica. Dyad two's discussion of novel topics increased from seven topics in baseline to ten topics during intervention (See Figure 6 for a visual depiction of the difference; see Table 8 for the list of topics discussed). The topics discussed during baseline also primarily centered on obsessive interests: Bruno Mars, a television show, a game on the phone, and Blaze pizza. During intervention the topics discussed expanded to also include neutral topics such as activities they have done with their families, weekend plans, and how they are feeling,

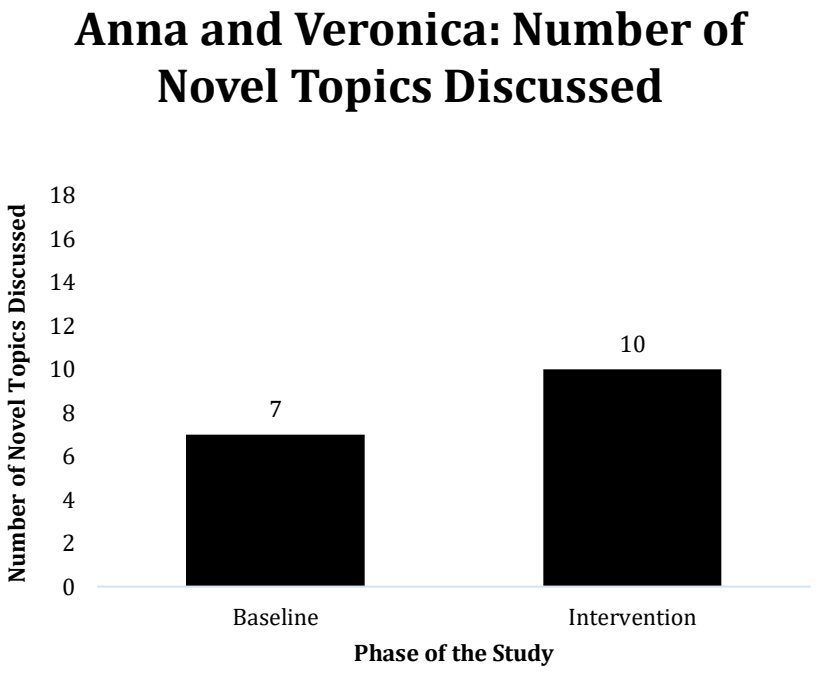


Figure 6. Number of Novel Topics Discussed by Anna and Veronica in Baseline Compared to Intervention

Baseline	Content Intervention
• Television shows • Applications on the phone • Music • Trips • Boba • Restaurants • Favorite pizza toppings	• Music • Applications on the phone • Trips • Apple products • What time they go to sleep at • How the day is going • Their thoughts on social distancing • Food • Activities they are doing • Weekend plans

Table 8. Novel Topics Discussed by Anna and Veronica in Baseline Compared to Intervention

Levi and Mick. Dyad three also increased their novel conversation topics from one topic discussed during both the baseline and the texting step intervention sessions to fifteen topics during the content intervention (See Figure 7 for a visual depiction of the difference; see Table 9 for the list of topics discussed).

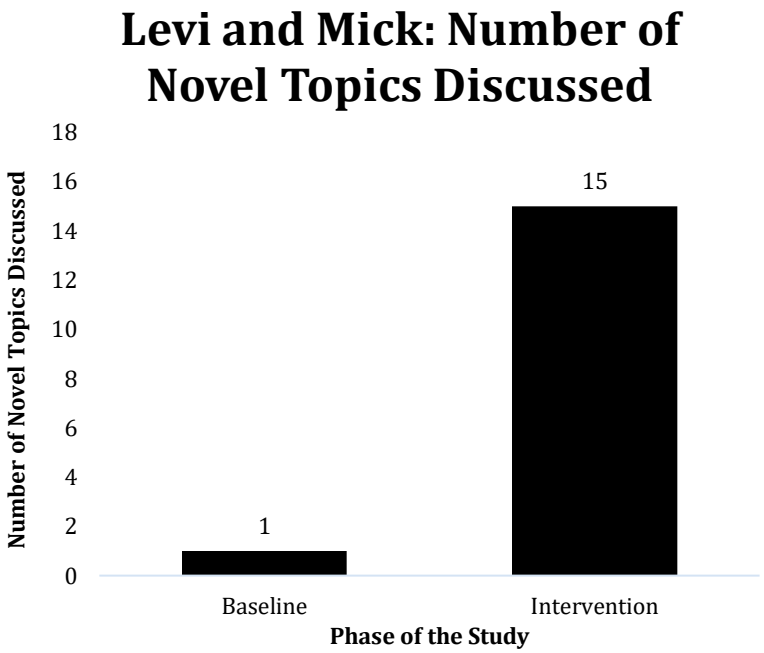


Figure 7. Number of Novel Topics Discussed by Levi and Mick in Baseline Compared to Intervention

Baseline/Text Step Intervention	Content Intervention
• Food	• How the day is going • Food • What time they woke up at • Favorite animals • Favorite colors • School • Outdoor activities • The weather • Favorite restaurants • Music • Favorite places to visit • Favorite exercises • The beach • Easter • Puzzles/games

Table 9. Novel Topics Discussed by Levi and Mick in Baseline Compared to Intervention

Ancillary Data

FaceTime® Probes

Bennet. During his baseline FaceTime® Probe, Bennet scored a 50% on appropriate verbal conversational content with his texting partner (See Figure 8). Following the texting content intervention being faded and reaching criterion, he scored an 88% on appropriate verbal conversational content produced during a FaceTime® Probe. This resulted in an increase of 38% of appropriate conversational content between the probes. In his last FaceTime® Probe, which was taken one month following the texting content intervention being faded, Bennet scored a 100% on appropriate verbal content. Overall, this demonstrated that his percentage of appropriate texting content doubled when comparing his FaceTime® Probe taken one month

following the texting intervention, to the probe taken prior to the texting intervention

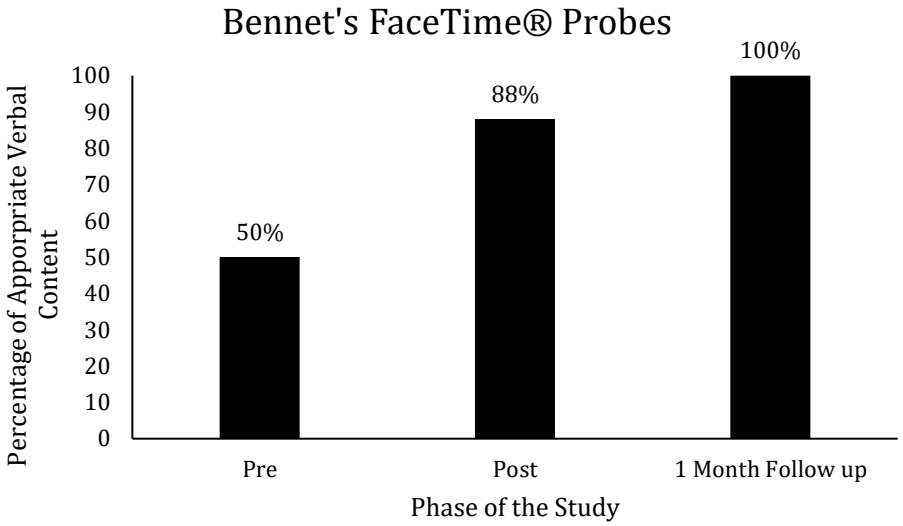


Figure 8. Bennet's Percentage of Appropriate Verbal Content during FaceTime® Probes Taken Prior to, Directly After, and One Month Following the Texting Content Intervention Being Faded

Milo. In his baseline FaceTime® Probe, Milo's percentage of appropriate verbal conversational content occurred was 63% (See Figure 9). After the texting content intervention was faded and criterion was met, he scored an 88% on percentage of appropriate verbal content during his FaceTime® Probe with his texting partner. Demonstrating an increase of 38% of appropriate conversational content between the probes. During Milo's final FaceTime® Probe, which was taken one month following the texting content intervention being faded, he scored a 100% on appropriate verbal content. This resulted in and increase of 37% between his first FaceTime® Probe, taken prior to the texting content intervention, and his third probe, which was taken one month following completion of the study.

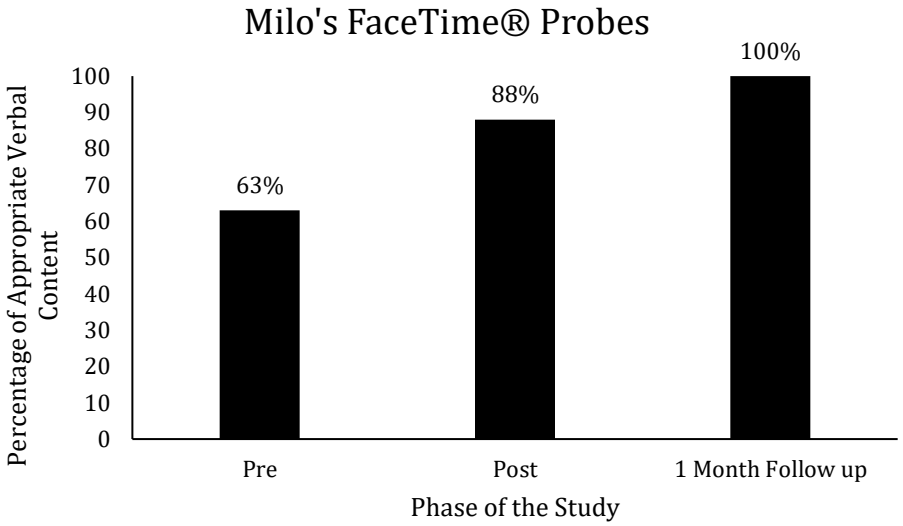


Figure 9. Milo's Percentage of Appropriate Verbal Content during FaceTime® Probes Prior to, Directly After, and One Month Following the Texting Content Intervention Being Faded

Anna. Anna's percentage of appropriate verbal content was 50% during her baseline FaceTime® Probe with her texting partner Veronica (See Figure 10). In the FaceTime® Probe following the texting content intervention being faded, she scored a 100% on appropriate verbal conversational content. Anna doubled her percentage of appropriate verbal conversational content over FaceTime® when examining the probes together. She also demonstrated 100% of appropriate verbal content on her FaceTime® Probe taken one month after study completion.

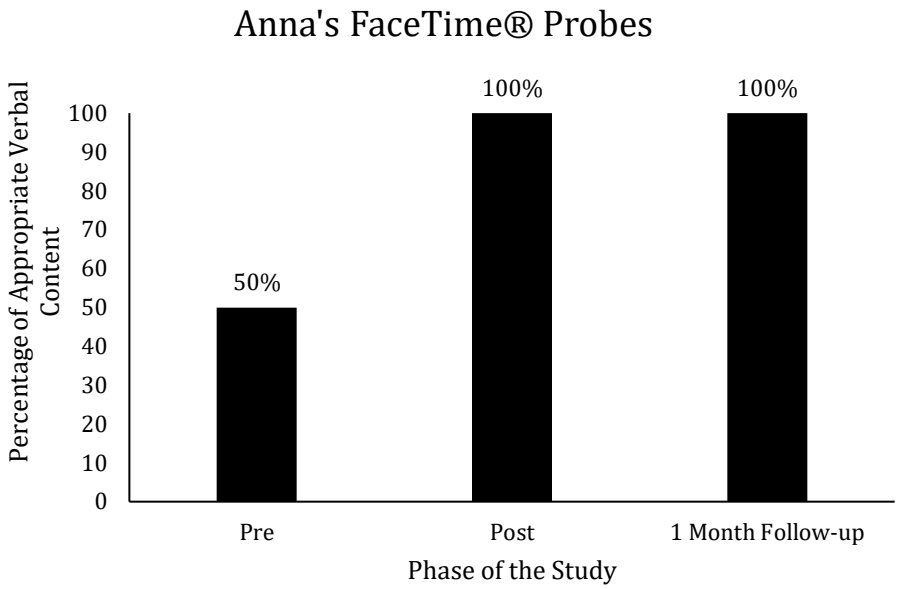


Figure 10. Anna's Percentage of Appropriate Verbal Content during FaceTime® Probes Prior to and Following the Texting Content Intervention

Veronica. Veronica's percentage of appropriate verbal content was 75% during her baseline FaceTime® Probe (See Figure 11). Following the texting content intervention being faded, she scored 100% during her FaceTime® Probe. When comparing the two probes, there was an increase of 25% in appropriate verbal conversational content. Veronica also scored 100% during her FaceTime® Probe taken one month following completion of the study.

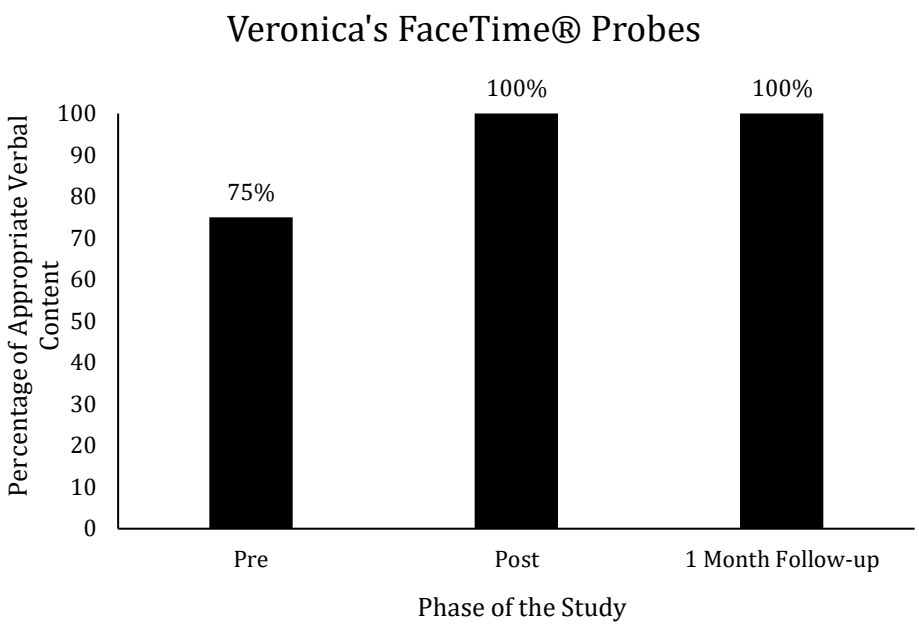


Figure 11. Veronica's Percentage of Appropriate Verbal Content during FaceTime® Probes Prior to and Following the Texting Content Intervention

Levi. In Levi's baseline FaceTime® Probe, he scored 53% on appropriate verbal content (See Figure 12). During his second FaceTime® Probe, which occurred after the texting content intervention was faded, he scored a 75% on appropriate verbal conversational content. This demonstrates an increase in 12% on appropriate conversational content between the two probes. In Levi's final FaceTime® Probe, taken one-month after completion of the study, he scored 88% on appropriate verbal content. The difference between is first and third FaceTime® Probes was 25%. He also scored 88% in his FaceTime® Probe one month after completion of the study. This demonstrates a second increase of 13% between the second and third FaceTime® Probe.

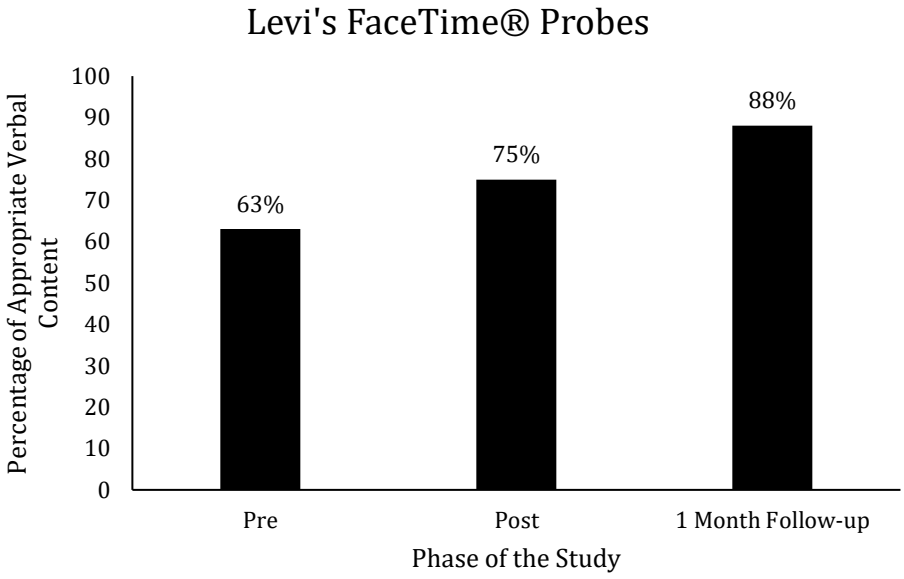


Figure 12. Levi's Percentage of Appropriate Verbal Content during FaceTime® Probes Prior to Directly After, and One Month Following the Texting Content Intervention Being Faded

Social Validity

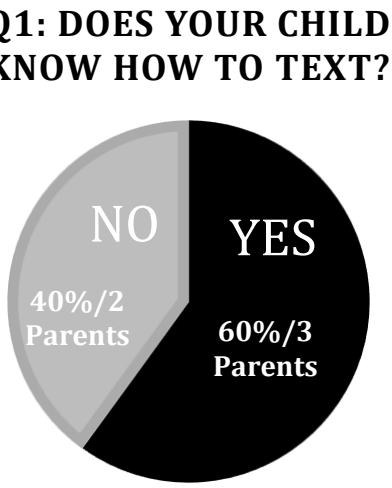
Parent Pre and Post Intervention Questionnaires

All five parents and participants completed the pre-questionnaires. One parent and her child were not available to complete the post-questionnaires. Therefore, the total sample on the post-questionnaires for both the parents and participants was out of four.

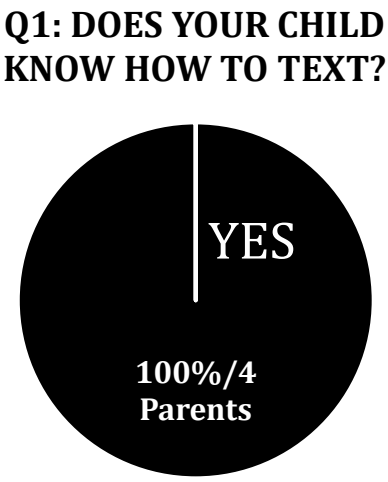
Question 1: Do you (Does your child) know how to text? In the pre-survey, 60% of parents (three parents) answered yes and 40% of parents (two parents) answered no (See Figure 13 A-D). Following completion of the study, 100% of the parents who were available to complete the survey (four parents) answered yes in their post-survey. In the participant completed pre-intervention survey, 60% of the participants (three participants) answered yes and 40% (two participants) answered no. On the post-survey, 100% of participants who were available to take the survey (four participants) answered yes.

Figure 13. Question One Answers on Pre and Post Surveys for Parents and Participants

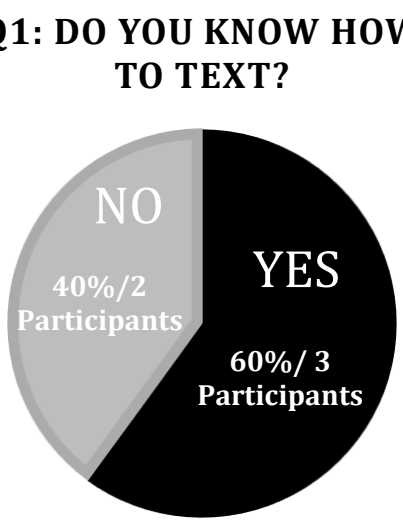
13A. Pre Survey for Parents



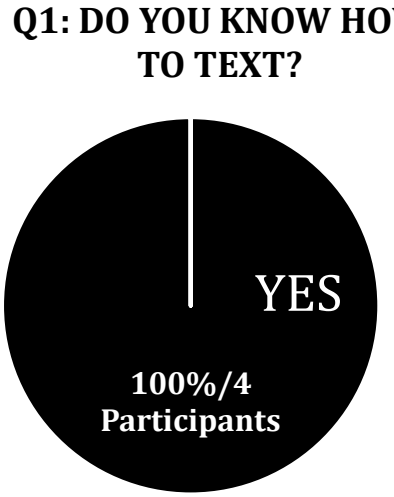
13B. Post Survey for Parents



13C. Pre Survey for Participants



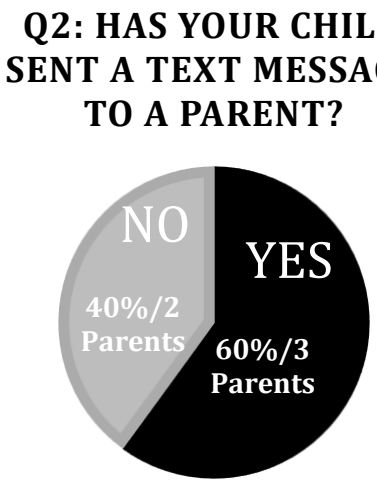
13D. Post Survey for Participants



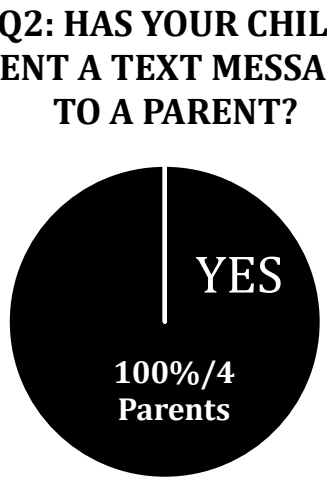
Question 2: Have you (Has your child) sent a text to a parent? When completing the pre-survey, 60% of parents (three parents) answered yes and 40% of parents (two parents) answered no (See Figure 14 A-D). Following intervention, 100% of the parents who completed the survey (four parents) answered yes. On the participant completed pre-survey, 60% of the children (three participants) answered yes and 40% (two participants) answered no. Following completion of the study, post-survey data demonstrated that 100% of the children who completed the survey (four participants) answered yes.

Figure 14.
Question Two Answers on Pre and Post Surveys for Parents and Participants

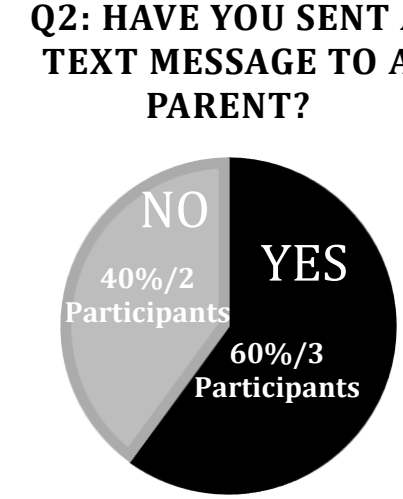
14A. Pre Survey for Parents



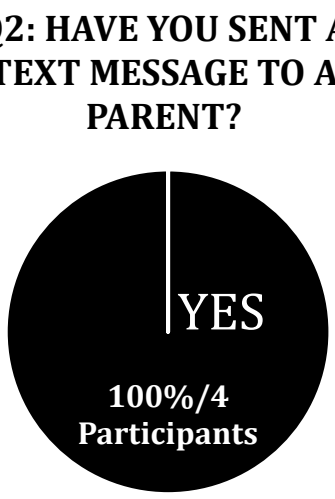
14B. Post Survey for Parents



14C. Pre Survey for Participants



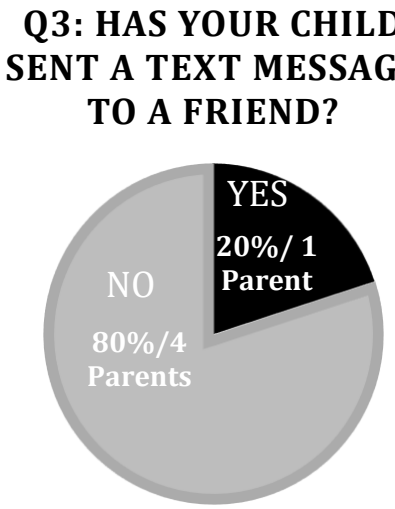
14D. Post Survey for Participants



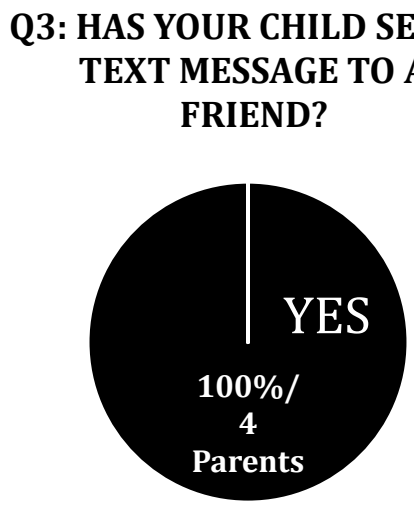
Question 3: Have you (Has your child) sent a text to a friend? On the pre-assessment, 20% of the parents (one parent) answered yes and 80% (four parents) answered no (See Figure 15 A-D). After their child completed the study, 100% of the parents (four parents) answered yes. The participant pre-assessment data revealed that 40% of participants (two participants) answered yes and 60% (three participants) answered no. In the post-assessment survey, 100% (four participants) answered yes.

Figure 15.
Question Three Answers on Pre and Post Surveys for Parents and Participants

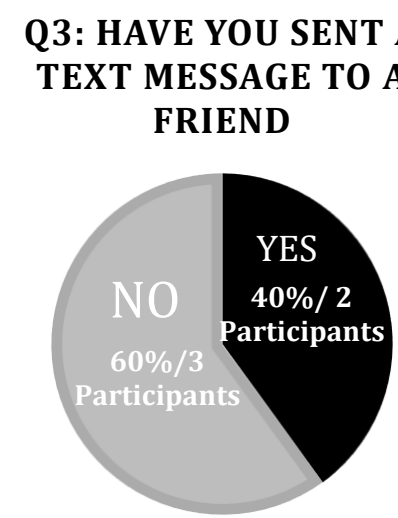
15A. Pre Survey for Parents



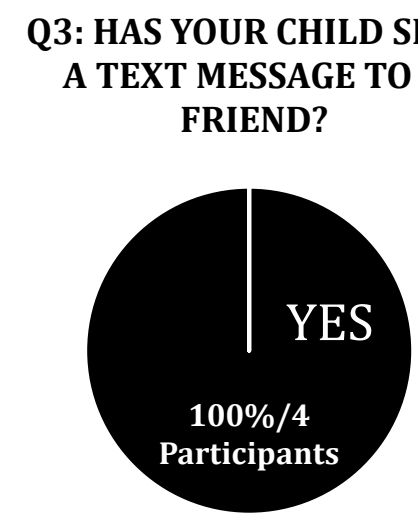
15B. Post Survey for Parents



15C. Pre Survey Participants



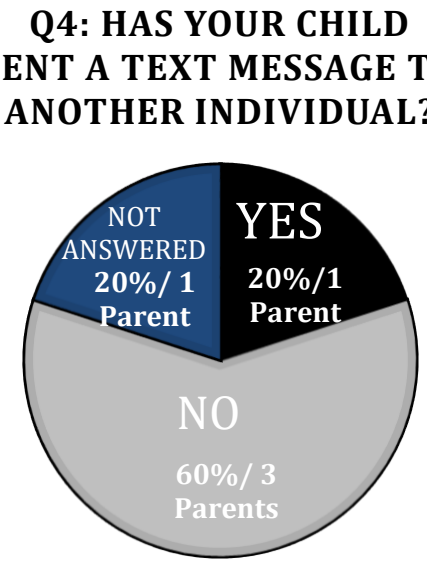
15D. Post Survey Participants



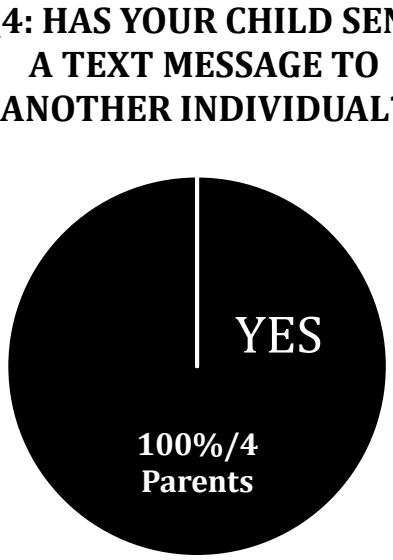
Question 4: Have (Has your child) you sent a text to another individual? When completing the pre-assessment survey, 20% of the parents (one parent) answered yes, 60% (three parents) selected no, and 20% (one parent) did not answer (See Figure 16 A-D). On the post-assessment survey, 100% of the parents (four parents) selected yes. Prior to taking part in the study, 40% of the participants (two participants) answered yes to question four on the pre-assessment survey and 60% (three participants) answered no. Following completion of the study, 100% of participants (four participants) answered yes.

Figure 16.
Question Four Answers on Pre and Post Surveys for Parents and Participants

16A. Pre Survey for Parents

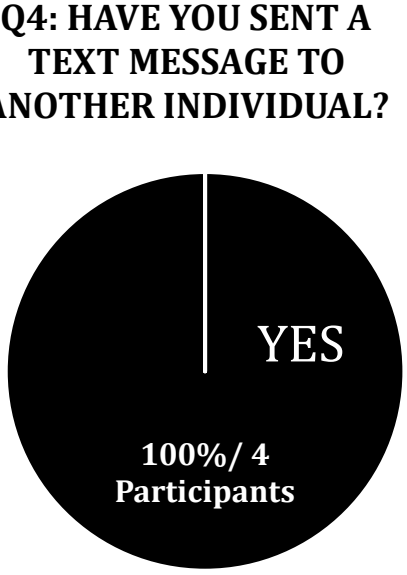


16B. Post Survey for Parents



16C. Pre Survey for Participants

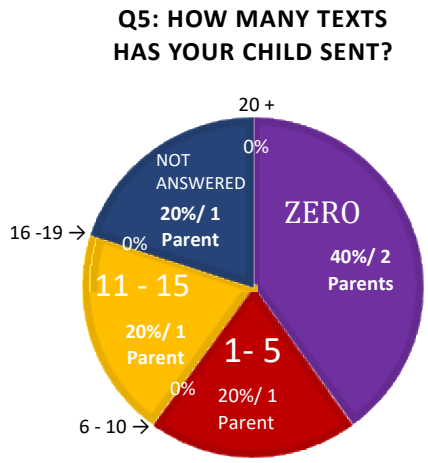
16D. Post Survey for Participants



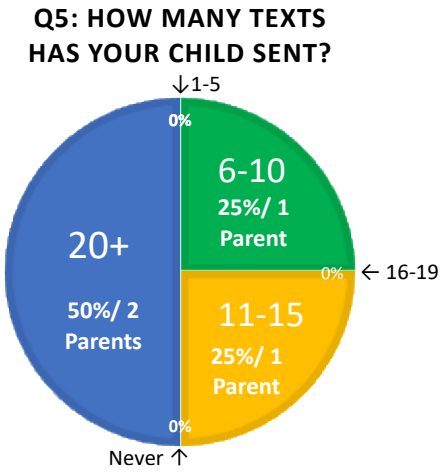
Question 5: How many texts (has your child) have you sent? In the pre-assessment survey, 40% of parents (two parents) said that their child had never sent a text, 20% (one parent) reported their child sending between 1-5 texts, 20% (one parent) indicated that their child had sent 11-15 texts, no one selected the answers 16-19 or 20 or more, and 20% of parents (one parent) did not answer (See Figure 17 A-D). For the post assessment, 25% of parents (one parent) reported their child sending between 6-10 texts, 25% (one parent) indicated that their child had sent 11-15 texts, and 50% (two parents) indicated that their child sent 20 or more. Prior to participating in the study, 40% of the participants (two participants) indicated that they had never sent a text, 20% (one participant) reported sending 1-5 texts, 0% sent 6-10 texts, 20% (one participant) selected 11-15, 0% had sent 16-19, and 20% (one participant) reported sending 20 or more texts. On the post-assessment survey, 25% (one participant) reported sending 1-5 texts and 75% of the participants' (three participants) indicated having sent 20 or more texts by the completion of the study.

Figure 17.
Question Five Answers on Pre and Post Surveys for Parents and Participants

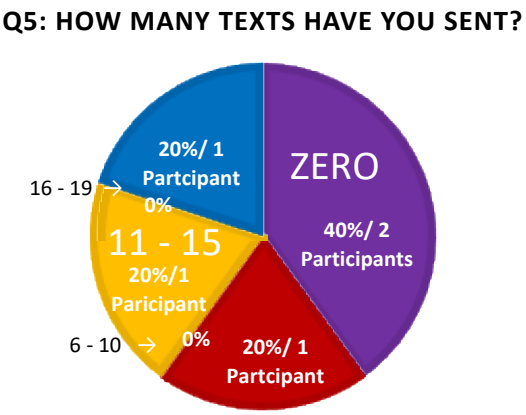
17A. Pre Survey for Parents



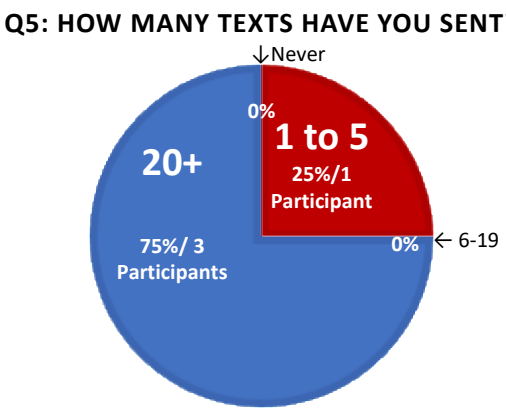
17B. Post Survey for Parents



17C. Pre Survey for Participants



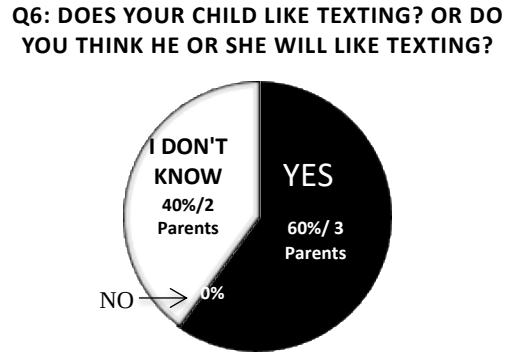
17D. Post Survey for Parents



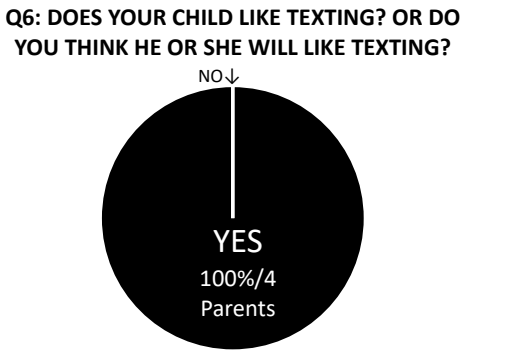
Question 6: Do you (does your child) like texting? Or do you think you (he or she) will like texting? On the pre-assessment survey, 60% of parents (three parents) selected yes, 0% selected no, and 40% (two parents) indicated that they did not know (See Figure 18 A-D). Following intervention, 100% of parents (four parents) selected yes in response to whether their child likes texting. For the pre-assessment participant survey, 80% of the participants (four participants) selected yes, 0% selected no, and 20% of participants (one participant) did not answer. In the post-assessment survey, 75% of participants (three participants) responded yes and 25% (one participant) said yes and no.

Figure 18.
Question Six Answers on Pre and Post Surveys for Parents and Participants

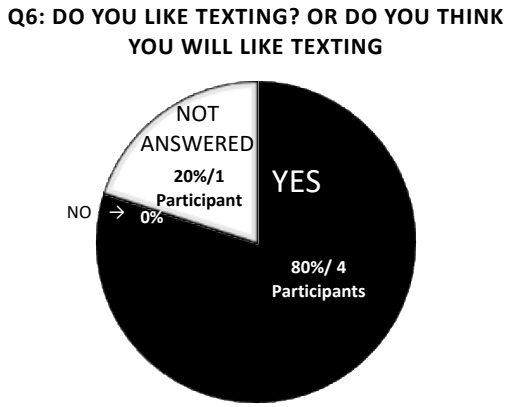
18A. Pre Survey for Parents



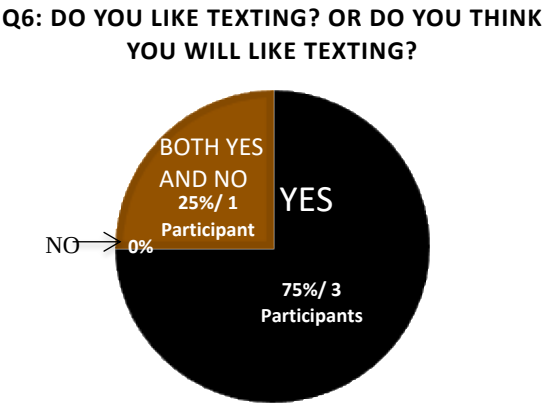
18B. Post Survey for Parents



18C. Pre Survey for Participants



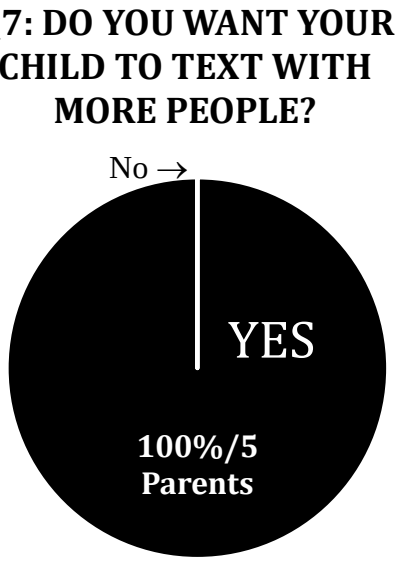
18D. Post Survey for Participants



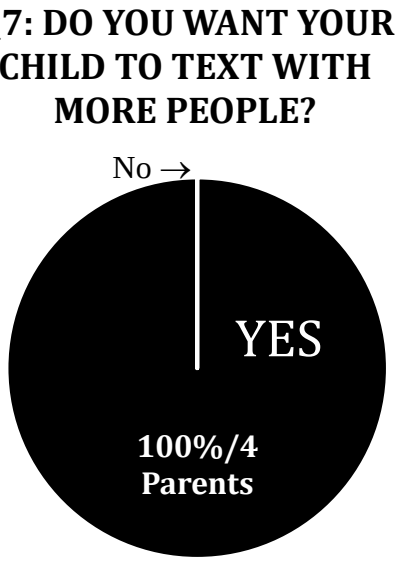
Question 7: Do you want (your child) to text with more people? On the pre-assessment and post-assessment survey, 100% of parents (five parents and four parents respectively) selected yes in response to whether they would like their child to text with more people (See Figure 19 A-D). The participants were also in 100% agreement on both the pre and post assessment (five participants and four participants respectfully) that they would like to text more people.

Figure 19.
Question Seven Answers on Pre and Post Surveys for Parents and Participants

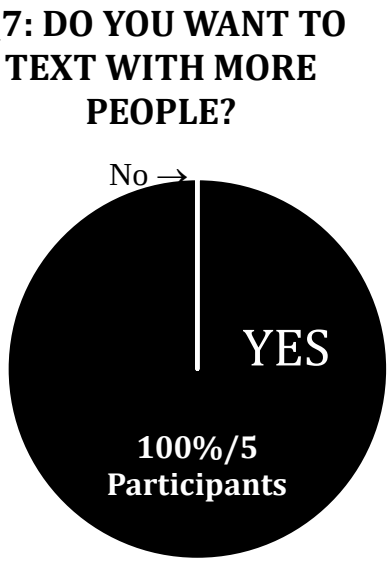
19A. Pre Survey for Parents



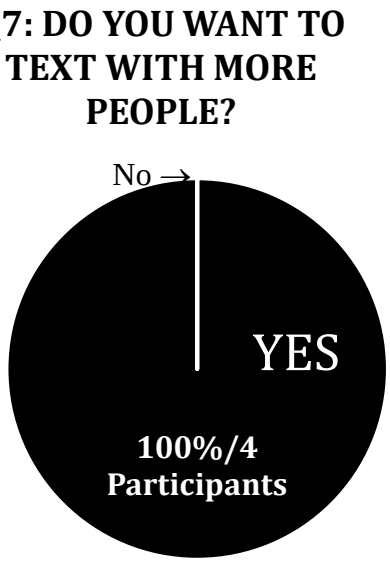
19B. Post Survey for Parents



19C. Pre Survey for Participants



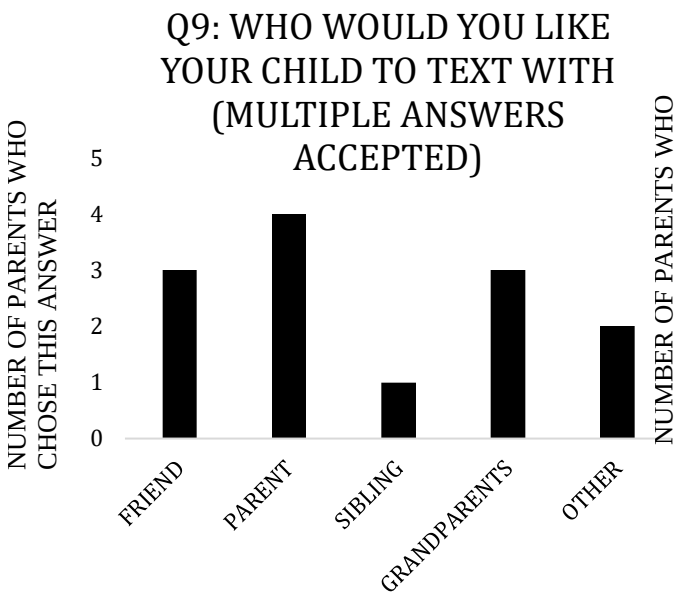
19D. Post Survey for Participants



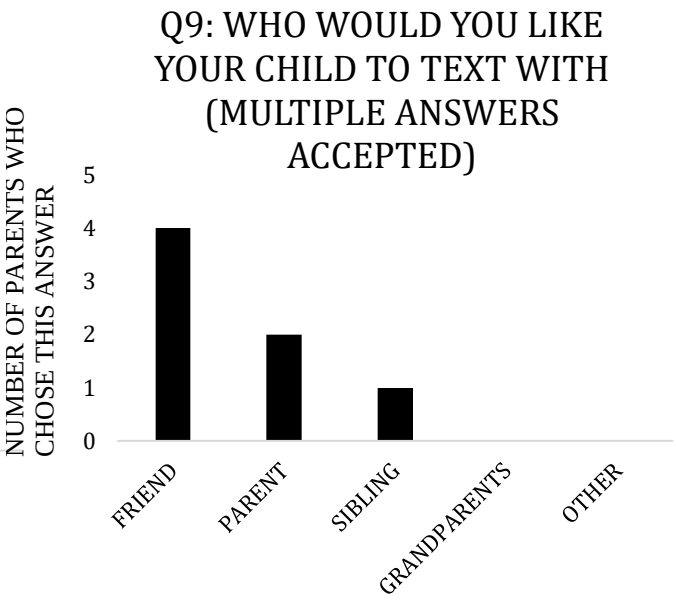
Question 8: Who would you like (your child) to text with (Fill in the blank: multiple answers accepted)? When completing the pre-assessment survey, four of the parents indicated that they wanted their child to be able to text with them, three selected friends, three selected relatives, one selected siblings, and two also selected other acquaintances (therapist, family friend, etc.) (See Figure 20 A-D). On the post-assessment survey, three of the parents selected themselves, four of parents chose friends, and 1 picked siblings. Prior to the intervention, all five participants indicated an interest in texting with friends, one also wrote down parents, and one selected an adult acquaintance. On the post-assessment survey, all four participants who completed the survey indicated a continued interest in texting with friends.

Figure 20.
Question Eight Answers on Pre and Post Surveys for Parents and Participants

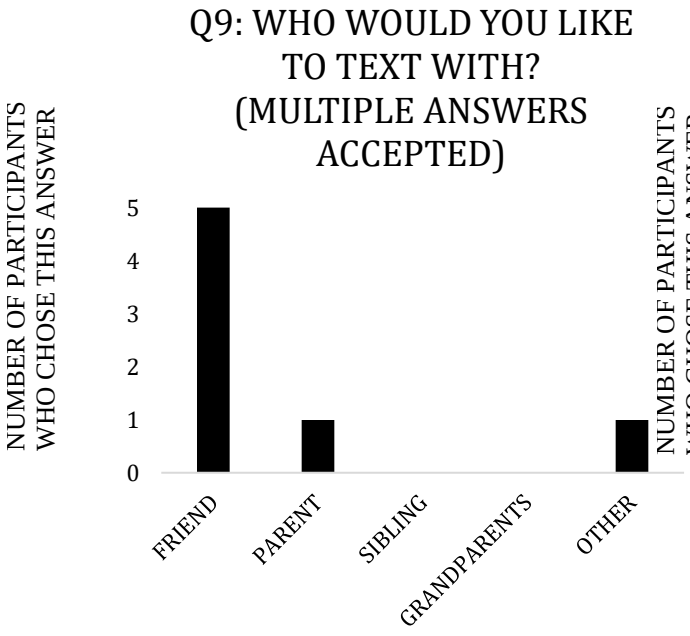
20A. Pre Survey for Parents



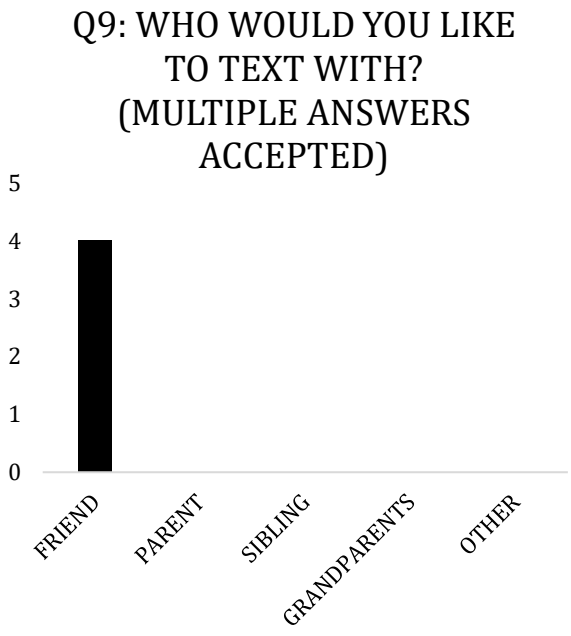
20B. Post Survey for Parents



20C. Pre Survey for Participants



20. Post Survey for Participants



Social Validity of the texting conversations

Thirteen young adults, naïve to the purpose of the study, scored eight conversations (four conversations randomly selected from baseline, interspersed with four intervention conversations) for each dyad as being appropriate or inappropriate. All thirteen young adults (100%) scored the four intervention conversations (100%) as appropriate. Seven of them (54%) also scored 100% of the baseline sessions as inappropriate. Five of the students (38%) scored one baseline conversation as appropriate and one student (8%) scored two baseline conversations as appropriate.

Chapter 8

Discussion

In this study, a non-concurrent multiple baseline design across dyads was employed to examine the effect of teaching five children and adolescents with ASD how to have a back and forth conversation through text. Overall, the findings provided support for all five hypotheses that were proposed at the start of the study. The hypotheses are examined in depth below.

Hypothesis 1: Acquisition of Texting Steps

There were two main hypotheses in the study. The first one proposed that participants, who were not able to complete all the texting steps required to send a text during baseline, would be able to meet the criterion of consistently completing all seven steps independently across two sessions following the texting step intervention. Levi was the only participant who was not able to complete all the texting steps consistently during baseline. The results showed that following intervention, Levi consistently demonstrated all seven of the steps required to send a text. He was able to meet both the texting steps criterion and the fading criterion with regards to these skills. In addition, this skill continued to be maintained during the other phases of the study (i.e. texting content intervention, fading, weekly texts).

Levi's acquisition of the texting step skills may be due to the fact that a total task chaining procedure was implemented (Helbig, Wright, Derieux, Schrieber, & Radley, 2019; Snell & Brown, 2006; Stokes, Cameron, Dorsey, & Fleming, 2004; Veazey, Valentino, Low, McElroy, & LeBlanc, 2016). This type of chaining procedure is beneficial to use when teaching a multi-step task analysis, in which some of the skills already exist in the child's repertoire (Helbig, Wright, Derieux, Schrieber, & Radlley, 2019; Snell & Brown, 2006). In previous research, total task chaining has been utilized when teaching multi-step tasks such as personal

hygiene (Stokes, Cameron, Dorsey, & Fleming, 2004; Veazey, Valentino, Low, McElroy, & LeBlanc, 2016). Specifically, this chaining procedure best met Levi's needs, since he was consistently performing two of the seven steps for sending a text during baseline. Therefore, using this procedure allowed Levi more independence since the experimenter was only providing prompting for certain steps not yet in his repertoire. Using the total-task chaining procedure also allowed Levi to practice all seven steps during each session (Snell & Brown, 2006). In addition, completion of the full sequence during every session allowed for Levi to gain the reinforcement of sending a text and in turn getting a response each time he practiced completing the task analysis (Snell & Brown, 2006). This may have been a very strong reinforcer for Levi since in his pre-assessment survey he specifically asked to text with his friend Mick.

Further support for Levi's acquisition of the skill may have been due to using the texting guidebook as a visual aid to teach the skill (Quil, 1995). Children and adolescents with ASD have been described as visual learners (Quil, 1995). In addition, promising results have been seen in the past when a visual teaching medium was employed while teaching skills to individuals with ASD (Brodhead, Kim, Rispoli, Sipila, & Bak, 2019; Knight, Sartini, Spriggs, 2014; Mechling & Gustafson, 2008). In the current study, the steps required to send a text were presented visually in the form of pictures along with text indicating each action that needed to be taken (i.e. "press this button"; See appendix A1). There was also a high degree of visual matching between the pictures presented in the manual and the skill being taught on the phone. This was because the manual contained pictures of the experimenter completing each step on an identical phone to the one the participant was currently using. The pictorial presentation of the steps in the guidebook was also structured to be similar to that of a visual activity schedule, which has been widely regarded by the literature as a strong intervention for teaching skills to

children with ASD (Knight, Sartini, Spriggs, 2014; Mechling & Gustafson, 2008; McClannahan & Krantz, 1999). A visual activity schedule is typically made up of a series of pictures or words that outlines the steps required to complete a sequence of behaviors (i.e. washing your hands, making a meal, etc.; McClannahan & Krantz, 1999).

Hypothesis 2: Acquisition of Appropriate Texting Content

The second primary hypothesis was that all five participants, three dyads, would increase their percentage of appropriate text content following intervention to 100% across two consecutive opportunities and that this skill would be maintained after fading at 80% or higher. This hypothesis was supported by the results, with all five participants meeting both the texting content criterion and the fading criterion. In addition, all the participants generalized this skill across texting partners and maintained the skill during the weekly texts and at the one-month follow up. Lastly, all three dyads increased the number of novel topics discussed (topics not discussed in the sample conversations) during intervention compared to baseline. These strong results may have occurred for several reasons including the presentation of the texting content examples visually and the use of a multiple exemplar training procedure (two different conversations were presented).

As previously stated, children and adolescents with ASD have been successful when learning skills through visual mediums, such as visual activity schedules (Knight, Sartini, Spriggs, 2014; Mechling & Gustafson, 2008; McClannahan & Krantz, 1999). In this current study, similar to the texting steps intervention, the sample conversations were also presented visually through pictures of a phone with the conversation displayed on it, as it naturally appears when engaging in a text conversation (See Appendix A2). In the guidebook, each picture was on a separate page and only showed one to four lines of text. This was done to help reduce the

amount of information that needed to be processed at a single time. Brodhead, Kim, Rispoli, Sipila, & Bak (2019) presented their visual script in a similar manner. In their study, targeted at teaching conversational speech over video-chat to three children with ASD, they visually presented the script by placing a single line of speech on each page of their conversational binders.

In addition to presenting the conversations visually, a multiple exemplar training (MET) approach was employed in which two different sample conversations were used. The research in the field provides support for this approach when targeting verbal behavior (Brodhead, Kim, Rispoli, Sipila, & Bak, 2019; Charlop, Gilmore, Chang, 2008; LaFrance & Tarbox, 2019). LaFrance & Tarbox (2019) suggest that MET is a strong intervention to use when the skill being taught consistently results in the same consequence, even when generalizing the skill. This was true of the current study since the consequence remained the same (i.e. receiving a response from their conversation partner) even when the conversation partners (from peer to parent or sibling) and the setting changed (afterschool center to home environment).

In the present study, the conversations were presented as examples, rather than as a set script to follow. One way this was done was that during each session, the participants in each dyad were asked to read different sample conversations (i.e. First session: Veronica has book A, Anna has book B; second session: Veronica has book B, Anna has book A). This act of interspersing the books may have been one reason the participants produced high levels of novel topic discussion, since MET has been shown in research to encourage response variation (Brodhead, Kim, Rispoli, Sipila, & Bak, 2019; Charlop, Gilmore, & Chang, 2008). This is important because children with ASD perseverate on particular topics and therefore conversations tend to revolve primarily around these interests (APA, 2013; Nadig, Lee, Singh,

Bosshart, Ozonoff, 2010). The focus on preservative topics was seen during baseline in this study. In particular the number of different topics discussed in baseline was low for all three dyads and centered around obsessive topics: food, Bruno Mars, a game on the phone, and a television show. These obsessive topics discussed were not shared interests of both participants in the dyads, leading to more one-sided conversations (Nadig, Lee, Singh, Bosshart, Ozonoff, 2010). Therefore, the finding that all three dyads increased their novel topic discussion from baseline to intervention is very promising.

The texting intervention was also successfully faded for two of the dyads using a full fade approach (the books and verbal prompting were faded in one session). When this procedure was used with Levi, his texting content levels returned to baseline. Employing booster sessions quickly brought his content back up to previous levels. Therefore, when fading a second time, a more gradual fading procedure needed to be employed. The second fading procedure used with Levi was a gradual script fading procedure, in which the varied script was faded in one word increments starting with the last word of each phrase over four conversations (Blanco & Charlop, 2015; Grosberg & Charlop, 2017; McClannahan & Krantz, 2005). Following the gradual fading intervention, Levi met the text content fading criterion and then continued to maintain the skill during his weekly text conversations and generalization probes. One reason the gradual fading procedure was successful could be that it was better matched to Levi's needs. Levi was the lowest functioning participant included in the study, and he demonstrated high levels of prompt dependence. Therefore, an immediate removal or all prompts may not have best met his needs. Employing a more gradual fading procedure allowed for the prompting to be removed in smaller increments. It is also important to note that despite needing two different fading procedures, Levi's number of novel topics discussed during intervention compared to baseline increased

from one to fifteen topics (the topics presented in the guidebook or included in any of the prompts were not counted). This suggests less reliance on the script and verbal prompting in order to produce novel content. Other studies that utilized a gradual script fading procedure had similar findings in terms of production of unscripted responses (Brown, Krantz, McClannahan, & Poulson, 2008; Grosberg & Charlop, 2017)

Hypothesis 3: Generalization Across Texting Partners

The third hypothesis was that all five participants would generalize the texting steps and content skills from their peer to their parent, and for one participant, to his sibling as well. The results provided support for this hypothesis, since all five children generalized both skills to their generalization texting partner following intervention, and generalization continued to be maintained following the weekly texting probes and in follow-up. One reason that all five children successfully generalized the skills to their texting partners could be due to the use of a multiple exemplar training procedure (Brodhead, Kim, Rispoli, Sipila, & Bak, 2019; Charlop-Christy & Kelso, 2003; Charlop, Gilmore, Chang, 2008; LaFrance & Tarbox, 2019; Marzullo-Kerth, Reeve, Reeve, Townsend, 2011; Pollard, Betz, Higbee, 2012).

As stated previously, this study employed a multiple exemplar training procedure, which has been associated with strong generalization results in previous research (Brodhead, Kim, Rispoli, Sipila, & Bak, 2019; Charlop-Christy & Kelso, 2003; Charlop, Gilmore, Chang, 2008; LaFrance & Tarbox, 2019; Marzullo-Kerth, Reeve, Reeve, Townsend, 2011; Pollard, Betz, Higbee, 2012). For example, Brodhead, Kim, Rispoli, Sipila, & Bak (2019) found that after utilizing a multiple exemplar approach in terms of the scripts, all three participants in their video-chat study generalized their social conversational skills from a familiar adult to two unfamiliar adults. Similarly, Charlop-Christy & Kelso (2003) also demonstrated strong generalization

results for all three children in their study when utilizing multiple conversational script variations for each child. In their study, all three children generalized across conversational partners, topics, and settings. Both of these studies, similar to the present one, demonstrated the potential of utilizing multiple versions of a script during training to promote strong generalization of the skills (Brodhead, Kim, Rispoli, Sipila, & Bak, 2019; Charlop-Christy & Kelso, 2003).

Additionally, teaching in the natural environment and fading out all non-natural stimuli (i.e. the guidebooks, the prompting, and the experimenter's presence) may have been beneficial in promoting generalization (Brown, Krantz, McClannahan, & Poulson, 2008; Pollard, Betz, Higbee, 2012). Brown, Krantz, McClannahan, & Poulson (2008) utilized a similar gradual script fading procedure in their study teaching three children and adolescents to converse. One of the primary goals of this study was to examine whether conversational speech would occur in a natural setting in the absence of any non-natural stimuli (i.e. script and prompting). The findings of their study confirmed their hypothesis that the behavior was able to be generalized from the classroom setting into three general stores, after fading all non-natural stimuli (Brown, Krantz, McClannahan, & Poulson, 2008).

The motivation for texting with both their peers and family members (generalization partners) may have increased in value during the time of the study. This is because social distancing orders had been put in place by the government which prevented the children from attending school and afterschool activities while the study was occurring. These social distancing requirements may have acted as an establishing operation (EO), that in turn increased the value of communicating with friends and family members through text (Michael, 2000).

Hypothesis 4: Maintenance of the Skills

The fourth hypothesis was that the texting steps and texting content skills would be maintained at the one month follow up. This hypothesis was supported by the findings that the participants demonstrated maintenance of the skills during their one month follow up sessions. One reason for the high rate of maintenance at the one month follow-ups could be due to how the procedure was faded to a level that replicated the natural texting environment (Bergstrom, Najdowski & Tarbox, 2012; Peterson, 2009). The strong reinforcing value of texting, especially in a time of social distancing, could also be a factor (Veltkamp, Aarts & Custers, 2009). This motivation to communicate in turn could have played a role in maintenance, since children are more likely to continue to practice a skill overtime that they enjoy (Ferguson, Gillis, Sevlever, 2013; Garcia-Mas, et al. 2010).

One key focus of the study was on replicating the texting environment and encouraging independent texting. This meant that not only were the texting guidebooks and the prompting faded, but the experimenter was faded out as well. Sessions were also conducted in the natural home environment. Additionally, during the weekly texting phase, the participants decided together when they wanted to text and at what point to end the conversation. Fading out the experimenter and having the children text from home were important components of the study that may have helped promote maintenance. Both components created a texting environment that the child would naturally experience in the future (Bergstrom, Najdowski & Tarbox, 2012; Peterson, 2009)

In addition, motivation is another important component essential for teaching children with ASD to communicate and maintain behaviors (Koegal & Koegal, 1995). One way to increase motivation for children with ASD involves providing the child with choices in terms of stimuli used (Elliott & Dillenburger, 2016; Vismara & Lyons, 2007). In the current study, the

participants had the opportunity to choose both the primary peers they wished to communicate with, as well as their generalization texting partners. Providing the children with this choice may have increased their motivation to talk to their peers through text messaging during and following the study.

Lastly, the fact that the children were not able to attend school or see each other due to the extended stay at home order may also have increased the value of texting with their peer (Veltkamp, Aarts & Custers, 2009). For example, natural reinforcers such as positive peer responses to verbal communication, play a role in maintaining social conversational behaviors (Loftin, Odom, & Lantz, 2007). Since the stay at home mandate placed a restriction on face-to-face communication with peers, an increased value may have been placed on texting, as a means for obtaining the same social reinforcement. This in turn could have impacted maintenance of the skill over time (Michael, 2000).

Hypothesis 5: Transfer of Text Content Skills into FaceTime® Probes

The fifth hypothesis concerned the ancillary data of the verbal content discussed during the FaceTime® probes. The experimenter predicted that teaching the children to have a back and forth conversation through text would have an ancillary effect on the back and forth nature of the FaceTime® probes. In particular, the experimenter predicted that the percentage of appropriate verbal content during the FaceTime® probes, taken following the texting intervention and during follow-up, would be higher than the percentage of appropriate content in the probes taken prior to the texting intervention. This hypothesis was supported by the data of all three dyads. One reason this transfer of content skills may have occurred could be due to the similarity of the content discussed over text and verbally (i.e. shared topics of interest, asking questions, responding to questions, etc.). Another explanation for this ancillary effect could be due to the

fact that following the text exchanges, the children began to learn more information about each other and strengthened their relationships, which in turn provided more content to discuss during the FaceTime® probes taken after the texting intervention and during follow-up.

One reason these findings may have occurred is due to the similarity of the content discussed through texts and verbal exchanges. Specifically, both types of conversations have a similar format: some type of greeting at the beginning and end, discussion of shared topics, asking questions, answering questions, etc. Therefore, since the texting content intervention targeted these common features, it is not surprising that an increase would also be seen in the FaceTime® probe content following the texting intervention.

In addition, through the texting intervention and fading session, the dyads learned information about each other and developed friendships that may have aided in providing content for the FaceTime® probes. One child even stated, through a text message to her peer, that the peer "was her best friend." Having an opportunity to first develop a relationship through text may have in turn allowed for an easier transition to face-to face communication, which is more dependent on the deficits children with ASD present, such as tone of voice, slower processing speed, eye-contact, etc. (Benford & Standen, 2009; Burke, Kraut, & Williams, 2010; van der Aa, Pollmann, Plaat, & van der Gagg, 2016; Glenwright & Agbayewa, 2011).

Importance and Relevance of These Findings to the Field of both ASD and Child and Adolescent Development Research and Practice

These findings are important to both the fields of ASD research and practice, and child and adolescent development. One reason is that this study provides the first support for the theory that children and adolescents with ASD can learn how to text. Particularly, in terms of acquiring the steps needed to send and receive texts and producing the appropriate content

required to maintain a back and forth conversation using this medium, while communicating with multiple communication partners (both peers and family members). In addition, the ancillary data suggests that some of the communication skills practiced through text messaging may even transfer into verbal face-to-face interactions. These findings are important since social communication is a significant deficit for children with ASD (APA, 2013), and this deficit has made it difficult for these individuals to form and maintain friendships. Teaching children and adolescents with ASD to text may be a way to practice social conversing while communicating using a medium that best meets their strengths (visual processing) and relies less on their deficits (tone of voice, eye contact, etc.; Benford & Standen, 2009; Burke, Kraut, & Williams, 2010; van der Aa, Pollmann, Plaat, & van der Gagg, 2016; Glenwright & Agbayewa, 2011; Quil, 1995). Additionally, since text messaging has become a popular form of communication among typically developing peers, teaching children and adolescents with ASD to text could help to expand their social networks and create and maintain new friendships (Pew, 2015, 2018).

In particular, the answers provided on the social validity surveys provide additional information concerning the practical and societal implications of teaching these children and adolescents to converse through text. This can be specifically seen when examining 1) the lack of texting experience the participants had communicating with peers prior to the study, 2) the interest all of the participants, and the parents, had for learning how to text and 3) the participants' interest in using this form of communication to primarily communicate with their peers.

Specifically, at the beginning of the study and at the end of the study, both the participants and their parents were asked questions about their (or their child's) texting experiences. One set of questions centered on who the participants have had experience texting

with or who they wished to text with in the future. These questions were asked prior to the study to help identify natural texting partners, and after the study to assess whether during the study they were able to communicate with these individuals. In addition, asking the participants and parents if they had any new texting partners in mind that they wanted to text with following completion of the study suggested the potential for continued practice of the skill and its social importance. For the three participants who had prior experience texting, the communication partners in the past had primarily been parents or relatives; only one child had sent a text to a peer prior to the study.

The social validity findings also suggested that the participants had an interest in maintaining this skill and expanding their communication partner network to include more peers following completion of the study. In particular, two of the children wrote down the name of a peer at school that they would like to start texting with on their post-assessment survey. These findings are important since texting has become a primary communication medium for typically developing children and adolescents (Pew, 2015, 2018). For example, children and adolescents report that texting is one of their primary forms of communication and that it is used specifically for forming new friendships and maintaining existing relationships (Pew, 2018). Taken together, this information provides support for the societal importance of teaching this skill to children and adolescents with ASD, as a way to not only support conversational skill development, but also to aid in friendship formation and maintenance.

Additionally, since a developmental milestone of adolescence is characterized by greater autonomy (Spear & Kulbok, 2004), it is not surprising that the participants had an interest in both learning to text and in using this medium to communicate with peers (Blair & Fletcher, 2011; Oksman & Turtiainen, 2004). Learning how to text can provide a sense of independence, since

the child has the ability to choose when they want to text, what they want to say, who they want to text with, and how long they want to talk (Blair & Fletcher, 2011). Since individuals with ASD may experience more restrictions on their independence due to developmental needs (relying on parents for transportation, needing additional assistance completing tasks, etc.; Hume, Loftin, & Lantz, 2009), having the ability to text could provide another way for them to exert some independence.

Strengths

Overall, this study had a number of methodological strengths. For example, a non-concurrent multiple-baseline design across dyads was used to examine the effects of the texting intervention on the acquisition of the texting steps and content skills by the five participants. A non-concurrent multiple-baseline design is a rigorous single subject design that helps to establish experimenter control (Cooper, Heron & Heward, 2007). In this design, the intervention is implemented at different times for each dyad, which allows the experimenter to control for the impact of confounding variables (Cooper, Heron & Heward, 2007). Specifically, this allows the experimenter to determine that change in the dependent variable (the texting behavior) most likely resulted due to changes in the independent variable (the texting intervention) and not because of a third variable (the date of school closures).

This study also demonstrated the potential of teaching the texting steps and content using a visual guidebook. In addition, the potential of employing a multiple exemplar training procedure when presenting the sample conversations is also supported. This is important since this is the first time teaching texting skills to this population has been experimentally examined, so identifying potential teaching procedures that were successful in this study may provide an avenue for future research to continue to explore.

Additionally, this study also provides further support for the potential of using a multiple exemplar approach to encourage varied speech (Brodhead, Kim, Rispoli, Sipila, & Bak, 2019; Charlop, Gilmore, Chang, 2008). All of the dyads increased the number of novel topics (not seen in the guidebooks) discussed during their conversations from one to seven topics in baseline to ten to seventeen topics during and following intervention. The participants' also relied less on obsessive topics when conversing following intervention. This is an important finding and strength of this study, since perseverative speech is a deficit seen in the conversational skills of both children and adolescents with ASD (APA, 2013).

Another strength of the study was that it included both female and male children and adolescents (8-17) of varying functioning levels (mild/moderate- severe ASD symptoms). Fading modifications may need to be used with participants demonstrating more severe symptoms and lower levels of expressive and receptive vocabulary, as was done in this study with Levi. The diversity of the sample is important, since it suggests the potential of using this intervention to teach a wide array of individuals diagnosed with ASD to text. Additionally, even though SES levels varied across participants, all of the participants had access to a phone (either their own or their parents phone) that could be used for both texting and video calls. This demonstrates the accessibility of texting as a means of communication for individuals of various SES levels (Pew, 2019).

Another strength of this study was the strong findings in terms of acquisition, generalization, and maintenance of the skills. In addition to the participants learning to have a back and forth conversation with peers, they also demonstrated generalization of these skills to their parents, and in one case a sibling. The one month follow-up data collected thus far also provides support for the maintenance of this skill.

In addition, a unique component of this study was the level of independence that was provided to the children and adolescents. Not only were the books and the experimenter faded, but the participants learned to text in their natural home environment. During the weekly texts sessions, they were also given the opportunity to decide when they wanted to text (which day and what time), who was going to start the conversation, how long they wanted to text for, and what they wanted to talk about.

Limitations

A limitation of this study was the number of participants. There were only three dyads and one of the three dyads contained a neurotypical college student peer. Therefore, this study needs to be replicated with a larger participant pool of children and adolescents with ASD. In addition, four out of the five participants tested out of intervention one (texting steps). Therefore, the texting steps manual will need to be tested on more individuals with ASD in order to assess its effectiveness as an intervention.

Conclusions and Suggestions for Future Research

This study, as a whole, introduces a new promising avenue for social conversational skill development in children and adolescents with ASD, since text messaging has not previously been experimentally examined. In particular, the findings demonstrate that children and adolescents with varying ASD severity levels (mild/moderate-severe) can learn to have independent back-and-forth conversations with peers and family members (parents and one sibling) about a wide array of topics, and that these skills can be maintained over time.

In addition, the ancillary data from the FaceTime® Probes, taken before and following the texting content intervention, suggests that learning to text may have had a potential transfer effect on the verbal conversational skills of the individuals. Specifically, in this study the

percentage of appropriate verbal content discussed during FaceTime® increased for all five participants in their probes following the texting intervention. This suggests the possibility of a transfer effect of the content skills learned through texting (asking questions, responding to questions, discussing novel topics) to the verbal content discussed during the FaceTime® Probes. This finding proposes that targeting one format of social conversing (texting) among children and adolescents with ASD may also impact other formats of social conversing (verbal conversing), since they are dependent on similar variables (shared focus, turn taking, asking and responding to questions, etc.) In turn, the findings from this study provide a promising new avenue for teaching social conversational skill development among both children and adolescents with ASD that future research can explore and validate.

Future research should replicate this study to confirm these results. In addition, it would be beneficial to also examine expanding the participant pool to include adults with ASD as well. Another avenue for future research to tackle is teaching individuals with ASD to engage in text conversations with multiple people at once, since group chats are common. Teaching proper use of emoji's in texting should also be explored with this population. For individuals with ASD who do not demonstrate the fine-motor skills needed to text, talk-to-text software for texting should be explored. Lastly, teaching children and adolescents to text in other languages would be an interesting avenue for future research.

This study provided the first step in experimentally examining how to teach children and adolescents of varying functioning levels with ASD to text. In addition, the findings, in terms of skill acquisition (of text steps and content), generalization across texting partners (peers to parents and siblings), and maintenance, are promising. The ancillary findings concerning the transfer effect that the texting content intervention may have had on the content discussed during

the verbal FaceTime® probes is another promising finding that should be examined further going forward. Future research should not only replicate this study to confirm these results, but also expand upon it by researching other formats of texting and other CMC mediums that could be beneficial to teach to this population.

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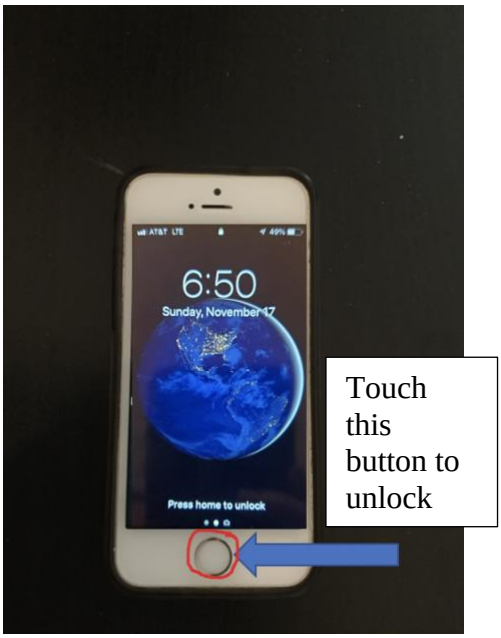
Appendix A

Texting Guidebook

Step 1: Unlock phone

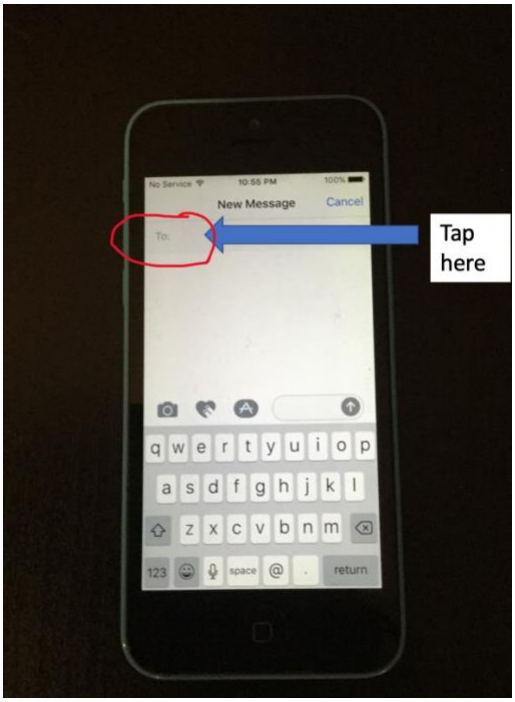


Step 2: Open up your text app

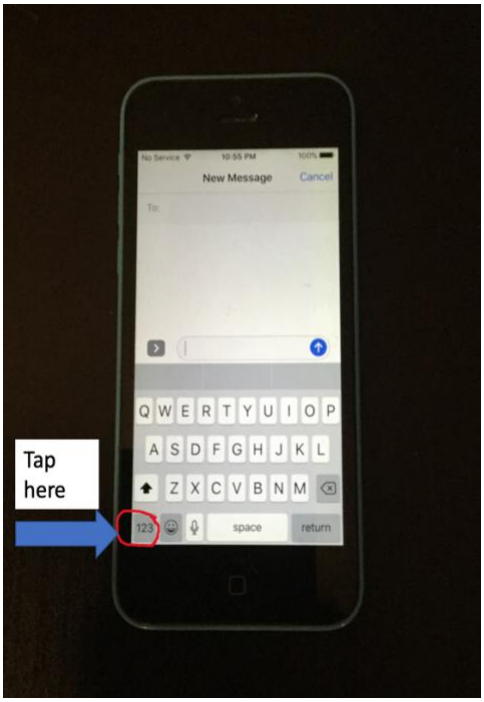
Step 3: Touch the "new message" button

Step 4: Type in your friend's number (Sub-steps A-D)

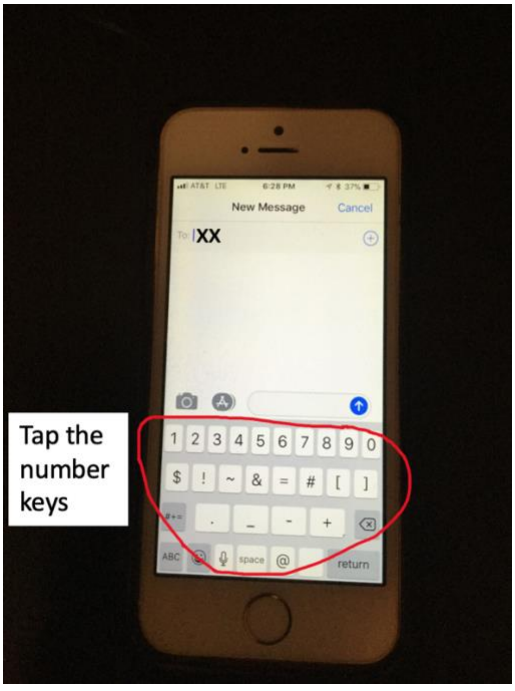
4A.



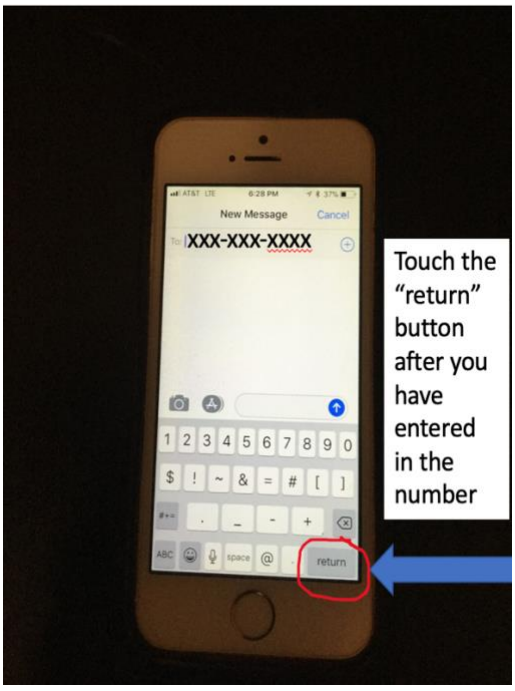
4B.



4C.

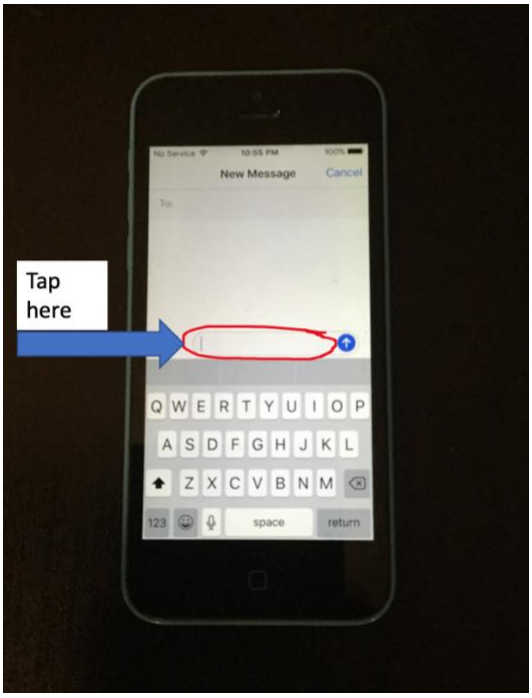


4D.

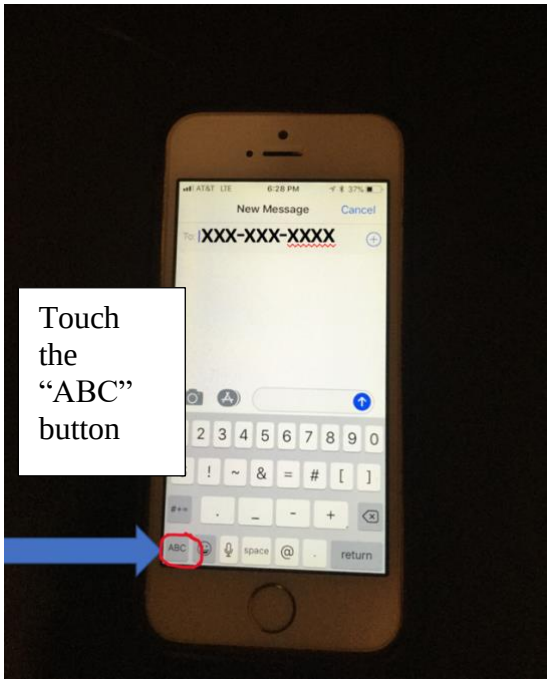


Step 5: Type in message (Sub-steps A-C)

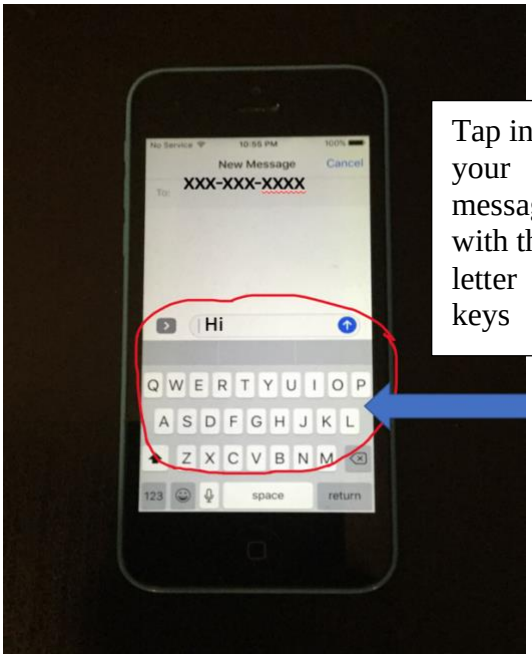
5A.



5B.

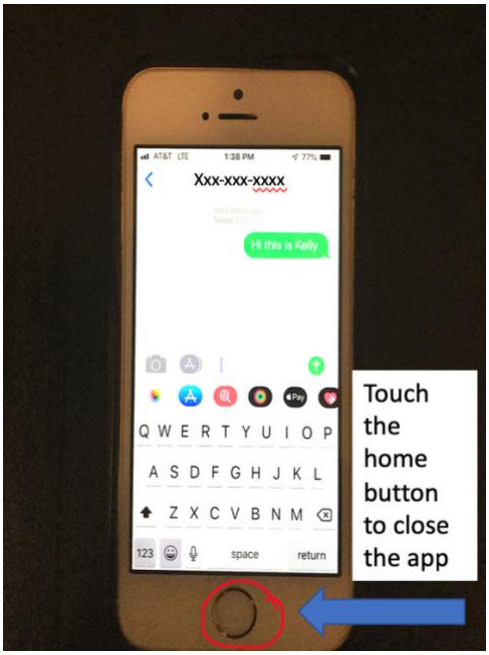


5C.



Step 6. Send the message

Step 7. Close the message app

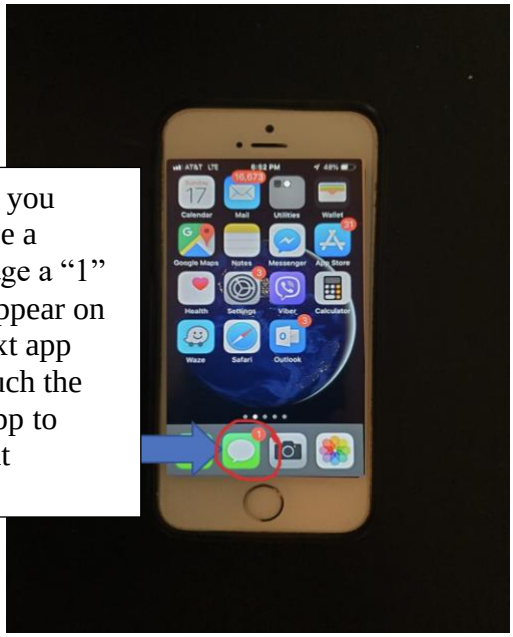


Step 8. Wait for a response

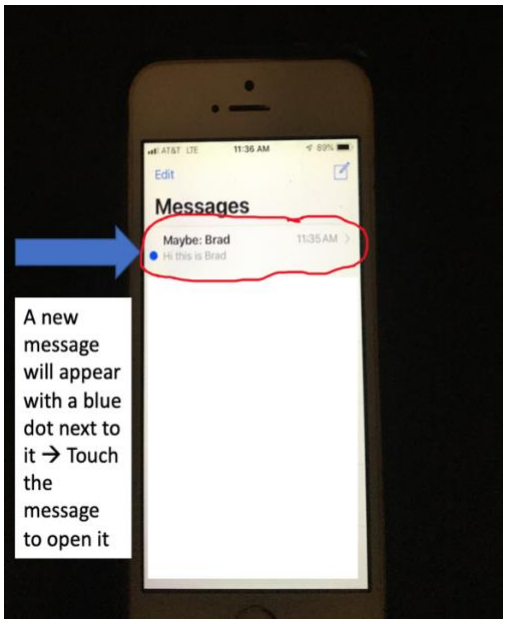
Step 9. Unlock the phone

Step 10: Open text app

When you receive a message a “1” will appear on the text app →Touch the text app to open it

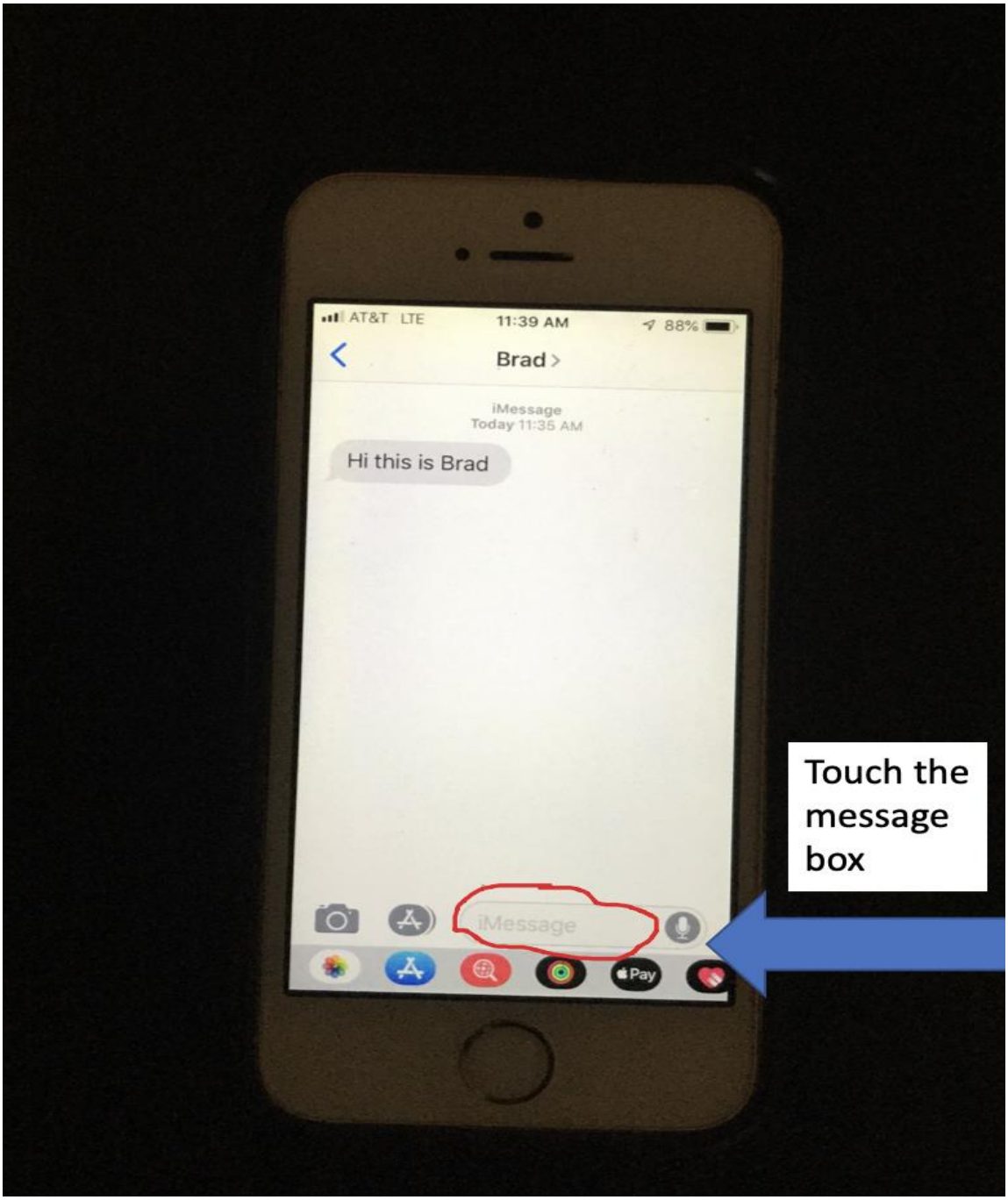


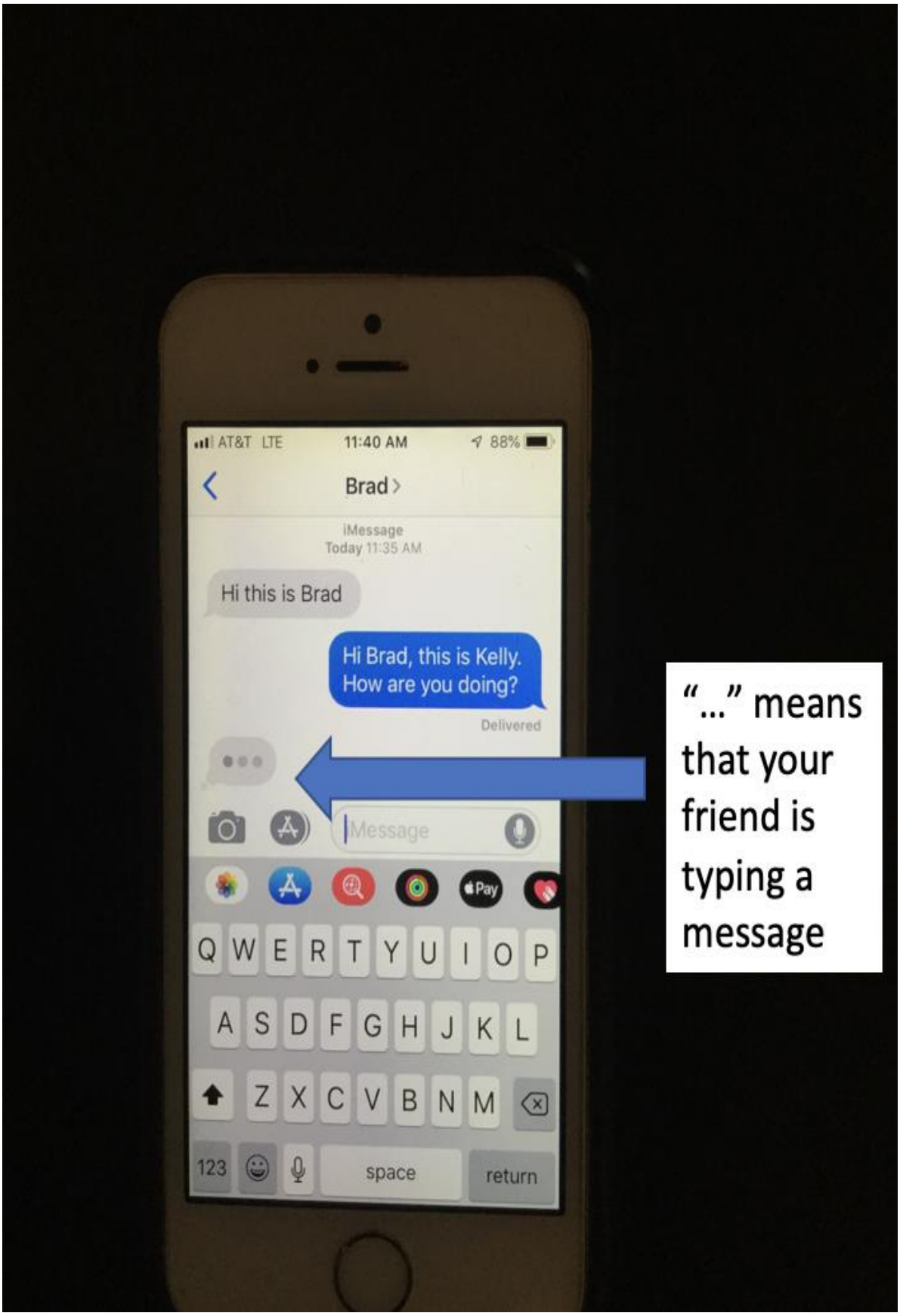
Step 11: Open message

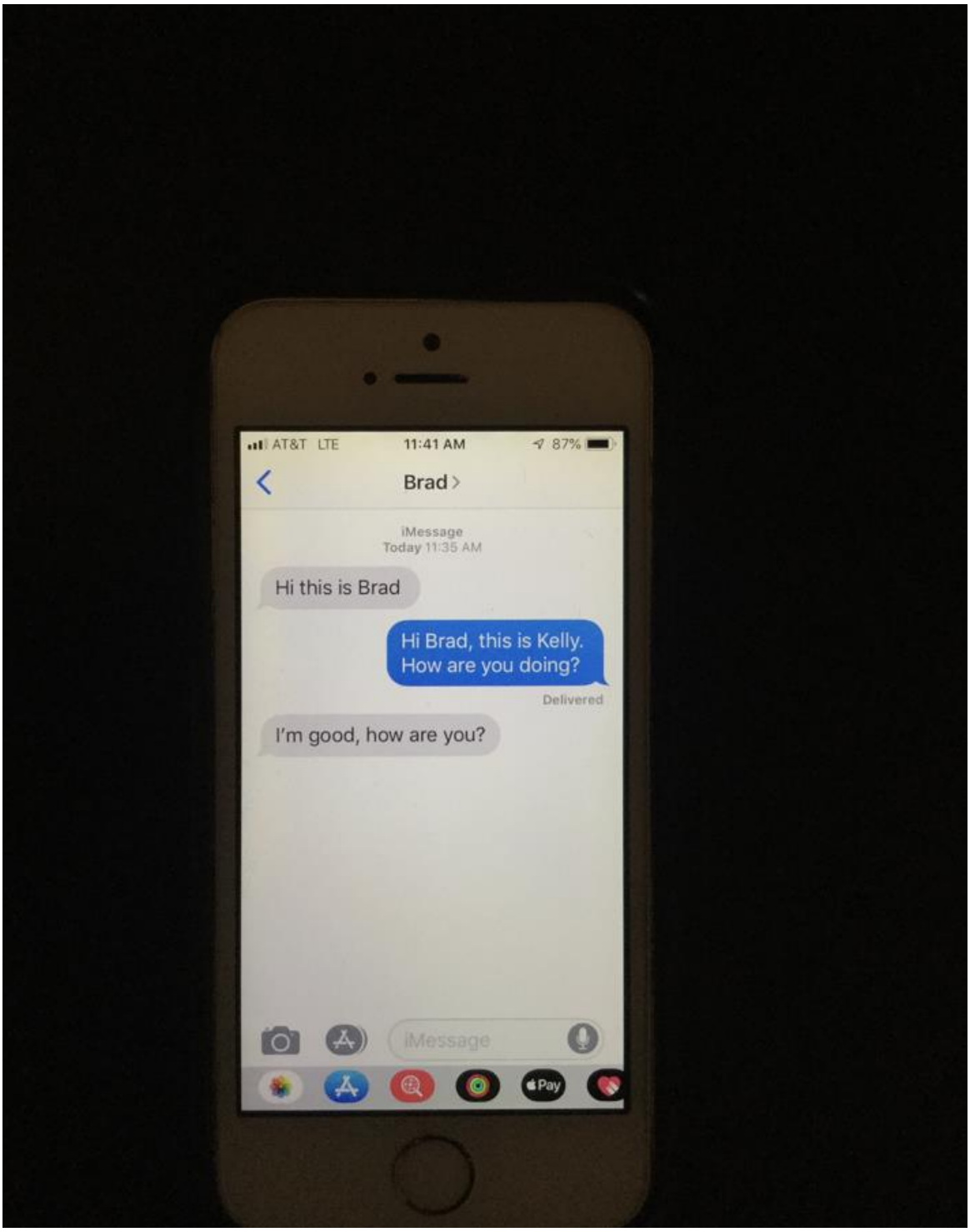


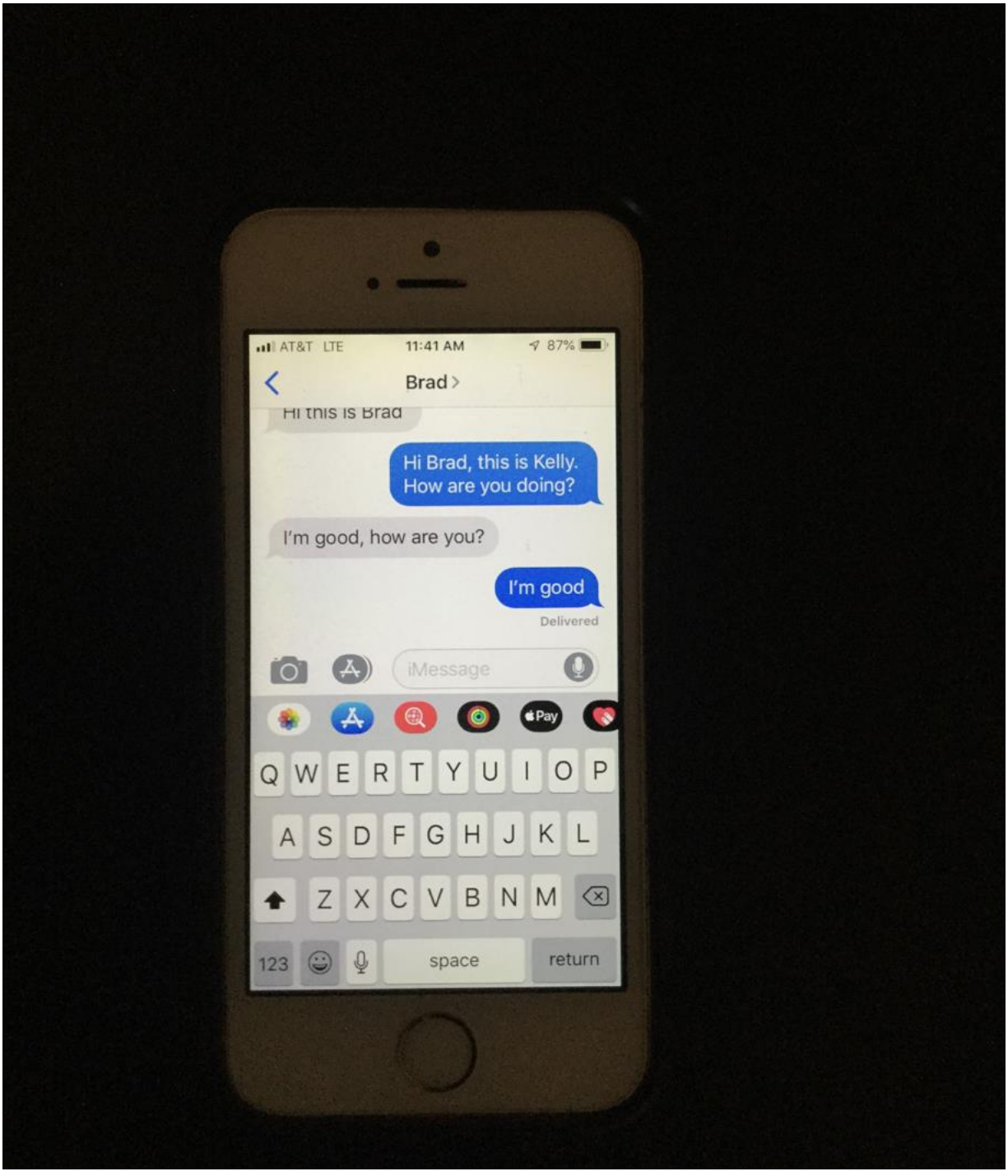
Step 12: Repeat Steps 5 & 6

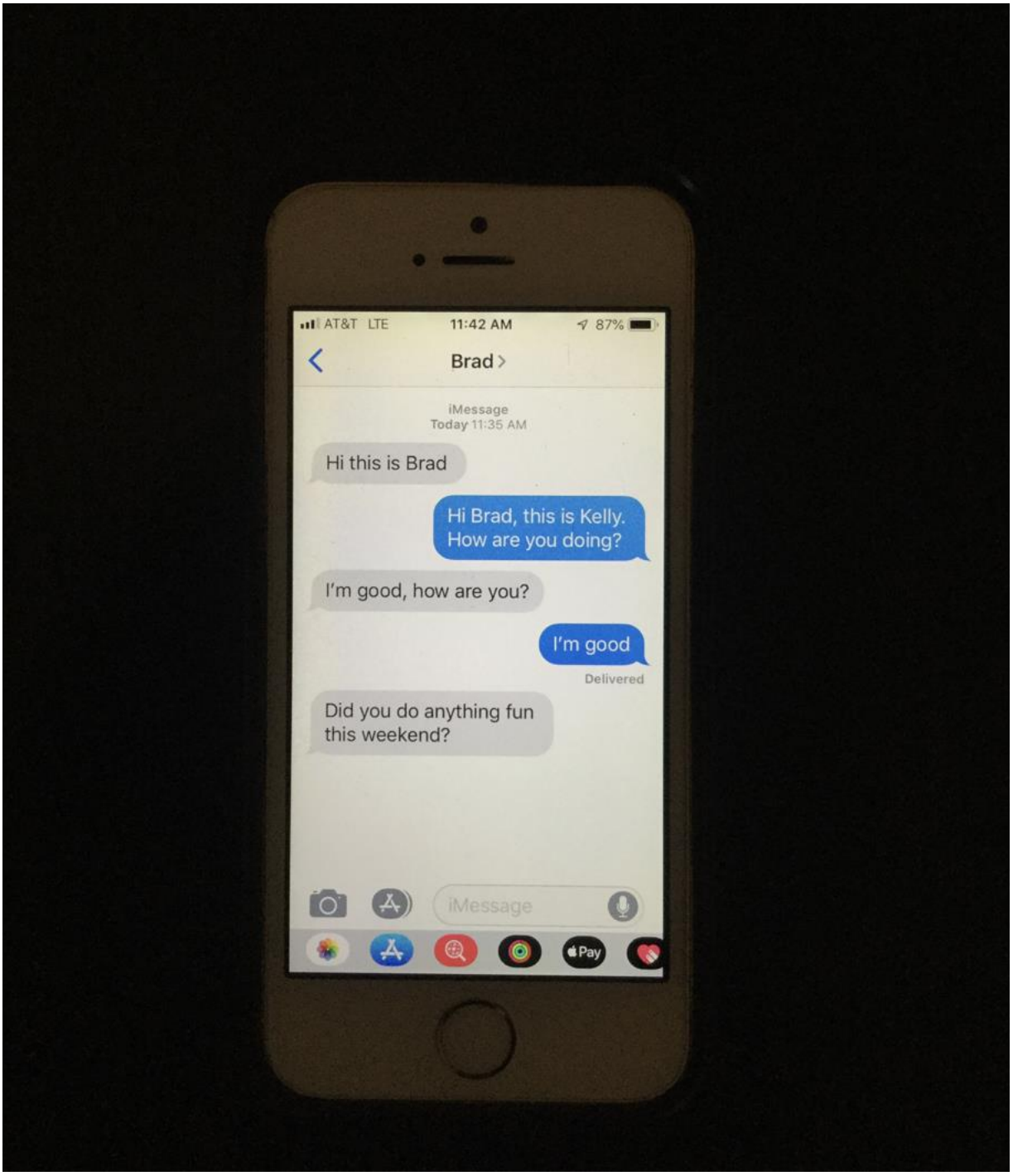
Appendix A2: Sample Conversation

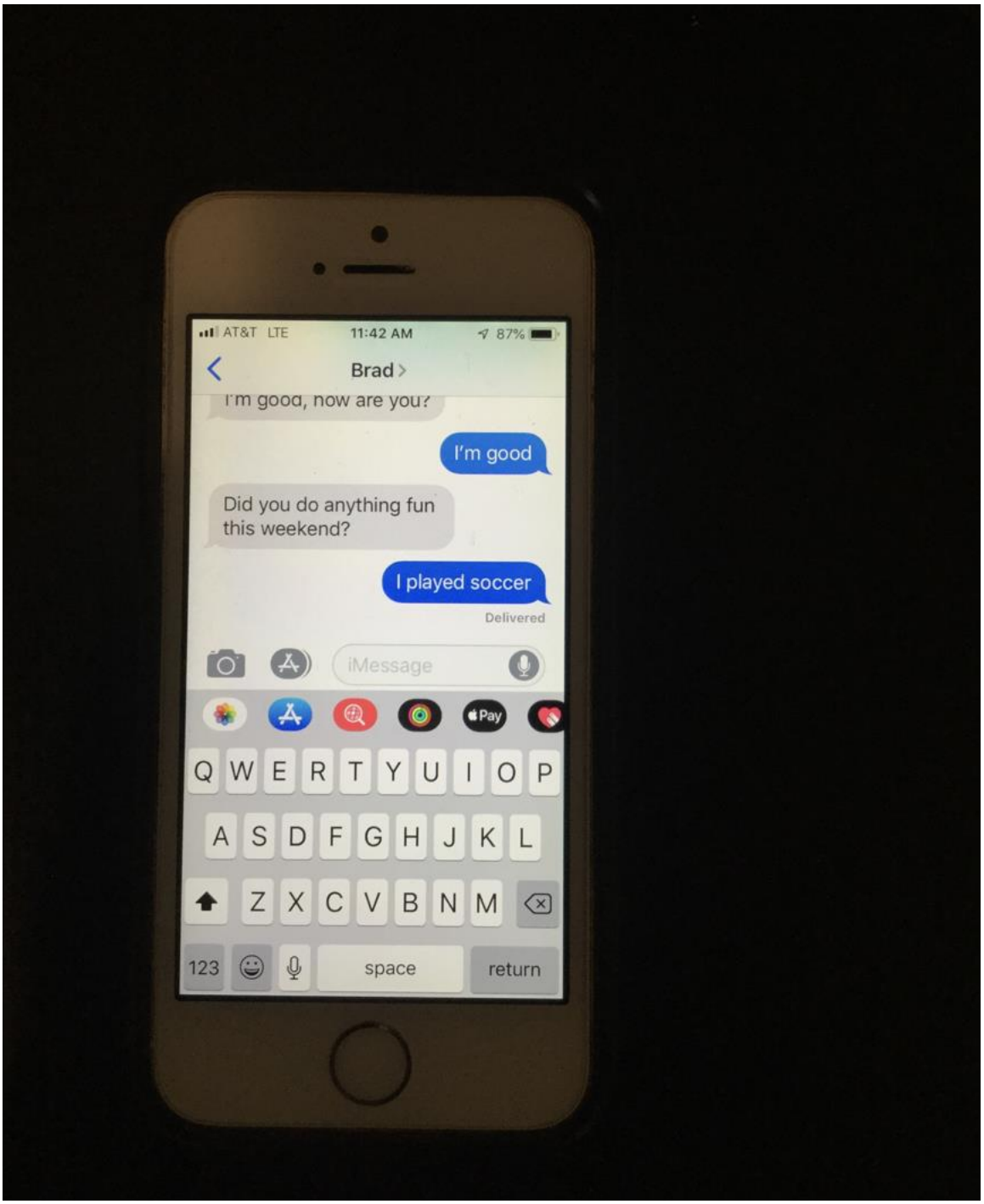


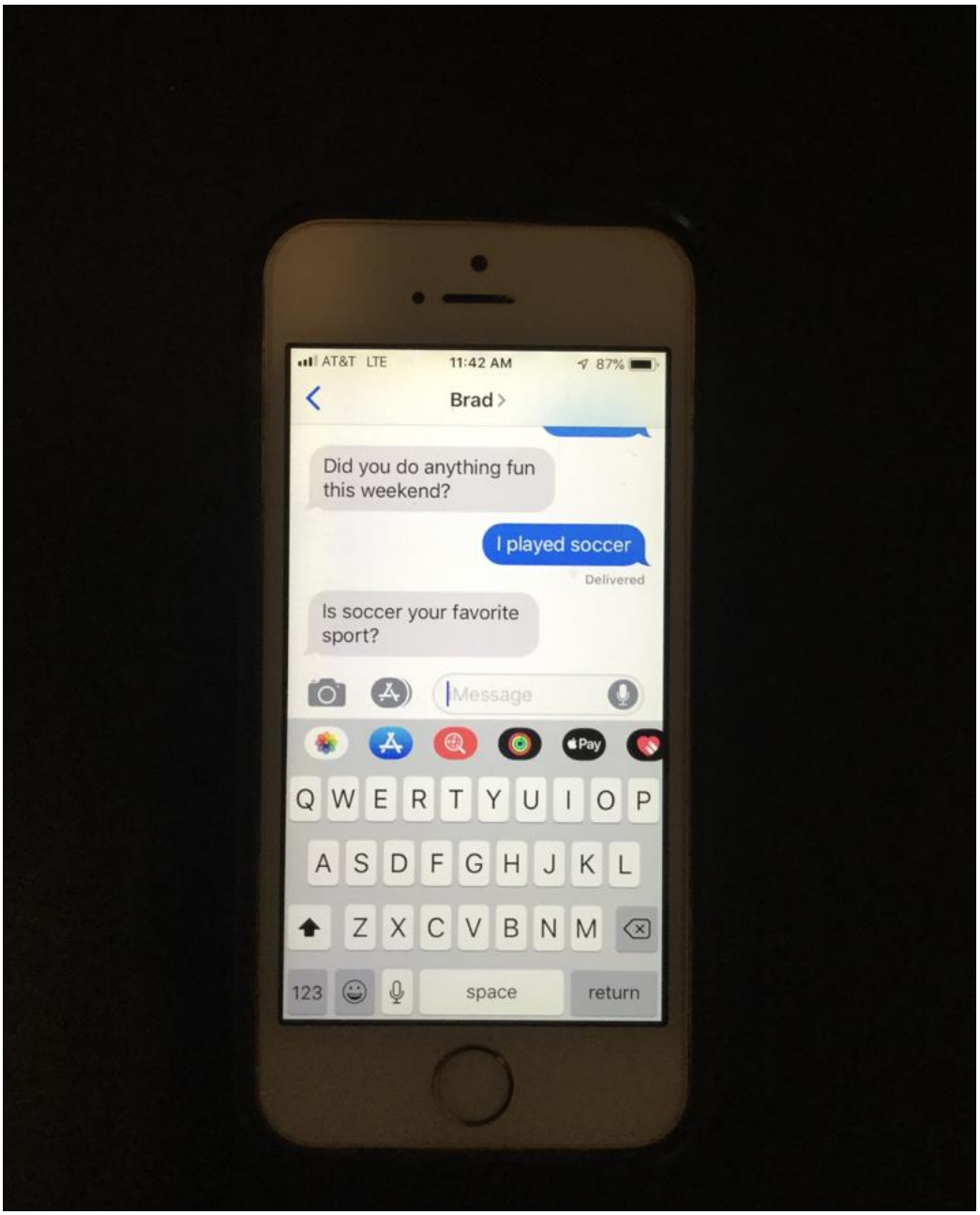

AT&T LTE
11:40 AM
88%
Brad
iMessage
Today 11:35 AM
Hi this is Brad
Hi Brad, this is Kelly. How are you doing?
Delivered
Message
Pay
Q W E R T Y U I O P
A S D F G H J K L
Z X C V B N M
123
space
return
"..." means that your friend is typing a message

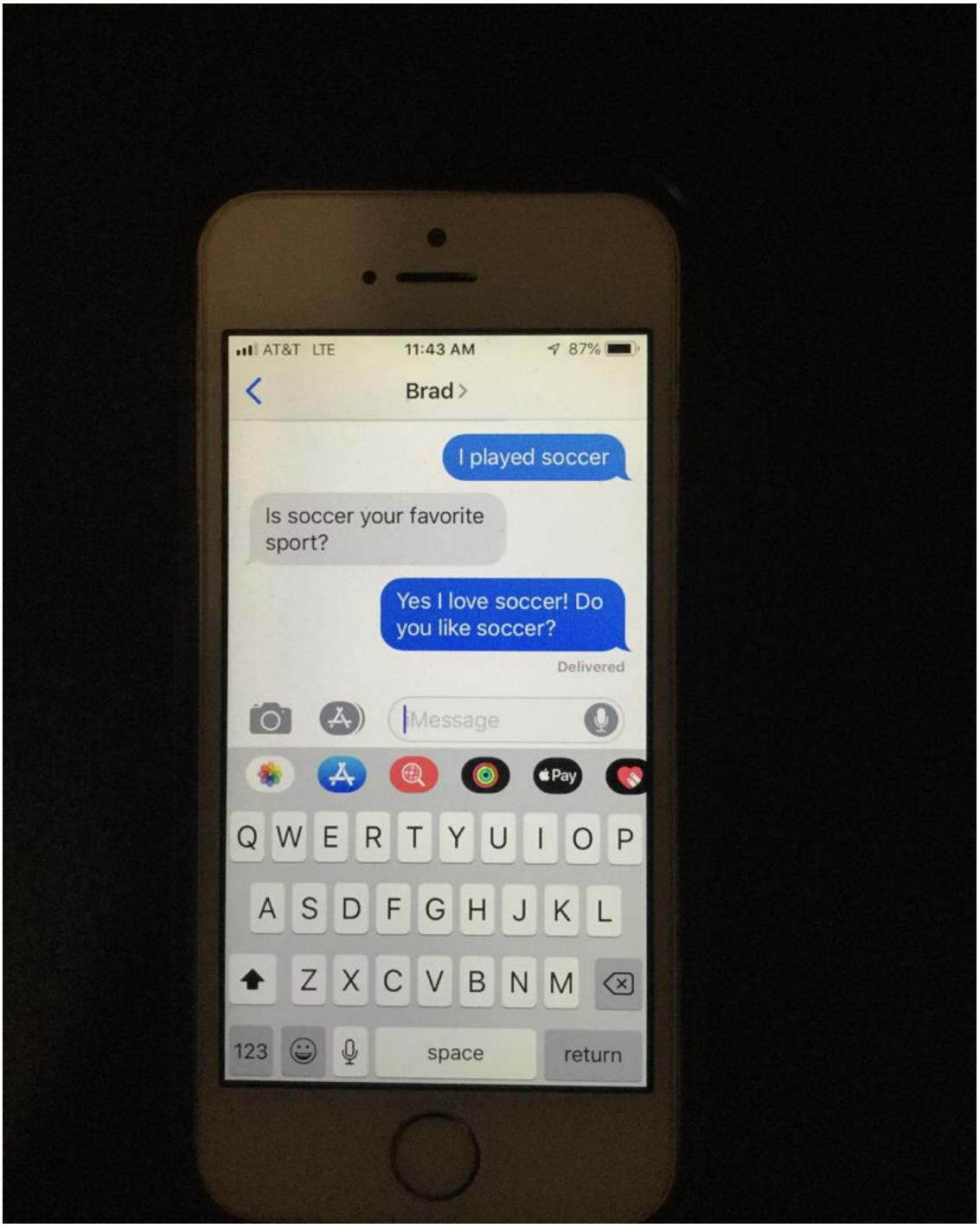

AT&T LTE
11:41 AM
87%
Brad
iMessage
Today 11:35 AM
Hi this is Brad
Hi Brad, this is Kelly. How are you doing?
Delivered
I'm good, how are you?
iMessage
Pay

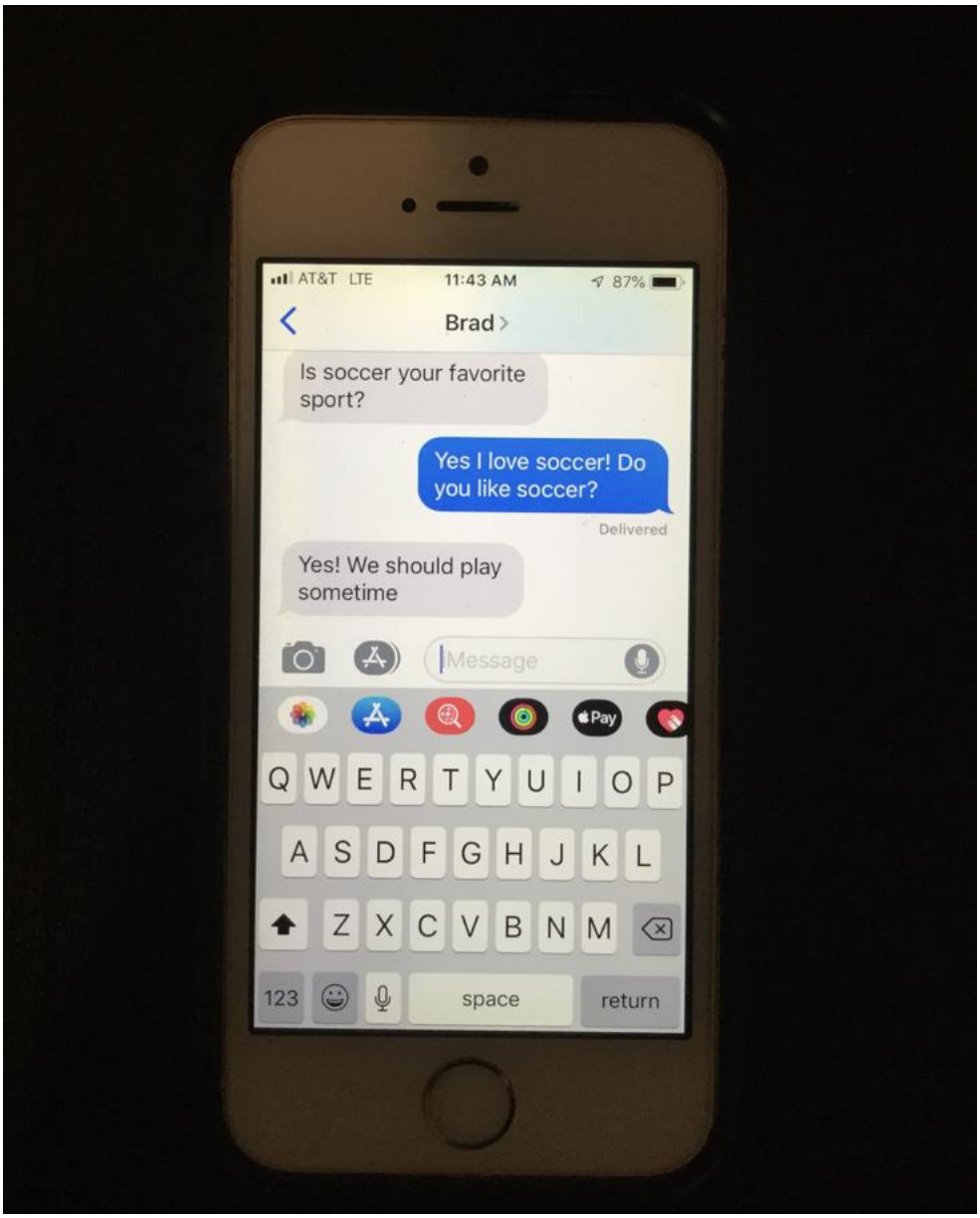

AT&T LTE
11:41 AM
87%
Brad
Hi this is Brad
Hi Brad, this is Kelly. How are you doing?
I'm good, how are you?
I'm good
Delivered
iMessage
Pay
Q W E R T Y U I O P
A S D F G H J K L
Z X C V B N M
123
space
return

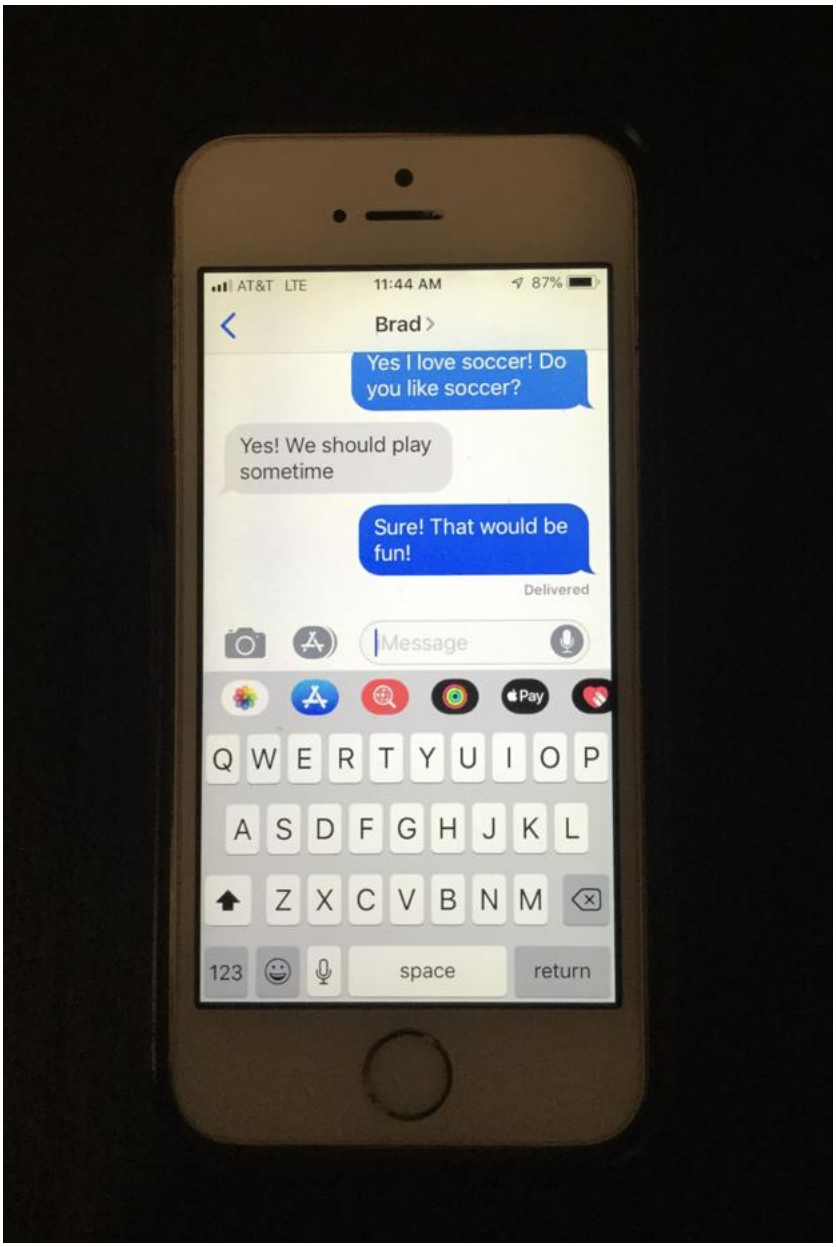

AT&T LTE
11:42 AM
87%
Brad
iMessage
Today 11:35 AM
Hi this is Brad
Hi Brad, this is Kelly. How are you doing?
I'm good, how are you?
I'm good
Delivered
Did you do anything fun this weekend?
iMessage
Pay


AT&T LTE
11:42 AM
87%
Brad
I'm good, now are you?
I'm good
Did you do anything fun this weekend?
I played soccer
Delivered
iMessage
Pay
Q W E R T Y U I O P
A S D F G H J K L
Z X C V B N M
123
space
return


AT&T LTE
11:42 AM
87%
Brad
Did you do anything fun this weekend?
I played soccer
Delivered
Is soccer your favorite sport?
Message
Q W E R T Y U I O P
A S D F G H J K L
Z X C V B N M
123
space
return


AT&T LTE
11:43 AM
87%
Brad
I played soccer
Is soccer your favorite sport?
Yes I love soccer! Do you like soccer?
Delivered
Message
Q W E R T Y U I O P
A S D F G H J K L
Z X C V B N M
123
space
return


AT&T LTE
11:43 AM
87%
Brad
Is soccer your favorite sport?
Yes I love soccer! Do you like soccer?
Delivered
Yes! We should play sometime
Message
Q W E R T Y U I O P
A S D F G H J K L
Z X C V B N M
123
space
return


AT&T LTE
11:44 AM
87%
Brad
Yes I love soccer! Do you like soccer?
Yes! We should play sometime
Sure! That would be fun!
Delivered
Message
Pay
Q W E R T Y U I O P
A S D F G H J K L
Z X C V B N M
123
space
return

Appendix B

Texting Survey for Participant

1. **Do you know how to send a text?**
   Yes or No

If you circled **yes** then answer the below questions:
If you circled **no** then skip to question 6 and 7

In the last month, have you:

2. **Sent a text message to a parent?**
   Yes or No

3. **Sent a text message to a friend?**
   Yes or No

   3b. If yes, then who is the friend you have texted with _____

4. **Sent a text message to another individual?**
   Yes or No

   4b. If yes, then who is the person you have texted with _____

5. **How many texts have you sent?**
   A) Never sent a text B) 1-5 C) 6-10 D) 11-15 E) 16-19 F) 20-above

6. **Do you like texting?**
   Yes or No

7. **Would you like to text with more people?**
   Yes or No

8. **Who would you like to text with? _____**

Texting Survey for Parent

9. Does your child know how to send a text?
Yes or No

If you circled **yes** then answer the below questions:
If you circled **no** then skip to question 6 and 7

In the last month, has your child:

10. Sent a text message to a you or another caregiver?
Yes or No

11. Sent a text message to a friend?
Yes or No

3b. If yes, then who is the friend your child has texted with? _____

12. Sent a text message to another individual?
Yes or No

4b. If yes, then who is the person your child has texted with? _____

13. Approximately, how many texts has your child sent (in the last month)?
A) Never sent a text B) 1-5 C) 6-10 D) 11-15 E) 16-19 F) 20-above

14. Does your child like texting?
Yes or No

15. Would you like your child to text with more people?
Yes or No

16. Who would you like your child to text with? _____

Appendix C

Task Analysis Checklist for sending and receiving a text

1. Open Text app
2. A) Touch the new message button B) or previous message
3. Type in friend's name (automatically done if 2B was completed)
4. Touch the name (automatically done if 2B was completed)
5. Touch the message box
6. Type in the message
7. Send the message