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The application of telehealth procedures to provide behavioral assessment and treatment to families with young children with autism spectrum disorder in Korea

Gunsung Lee
University of Iowa

THE APPLICATION OF TELEHEALTH PROCEDURES TO PROVIDE BEHAVIORAL ASSESSMENT AND TREATMENT TO FAMILIES WITH YOUNG CHILDREN WITH AUTISM SPECTRUM DISORDER IN KOREA

by

Gunsung Lee

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Thesis Supervisors: Associate Professor Kathryn C. Gerken
Adjunct Faculty Wendy K. Berg

Graduate College
The University of Iowa
Iowa City, Iowa

CERTIFICATE OF APPROVAL

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PH.D. THESIS

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This is to certify that the Ph.D. thesis of

Gunsung Lee

has been approved by the Examining Committee for the thesis requirement for the Doctor of Philosophy degree in Psychological and Quantitative Foundations (School Psychology) at the May 2016 graduation.

Thesis Committee: _____
Kathryn C. Gerken, Thesis Supervisor

_____
Wendy K. Berg, Thesis Supervisor

_____
David P. Wacker

_____
Scott D. Lindgren

_____
Stewart W. Ehly

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ABSTRACT

The current study evaluated the effectiveness of delivering behavioral assessment and treatment to reduce challenging behavior shown by Korean children with ASD by using in-home telehealth from the U.S. The participants were five young children diagnosed with autism who lived in Korea and displayed challenging behavior. The children's mothers, who had no previous experience in functional analysis (FA) and functional communication training (FCT) procedures, implemented all procedures with coaching provided by a behavior consultant during assessment and treatment sessions via telehealth. The results of the current study showed that functional analyses conducted via telehealth from the U.S. to the children's homes in Korea were effective in identifying the function of challenging behavior for each participant. Furthermore, the results also showed that challenging behavior was reduced by 100% across all children by the end of treatment. These results suggest that telehealth can be an effective and efficient way to deliver behavior analytic services for underserved populations in countries like Korea.

PUBLIC ABSTRACT

Children with autism spectrum disorder (ASD) may display challenging behaviors. Challenging behavior may influence a child's life in a negative way. Therefore, it is important that effective treatment be provided to address challenging behaviors of children with ASD.

Previous studies have shown that telehealth consultation can be an effective and efficient method for conducting functional analysis (FA) and implementing functional communication training (FCT) with children who engage in challenging behaviors living in underserved areas of a rural state. The current study evaluated the effectiveness of conducting FA and FCT with families living in Korea using telehealth technology. In Korea, it is hard for parents whose child engages in challenging behavior to gain access to behavior therapists who can provide behavior analytic services. This study was designed to test whether telehealth technology could be used to conduct FA and FCT from the U.S. to persons in another country (Korea) with limited access to ABA services.

The participants were five young children living in Korea who had ASD and who engaged in challenging behaviors. A behavior analyst provided behavioral coaching to the participants' mothers via telehealth during weekly one hour visits as they conducted all procedures of FA and FCT within their homes. Behavior assessment results show that the FA procedures identified social functions of challenging behavior for all participants. In addition, FCT treatments produced substantial reductions in problem behavior by the end of treatment for all participants. These results suggest that telehealth can be an effective and efficient way to deliver behavior analytic services for populations in countries with limited access to ABA services like Korea.

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CHAPTER 1

INTRODUCTION

In this chapter, the first section describes characteristics of challenging behaviors in children with developmental disabilities. The second section describes negative implications associated with challenging behaviors in children. The third section briefly reviews behavioral assessments, and treatments in Applied Behavior Analysis (ABA), along with the use of telehealth to conduct ABA. The fourth section briefly reviews ABA in Korea. Finally, the fifth section provides a description of the current study and the research questions addressed.

Challenging Behavior in Children with Developmental Disabilities

Emerson (2001) defined the term 'challenging behavior' as "culturally abnormal behavior(s) of such intensity, frequency or duration that the physical safety of the person or others is likely to be placed in serious jeopardy, or behavior which is likely to seriously limit use of, or result in the person being denied access to, ordinary community facilities" (p. 3). Challenging behaviors include various topographies of behavior such as self-injury (e.g., hitting, biting), stereotypies (e.g., flapping, body rocking), aggression (e.g., kicking, slapping), and property destruction (e.g., breaking objects) (Lancioni, Singh, O'Reilly, & Sigafoos, 2009; Neidert, Dozier, Iwata, & Hafen, 2010; Stokes & Luiselli, 2009). Challenging behaviors are more likely to occur among children with developmental disabilities such as autism and/or intellectual disabilities than typically developing children (Kurtz, Chin, Huete, Tarbox, O'Connor, Paclawskyj, & Rush, 2003; Lancioni et al., 2009). The two most prevalent disorders in which challenging behaviors occur are intellectual disabilities (ID) and autism spectrum disorders (ASD) (Farmer & Aman, 2009; Murphy, Healy, & Leader, 2009; Holden & Gitlesen,

2006; Emerson, Kiernan, Alborz, Reeves, Mason, Swarbrick, Mason, & Hatton, 2001a; Emerson, Kiernan, Alborz, Reeves, Mason, Swarbrick, Mason, and Hatton, 2001b; Murphy, Beadle-Brown, Wing, Gould, Shah, & Holmes, 2005; Jang, Dixon, Tarbox, & Granpeesheh, 2011). A number of studies have examined challenging behaviors in children with developmental disabilities and have looked at prevalence, risk factors, relations between severity and behavior, and characteristics (Matson, Kozlowski, Worley, Shoemaker, Sipes, & Horovitz, 2011; Jang, Dixon, Tarbox, & Granpeesheh, 2011; Matson, Mahan, Hess, Fodstad, & Neal, 2010; Murphy, Healy, & Leader, 2009; Poppes, Putten, & Vlaskamp, 2010; Matson, Wilkins, & Macken, 2008; Matson, & Nebel-Schwalm, 2007; Emerson et al., 2001a; Baghdadli, Pascal, Grisi, & Aussilloux, 2003; Lundqvist, 2013).

Young children with developmental disabilities such as autism and intellectual disability often show challenging behavior (Baghdadli, Pascal, Grisli, & Aussiloux, 2003; Oliver, Petty, Ruddick, & Bacarese-Hamilton, 2012; Rogers & Wallace, 2011). The main characteristics of ASD include deficits in social skills and communication and the presence of repetitive behavior (American Psychiatric Association, 2013). Delays in these skills put children with ASD at risk for displaying challenging behaviors (McClintock, Hall, & Oliver, 2003). Matson, Wilkins, and Macken (2009) found that approximately 94% of children with ASD emit at least one challenging behavior. Baghdadli et al. (2003) reported that approximately 50% of children with autism engaged in self-injurious behaviors (SIB). Children with ID also often display challenging behavior. Murphy, Healy, and Leader (2009) reported that 64% of individuals with ID in their Irish population displayed challenging behavior. Benson and Brooks (2008) reported that over 50% of individuals with ID in their U.S. sample evinced challenging behavior.

Negative Implications Caused by Challenging Behavior

Physical Consequences of Challenging Behavior. Challenging behavior may affect an individual's life negatively (McTiernan, Leader, Healy, & Mannion, 2011). One negative implication can be physical injury to themselves and others around them (McTiernan et al., 2011). Physical consequences of SIB may lead to secondary infections, physical malformation of the body, loss of sight or hearing, additional neurological injury, and death (Borthwick-Duffy, 1994; Nissen & Haveman, 1997).

Challenging behavior puts the individual at an increased risk for physical restraint and the prescription for psychotropic medications (Oliver, Murphy, & Corbett, 1987; Sturmey, Lott, Laud, & Matson, 2005). Individuals with challenging behavior are also more likely to be placed in a residential facility (Borthwick-Duffy, Eyman, & White, 1987). Oliver et al. (1987) conducted a research survey of self-injurious behavior in people with ID. Six hundred sixteen individuals who displayed self-injurious behavior were included in this study. They found that 50% of the participants were hospitalized; 28% were residents in nonhospital residential care; and 21% lived at home. In addition, only 2% of participants had formal psychological treatments and approximately 50% of participants were on psychotropic drugs.

Nissen and Haveman (1997) investigated mortality and avoidable death in people with severe self-injurious behavior. At baseline in 1990, a cohort of 1168 people with severe self-injurious behavior living in facilities in Netherlands participated in this study. At follow-up in 1995, all participants were traced. Fifty-seven people (4.9%) had died over the 5 year period. Regarding the cause of death, the authors reported that six cases of death (12%) were thought to be associated with SIB.

Parental Stress. A number of studies demonstrated that challenging behavior in children with developmental disabilities can negatively affect the quality of life for the child and their family and is associated with future negative outcomes (Emerson, 2003; Murphy et al., 2005). Challenging behaviors have a negative impact on the child's overall development and the well-being of the family (Baker, McIntyre, Blacher, Crnic, Edelbrock, & Low, 2003; Baker, Blacher, Crnin, & Edelbrock, 2002).

McIntyre, Blacher, and Baker (2002) investigated how the behavior and mental health problems of young adults with severe ID impacted their mothers' perceived levels of stress and decisions about residential placements. The authors interviewed 103 mothers of young adults with ID to measure their child's adaptive functioning, behavior and mental health problems, the level of parental stress, and their thoughts on residential care outside the family. The results from this study demonstrated that the young adults' behavior and mental health problems contributed to the mothers' perceived stress in the family. The authors also reported that behavior and mental health problems in a child may be a good predictor of whether the family seeks out-of-home placements.

Several other studies have found that behavior problems in children could result in significant levels of parental stress (Baker et al., 2003; Hodapp, Fidler, & Smith, 1998; Stores, Stores, Fellows, & Buckley, 1998; Hauser-Cram, Warfield, Shonkoff, Krauss, Sayer, Upshur, & Hodapp, 2001). Baker et al. (2003) examined the relationship between parental stress and behavior problems. The main purpose of their study was to determine whether behavior problems contributed to subsequent increased parental stress. The results from the study demonstrated that children's behavior problems were associated with the level of parental stress; higher levels of problem behaviors were more likely to lead to higher level of parental stress. In

addition, the authors showed that high parental stress predicted subsequent increased child behavior problems.

Staff Stress. Challenging behavior can pose significant burdens for educators and support staff who provide educational services for the child (Carr, Taylor, & Robinson, 1991). Challenging behavior can also negatively influence the teachers' well-being and result in a high attrition rate for special education teachers (Lane & Canosa, 1995; Hastings & Brown, 2002).

Chung, Corbett, and Cumella (1996) examined the burnout of twenty six care staff working with individuals who displayed challenging behaviors. The authors indicated that staff members were found to have high levels of burnout. Jenkins, Rose, and Lovell (1997) investigated psychological well-being in staff working with individuals who displayed challenging behaviors. The participants were seventy eight staff working in community houses. Staff working with individuals who displayed challenging behaviors reported having higher levels of anxiety, feeling less supported, being less clear about the identification of risk situations, and feeling lower level of job satisfaction, than other staff. Studies exploring a link between stress and challenging behavior have emphasized the significance of staff stress when caring for individuals who exhibit challenging behaviors.

Social Isolation and Barrier to Effective Learning. Challenging behaviors may decrease the opportunities to engage in social activities (Anderson, Lakin, Hill, & Chen, 1992; Hill & Bruininks, 1984) and limit access to health and social services (Jacobson, Silver, & Schwartz, 1984). Research has also suggested that challenging behavior is associated with an increased need for residential placement (McIntyre et al., 2002).

Challenging behaviors can interfere with learning, thus resulting in being excluded from school and other day time services (Sigafoos, Arthur, & O'Reilly, 2003). Furthermore,

challenging behavior may be detrimental to effective education (Carr et al., 1991; Horner, Diemer, & Brazeau, 1992) and the development of social relationships (Matson & Wilkins, 2007; Matson, Neal, Fodstad, & Hess, 2010; Myrbakk & Tetzchner, 2008).

Persistence in Challenging Behavior. Although challenging behavior may be less severe at early ages, challenging behavior is not likely to decrease without intervention and it puts the child at greater risk for self-harm (Berkson, Tupa, & Sherman, 2001). If challenging behaviors go untreated, these behaviors can maintain over time and result in significant consequences (Brosnan & Healy, 2011; Doehring, Reichow, Palka, Phillips, & Hagopian, 2014; Murphy, Beadle-Brown, Wing, Gould, Shah, & Holmes, 2005). For example, challenging behavior can begin in childhood and persist into adolescence and adulthood (Oliver, Murphy, & Corbett, 1987). Emerson et al. (2001b) examined the persistence of challenging behavior of individuals with intellectual disability and reported the outcomes of a seven year follow up of these individuals. Data were obtained from 95 individuals. At follow-up, self-injurious behavior was maintained among 71% of participants. Emerson et al. (2001b) concluded that these dangerous behaviors may result in social exclusion. Taylor, Oliver, and Murphy (2011) found that among 49 individuals with ID and/or ASD, 84% of individuals continued to show challenging behavior at 20 years follow-up and had no changes in topography or severity of problem behavior.

Given the negative implications of challenging behavior described above (e.g., physical harm, social isolation, parental/staff stress, and disrupted education etc.), it is necessary that effective interventions be provided to reduce challenging behavior of individuals with developmental disabilities.

Functional Assessment of Challenging Behavior

Functions of Challenging Behavior. The functions of challenging behavior can be categorized into three components; social positive reinforcement, social negative reinforcement, and automatic reinforcement (Carr, 1977). In social positive reinforcement, problem behavior is maintained by the delivery of socially mediated stimuli; for example, forms of attentions (Iwata, Dorsey, Slifer, Bauman, & Richman, 1982/1994; Northup, Broussard, Jones, George, Vollmer, & Herring, 1995) and preferred items or activities (Lalli, Casey, & Kates, 1997; Ringdahl, Christensen, & Boelter, 2009). In social negative reinforcement, problem behavior is maintained by the removal of socially mediated stimuli; for example, removal of task demands (Carr & Durand, 1985). In automatic reinforcement, problem behavior is maintained by non-social consequences; in other words, challenging behavior occurs independent of the social environment (Vaughan & Michael, 1982).

Identifying the function of challenging behavior is needed to identify a reinforcement-based treatment that will be effective in reducing challenging behavior (Iwata et al., 1982/1994). Reinforcement treatments that do not match the function of the behavior are less likely to be effective in reducing the behavior (Carr & Durand, 1985).

Experimental Functional Analysis. Experimental functional analyses involve the systematic manipulation of antecedent and consequence stimuli in relation to the target behavior (Horner & Carr 1997; Iwata et al., 1982/1994). As discussed by Hanley, Iwata, and McCord (2003), the functional analysis developed by Iwata et al. (1982/1994) is often regarded as the standard for functional analysis. Iwata et al. (1982/1994) described the use of operant technology to demonstrate behavior-environmental relations for self-injurious behavior. The participants were nine individuals with developmental disabilities who displayed self-injurious behavior. The

situations to which each participant was exposed were the followings: play materials (present vs. absent), demands (high vs. low), and social attention (absent vs. noncontingent vs. contingent). The results indicated that six out of nine participants had higher levels of self-injury during a specific stimulus condition. This empirical study showed that self-injury could be maintained by social reinforcement. An experimental functional analysis of challenging behavior provides a method for testing the effects of specific social consequences on the occurrence of challenging behavior (Hanley et al., 2003).

Function Based Behavioral Interventions for Children with Developmental Disabilities

As already stated, if challenging behaviors go untreated, they can persist over time, thereby resulting in significant consequences such as limiting educational opportunities and the development of social skills, and higher risk for physical harm (Baker et al., 2003; Chadwick et al., 2000; Sigafoos et al., 2003). Thus, treatment should be implemented as early as possible in order to provide the best quality of life for children with challenging behaviors.

One intervention used frequently is differential reinforcement of alternative behaviors (DRA). DRA has been found to address challenging behavior in individuals with developmental disabilities (Chowdhury & Benson, 2011; Petscher, Rey, & Bailey, 2009). DRA has been shown to be the most frequently used treatment to address challenging behavior (Lennox, Miltenberger, Spengler, & Erfanian, 1988).The main purpose of DRA is to provide the same functional reinforcer that maintains challenging behavior contingent on appropriate behavior, while withholding reinforcement for problem behavior (Vollmer, Roane, Ringdahl, & Marcus, 1999). DRA can provide the individual with an option to access the same class of reinforcement identified in the behavioral assessment (Rolider & Van Houten, 1990).

Functional communication training (FCT) is a type of DRA in which an individual is taught an appropriate communicative response as an alternative to engaging in problem behavior in order to access the same class of reinforcement (Carr & Durand, 1985). FCT is an individualized treatment that can teach the individual how to use appropriate communication to gain access to what he/she wants (e.g., a toy, attention, or break from a task) (Tiger, Hanley, & Bruzek, 2008). To be more effective in reducing problem behavior, FCT includes both differential reinforcement and extinction (Hagopian, Fisher, Sullivan, Acquisto, & LeBlanc, 1998). Prior to FCT implementation, an antecedent analysis (Carr & Durand, 1985) or FA (Iwata et al., 1982/1994) is conducted to identify a functional reinforcer that maintains problem behavior. The FCT procedure is paired with the results of the functional analysis so that the reinforcer identified during the FA is provided contingent on an appropriate communicative response during FCT (Fisher, Piazza, Cataldo, Harrell, Jefferson, & Conner, 1993; Wacker, Steege, Northup, Sasso, Berg, Reimers, Cooper, Cigrand, & Donn, 1990).

A great deal of research has shown that reinforcement-based treatments can be very effective in reducing problem behavior when an assessment is conducted to identify the reinforcer that maintains problem behavior and that reinforcer is provided for appropriate behavior while placing problem behavior on extinction (Neef & Iwata, 1994; Tiger et al., 2008; Vollmer, Iwata, Zarcone, Smith, & Mazaleski, 1993). For example, Iwata, Pace, Dorsey, et al. (1994) suggested that it is important to match treatment to the identified function of problem behavior in order to effectively reduce the challenging behaviors. This two-step approach has been shown to be effective in reducing challenging behavior (Asmus, Ringdahl, Sellers, Call, Andelman, & Wacker, 2004; Kurtz et al., 2003; Wacker, Berg, Harding, Derby, Asmus, & Healy, 1998). A number of studies demonstrated that FCT is an effective treatment in reducing

problem behavior. FCT procedures reduced the occurrence of problem behavior by approximately 90% on average (Berg, Wacker, Harding, Ganzer, & Barretto, 2007; Derby, Wacker, Berg, Deraad, Ulrich, Asmus, Harding, Prouty, Laffey, & Stoner, 1997; Wacker, Berg, Harding, Barretto, Rankin, & Ganzer, 2005). The results from these studies also found that FCT can be conducted by parents in their homes when coaching from a behavior analyst was available.

Telehealth in Applied Behavior Analysis

The above interventions have most often been delivered in clinic or home settings, but in the last 15 years a new delivery system has been developed and tried. As Glueckauf and Ketterson, (2004) suggested, telehealth services are one of the most innovative technologies in health care delivery. Glueckauf, Pickett, Ketterson, Loomis, and Rozensky (2003) defined telehealth as "the use of telecommunications and information technologies to provide access to health information and services across a geographical distance, including (but not limited to) consultation, assessment, intervention, and follow-up programs to ensure maintenance of treatment effects" (p. 160). Telehealth has the potential to expand the range of physical and psychological health services, increase the quality of service, and reduce the cost of services (Glueckauf, Hufford, Whitton, Baxter, Schneider, Kain, & Vogelgesang, 1999; Glueckauf, Whitton, & Nickelson, 2001; Jerome, DeLeon, James, Folen, Earles, & Gedney, 2000).

Recently, telehealth has been used in the field of ABA to reduce problem behavior of children with developmental disabilities who live in rural areas and have limited access to ABA services (Barretto, Wacker, Harding, Lee, & Berg, 2006; Wacker, Lee, Dalmau, Kopelman,

Lindgren, Kuhle, Pelzel, & Waldron, 2013a; Wacker, Lee, Dalmau, Kopelman, Lindgren, Kuhle, Pelzel, Dyson, Schieltz, & Waldron, 2013b).

Barretto et al. (2006) found that it was possible to conduct brief functional analyses for two children with challenging behaviors via telehealth. They reported that social functions were identified for both children, thus showing that FA procedures could be done via telehealth. Machalicek, O'Reilly, Chan, Lang, Rispoli, Davis, Shogren, Sigafoos, Lancioni, Antonucci, Langthorne, Andrews, and Didden (2009) showed that FAs could be conducted for children with autism via videoconferencing. They suggested that treatment derived from the results of the FAs could effectively be implemented in the classroom, resulting in substantial reductions in problem behavior. Gibson, Pennington, Stenhoff, and Hopper (2010) reported that professional staff in a school setting could implement FCT effectively to reduce the elopement of a student with autism via videoconferencing. They found that FCT was implemented by the school staff with a high degree of fidelity via videoconferencing and that the problem behavior decreased following FCT intervention.

Wacker et al. (2013a) also reported that FAs could be conducted effectively via telehealth by behavior analysts. They reported that behavior analysts effectively conducted FAs via telehealth with 20 children with ASD who displayed challenging behavior. The weekly cost of conducting FAs via telehealth was approximately 5/6 less expensive than the cost of behavior analysts delivering FAs in the participants' homes. Wacker et al. (2013b) also demonstrated that FCT could be implemented via telehealth by parents when behavior consultation was provided. Wacker et al. (2013b) reported that after parents received coaching from staff via telehealth, they effectively implemented FCT with a high degree of integrity. The cost of delivering FCT treatment via telehealth was about 80% lower than in-vivo behavioral therapy in the caregivers'

homes. Overall telehealth appears to be an effective way to conduct FA and FCT treatment packages.

Applied Behavior Analysis Services in Korea

According to the Korean Institute for Health and Social Affairs' research on Korean persons with disabilities (2011), the total number of people with intellectual disability is 181,100. There are 2.54 children between the ages of birth and 9 years old out of every 1,000 children who have intellectual disability and 7.53 children between the ages of 10 and 19 years old out of every 1,000 persons who have intellectual disability. The total number of people with ASD is 21,421. Of children between the ages of 0 and 9 years, 1.52 out of 1,000 have ASD. Children between the ages of 10 and 19 years, 1.19 out of 1,000 have ASD. Recently, Korean and American researchers attempted to estimate ASD prevalence of school-aged children in Korea. Kim, Leventhal, Kim, et al. (2011) included 55,266 Korean children ranging in age from 7 to 12 years. The authors reported that 2.64% of participants were found to have ASD. This study reported that Korean children have higher ASD prevalence estimates than previously reported prevalence ranging from .6 to 1.8% (Fombonne, 2009). These results suggest that there is a need for ABA services for Korean children with ASD. In Korea, it is difficult for parents whose child has ASD with challenging behavior to obtain access to applied behavior analysts who can provide ABA services. Currently the Behavior clinic at Seoul Metropolitan Children's hospital is the only one in which behavioral treatment services are provided, thus resulting in a long waiting time to receive ABA treatment to address challenging behaviors. Furthermore, there are fewer than 20 Board Certified Behavior Analysts listed in the Korea certificant registry (Behavior Analysis Certification Board, 2015). The lack of access to ABA services in Korea may lead to

long delays in having needed services by behavior analysts in Korea. The use of telehealth services could be one solution to the limited access to ABA services in Korea.

Purpose of Current Study

The major goals of this study were (a) to evaluate the effectiveness of delivering an empirically validated behavioral assessment and intervention for problem behavior to Korean children who have ASD by using in-home telehealth, and (b) to evaluate the acceptability of treatment procedures by participant's parents.

The current study attempted to replicate recent work conducted by Wacker et al. (2013a and 2013b) and Suess, Romani, Wacker, Dyson, Kuhle, Lee, Lindgren, Kopelman, Pelzel, and Waldron (2014a). These authors evaluated the effectiveness of using telehealth to deliver FA and FCT to young children (ages 6 years and younger) with autism. The main differences between the current study and the studies by Wacker et al. (2013a and 2013b) and Suess et al (2014a) are: 1) this study was conducted in another country using an Iowa home base and 2) the current study included reliable, relatively low cost, readily accessible electronic devices such as parent's smart phones and an iPad as well as a desktop for the video connection in the participants' homes. Telehealth studies have typically involved the use of relatively expensive electronic equipment (e.g., computers, dedicated monitors, and cameras) at both settings, which increases the costs of providing telehealth care. But, in the current study, parent's smartphones were used as the electronic equipment for three of the cases.

The participants in this study were young children living in Korea who have ASD and who engaged in problem behavior. A trained therapist at UIHC coached the participants' parents as they conducted a functional analysis of problem behavior and implemented FCT in Korea.

The current study was designed to extend telehealth consultation to an underserved country, Korea. By providing early interventions, it should be possible to reduce problem behavior of Korean children with developmental disabilities. It is hoped that this study will serve as a model for other underserved countries to increase access to ABA services.

Research Questions

1. Can functional analysis conducted via telehealth identify the social functions of problem behavior in children with ASD living in Korea? (Experiment 1)

2. Can functional communication training conducted via telehealth be effective in decreasing challenging behavior displayed by children with ASD living in Korea (Experiment 2)?

3. What is the acceptability level of the FA plus FCT package for parents?

4. Would the use of readily available electronic devices (i.e., parent's smart phones) be as effective for delivering coaching via telehealth as the use of computers, webcams, and designated monitors?

CHAPTER 2

LITERATURE REVIEW

This chapter begins with a review of the research literature on challenging behaviors. The next section focuses on studies regarding functional analysis and functional communication training. Finally, the research on using telehealth to deliver applied behavior analysis assessment and intervention is reviewed.

Challenging Behaviors in Children with Developmental Disabilities

Emerson et al. (2001a) investigated characteristics of people with ID in England who were reported to display challenging behaviors. The participants consisted of 2,189 persons identified as having ID in England. To gather data about challenging behavior, the informant was interviewed using the Individual Schedule (Alborz et al., 1994) and Setting Interview (Kiernan & Qureshi, 1986). Results from this study reported that 10-15% of participants were reported as displaying some form of challenging behaviors, and that disruptive behavior (9-12% of the sample screened) (e.g., generalized noncompliance, temper tantrum, screaming etc.) was reported to be the most common form of challenging behaviors, followed by aggression (7%), destructive behavior (4-5%), and self-injury (4%). The authors also reported that most of the participants who identified as having challenging behavior had two or more forms of challenging behavior. Finally, participants with more severe challenging behavior were reported to need more assistance in daily living areas such as eating and washing and had greater deficits in communication.

Baghdadli, Pascal, Grisi, and Aussilloux (2003) examined the risk factors for self-injurious behaviors in 222 children with ASD who were under age 7. Measures used in this study

included a questionnaire about episodes of SIB, the Autism Diagnostic Interview-Revised (Lord, Rutter, & Lecoutteur, 1994), the Childhood Autism Rating Scale (CARS; Schopler, Reichler, De Vellis, & Daly, 1980), and the Vineland Adaptive Behavior Scales (VABS; Sparrow, Balla, & Chiccetti, 1984). Results of this study showed that 109 children (53%) were reported to display SIB: 44 children (21.5%) had mild SIB, 35 children (17.1%) had moderate SIB, and 30 children (14.6%) had severe SIB. The results from this study also indicated that lower age, presence of perinatal condition, a higher degree of autism, and a lower level of daily living skills were associated with the presence of SIB. However, parental social class, gender, and epilepsy were not found as risk markers for SIB.

In a meta-analytic study, McClintock, Hall, and Oliver (2003) investigated risk factors associated with challenging behaviors among people with ID. This meta-analytic review covered studies over a 30 year time period. The results from the meta analysis identified several risk factors for particular types of problem behavior. SIB was more likely to be observed in people with a severe/profound degree of ID, an autism diagnosis, and persons who had deficits in receptive and expressive communication. Aggressive behavior was more likely to be seen in males, individuals with a diagnosis of ASD, and individuals with a deficit in expressive communication. Stereotypical behavior was more likely to occur in people with a severe/profound degree of ID. Destructive behavior was more likely to be seen in people with ASD. Overall, the results from this meta-analysis indicated that severe ID, a diagnosis of ASD, and deficits in communication skills were risk markers for challenging behaviors.

Holden and Gitlesen (2006) investigated the prevalence and risk markers of challenging behaviors in 904 Norwegian children and adults with intellectual disability. Mild intellectual disability was found in 233 participants (28.3%); 371 (45.1%) participants had moderate

intellectual disability; 128 (15.6%) participants had severe intellectual disability; and 90 (10.9%) participants had profound intellectual disability. Each participant was assigned an informant such as a staff member from local health authority or a parent who could offer information on the participant. Each informant completed a questionnaire which was a simplified version of the Challenging Behavior Survey: Individual schedule (Alborz, Emerson, Kiernan, & Qureshi, 1994). Results from Holden and Gitlesen's (2006) study showed that 91 participants (11.1%) had challenging behavior, and of these participants 60 (7.3%) showed less demanding challenging behavior and 31 (3.8%) showed more demanding challenging behavior. Participants with more demanding challenging behavior displayed more forms of challenging behavior than participants with less demanding challenging behavior. No significant association was found between gender and challenging behavior. Challenging behavior was associated with severity of intellectual disability. Individuals with challenging behavior experienced greater deficits in communications and social skills. The participants with a comorbid diagnosis of intellectual disability and autism spectrum disorder displayed challenging behavior more frequently than participants without a diagnosis of autism. Only 40 participants (44%) received behavioral treatment.

Crocker, Mercier, Lachapelle, Brunet, Morin, and Roy (2006) explored the prevalence and forms of aggressive behaviors in people with intellectual disabilities. The sample consisted of 3,165 people aged 18 years or more with ID receiving services from agencies in Quebec, Canada. Aggressive behavior over the past 12 months was reported using the Modified Overt Aggression Scale (MOAS; Kay Wolkenfeld, & Murrill, 1988). Results showed a prevalence of 51.8% (n=1,639) for overall aggressive behavior across the entire sample of participants. Among five types of aggressive behaviors, the most prevalent form was verbal (37.6%). Property damage, physical aggression, and self-aggression were seen in 24% of the participants. Finally,

9.8% of participants displayed sexually aggressive behavior, which was the least prevalent of the five types of aggressive behaviors investigated.

Matson, Wilkins, and Macken (2008) examined the relationship of challenging behaviors to severity and symptoms of autism spectrum disorders. The sample consisted of 176 children and adolescents with ASD. Approximately 94% of the sample evinced some form of challenging behavior. The authors reported that children with ASD showed greater levels of challenging behavior (e.g., SIB) than both the typically developing group and children with psychopathology. Results also indicated that children with severe ASD were more likely to show higher levels of challenging behaviors than children with mild or moderate ASD.

Poppes, van der Putten, and Vlaskamp (2010) investigated the prevalence, frequency, and severity of challenging behavior in 181 persons, ages 3 to 62, who had intellectual disabilities. They were recruited from treatment facilities in the Netherlands. Challenging behavior was measured by the Dutch translation of the Behavior Problem Inventory (BPI-01; Rojahn, Matson, Lott, Esbensen, & Smalls, 2001). In this study, 166 participants (82%) were reported to display one or more forms of challenging behavior. SIB and stereotypical behavior were reported in 82% of the 166 participants. The prevalence of aggressive/destructive behavior was observed in 45% of the sample. When it came to frequency of challenging behavior, SIB occurred on a daily or weekly basis. Stereotypical behavior occurred on a daily basis and aggressive/destructive behavior was seen once a week.

Jang, Dixon, Tarbox, and Granpeesheh (2011) examined the relationship between symptom severity and challenging behavior in 84 children with ASD (66 males and 18 females). The Autism Spectrum Disorders-Diagnostic for Children (ASD-DC; Matson, Gonzales, Wilkins, & Rivet, 2008) and Autism Spectrum Disorder-Behavior Problems for Children (ASD-BPC;

Matson, Gonzales, & Rivet, 2008) were the assessment instruments. Results found that 94% of the children displayed some form of challenging behavior, and that ASD severity was a strong predictor of challenging behavior.

Mazurek, Kanne, and Wodka (2013) investigated the prevalence and clinical markers associated with physical aggression in 1,584 children and adolescents (ages 2 to 17) with ASD who were enrolled in the Autism Treatment Network (ATN). The ATN battery was used to gather information about diagnostic, medical, and problem behaviors of the participants. Results from this study showed that physical aggression was seen in 53.7% of the entire sample, with the highest prevalence in 2-4-year-old children. The results indicated that physical aggression was associated with several factors such as self-injury, sleep problems, sensory problems, GI problems, communication, and social functioning.

Lundqvist (2013) examined the prevalence and risk factors of challenging behavior in 915 Swedish adults with intellectual disability. The participants were receiving care from the local health authorities. The Behavior Problems Inventory (BPI; Rojahn et al., 2001) was used to assess challenging behaviors. The informants were staff members who knew the participant. Results showed that of the 915 participants, 62% of the individuals with ID were reported to display at least one challenging behavior (e.g., self-injurious, stereotypic, or aggressive/destructive behavior). The prevalence of severe challenging behavior, defined as behavior rated as severe on a daily basis, was 11.8%. The authors indicated that severity of ID, autism, night sleep disturbances, sensory hypersensitivity, deficits in social skills and communication, psychiatry involvement, and psychotropic medication were the most pronounced risk markers for problem behaviors.

Summary

Overall research showed that the prevalence of challenging behavior in people with developmental disabilities ranges from 10-15 % in population-based studies (Holden & Gitlesen, 2006) to 70-90% in specific setting-based studies (Matson, Wilkins, & Macken, 2009; Poppes et al., 2010; Rojahn et al., 2001). As Benson and Brooks (2008) suggested, it is difficult to compare results of prevalence research of challenging behavior because these studies used different methods, settings, populations, sampling procedures, and definitions of the challenging behaviors. The results of the studies indicated that that there were a number of variables identified as risk markers for challenging behavior. Challenging behavior was more likely to be seen in people with autism and was associated with increased severity of ID and receptive and expressive communication dysfunction (McClintock et al., 2003; Simeon & Favazza, 2001). Other risk factors included night sleep disturbances, sensory hypersensitivity, social deficits, psychiatry involvement, and psychotropic medication (Lundqvist, 2013). The studies regarding prevalence and risk factors of challenging behaviors have provided implications for treatment of challenging behaviors (Emerson et al., 2001a). Given the findings from these studies that challenging behaviors are common in persons with developmental disabilities and a minority of those with challenging behaviors receives formal behavioral treatment (Holden & Gitlesen, 2006), it is important that early treatment program be provided to address challenging behavior of individuals with developmental disabilities.

Research Studies on Functional Analysis

Functional Analysis. Iwata et al. (1982/1994) introduced the initial standard method for implementing functional analysis. The authors described the use of operant technology to identify functional relationships between behavior and environmental variables. The participants consisted of nine individuals with developmental disabilities who displayed self-injurious behavior. Each participant was observed during a series of analogue conditions. The analogue conditions were arranged to manipulate: play materials (present vs. absent), experimental demands (high vs. low), and social attention (absent vs. noncontingent vs. contingent). The results indicated that six out of nine participants had higher levels of self-injury during a specific stimulus condition. This empirical evidence showed that self-injury can be maintained by social reinforcers and the identified social reinforcer is referred to as the function of the problem behavior. Following Iwata et al.'s (1982/1994) publication, a great deal of research has been conducted to analyze environment-behavior relations that maintain problem behaviors.

Iwata, Pace, Dorsey, et al. (1994) summarized the results of functional analyses of 152 individuals with developmental disabilities who displayed self-injurious behaviors (SIB). The data were gathered over an 11 year period in order to create a data base of the reinforcers that strengthened and maintained SIB. The participants were either in a pediatric hospital or a state residential facility. Each participant was involved in several test and control conditions designed to examine the effects of antecedent and consequence stimuli on the occurrence of SIB. The conditions included tests for: 1) social-positive reinforcement (access to attention), 2) social-negative reinforcement (escape from demands or aversive stimulation), and 3) automatic reinforcement (sensory). The functional analyses were conducted within one of three design formats: multi-element, reversal, or a combined design. Approximately 4,000 experimental

sessions were conducted over the course of the study, resulting in approximately 1,000 hours of running time. The average number of sessions was 26, consisting of 6.5 hr of observation. Results suggested that 145 individuals (95.4%) showed differentiated responding between tests conditions. The proportion of participants whose SIB was maintained by social negative reinforcement was 38.1% of the sample. The proportion of participants whose SIB was maintained by social positive reinforcement was 26.3% of the sample, and an automatic function was identified for 25.7% of the participants. The proportion of participants whose SIB was maintained by multiple controlling variables was 5.3%. Seven cases (4.6%) were identified as undifferentiated responding. These results suggested that functional analysis methodology could be effective in identifying events that strengthen and maintain SIB, and lead to treatment selection.

Kurtz et al. (2003) conducted functional analyses with 30 young children (*M* = 2 years 9 months of age) who displayed SIB as the primary target behavior. Twenty five participants also displayed other problem behavior such as aggression, disruptive behavior, dangerous behavior, or tantrums. All sessions occurred in a therapy room in an outpatient clinic. Functional analyses were implemented as described by Iwata et al. (1982/1994) with condition-specific modifications (e.g., divided-attention condition was included for 9 participants). During the functional analysis assessments, primary caregivers for 21 of the 30 children served as therapists and clinic professionals served as therapists for the remaining 9 children. The trainers taught the caregivers to use a training protocol similar to the one described in Iwata, Wallace, Kahng, et al. (2000), which consisted of reading materials, watching a videotaped simulation, role playing, and feedback on the performance. Results showed that sources of reinforcement for SIB and other problem behavior were identified for 26 cases (87.5%). Social-positive reinforcement accounted

for 15 cases (62.5%), whereas social-negative reinforcement accounted for 1 case (4.2%). Multiple controlling variables (attention or tangible and escape) accounted for 4 cases (16.6%) and automatic reinforcement accounted for 1 case (4.2%). Sources of reinforcement were not identified for 3 cases (12.5%). These results suggested that functional analyses could be effective in identifying sources of reinforcement for problem behavior. Results also indicated that caregivers could learn basic skills to conduct functional analysis conditions with adequate training.

Skill Acquisition in Functional Analysis. Iwata, Wallace, Kahng, et al. (2000) showed that 11 undergraduate college students who were enrolled in an applied behavior analysis course could be trained to acquire the skills needed to conduct a functional analysis. All participants had limited prior experience in functional analysis methodology. All FA sessions were conducted in the therapy rooms of a day treatment program at a residential facility. Training components consisted of reading materials about descriptions of FA conditions, watching a videotaped simulation of FA conditions, passing a quiz, and receiving verbal feedback on the participant's performance. The participant's performance was evaluated during the simulated sessions, while the participants served as therapists and conducted simulated functional analyses with graduate students who served as clients and displayed problem behaviors (i.e., SIB, destructive behavior). A multiple baseline across participants design was employed to examine the effectiveness of the training program. Results indicated that participants scored approximately 70% correct responses on average during baseline. After receiving 2 hours of training, performance accuracy level of all participants exceeded 95%. These results indicated that basic skills for implementing functional analyses could be obtained easily with a relatively small amount of training.

Moore, Edwards, Sterling-Turner, Riley, DuBard, and McGeorge (2002) attempted to extend the results of the Iwata, Wallace, Kahng, et al. (2000) study by evaluating methods for school teachers to implement functional analysis. The participants were three teachers (first and fourth grade general education teachers, and a fifth grade special education teacher) and three students (two typically developing students, one student with specific learning disabilities). Student target behavior was yelling during class. Training and classroom probes were conducted in the classroom. A multiple baseline across participants design was used to evaluate the effectiveness of the training. Training protocols consisted of reading materials regarding the FA conditions, a verbal quiz about the procedures, rehearsal, modeling, and performance feedback. Classroom probes were conducted during ongoing instruction. Following training, all teachers achieved an accuracy level of 95%.

Brief Functional Analysis. Although functional analysis is effective for identifying the function(s) of challenging behavior, there are some disadvantages. One of the disadvantages is the amount of time required to conduct an FA. Iwata, Pace, Dorsey et al. (1994) reviewed more than 150 functional analyses reported in the literature and found the average number of sessions conducted during a functional analysis was 26 and represented an average of 6.5 hours of assessment. In some settings such as outpatient clinics and classrooms, time constraints may make conducting a functional analysis unfeasible. Researchers have investigated methods to increase the efficiency of functional analyses. One of the best examples is the brief functional analysis described in Northup, Wacker, Sasso, Steege, Cigrand, Cook, and DeRaad (1991), which involves shortened session length as well as fewer sessions.

Northup et al. (1991) investigated the feasibility of implementing brief functional analysis with individuals who displayed aggressive behavior in an outpatient setting during a 90-

min evaluation. The participants were three individuals with intellectual disability who had aggressive behavior. All sessions occurred in an outpatient clinic. A multielement design was employed in this study. An analogue assessment was initially conducted, followed by a contingency reversal phase. During the analogue assessment, a potential social reinforcer was provided to the participant contingent on the occurrence of aggression. Each analogue condition lasted from 5 min to 10 min. Results of the analogue assessment showed that each participant showed different levels of aggression across analogue conditions and at least one analogue resulted in higher levels of aggression than the other analogues. During the contingency reversal phase, the reinforcer identified during the preceding analogue condition was presented to the participant contingent on the occurrence of a targeted mand. The results of the contingency reversal showed a substantial reduction in aggressive behavior and increase in use of the target mand for each participant.

Kahng and Iwata (1999) investigated correspondence among outcomes from extended functional analyses, brief functional analyses, and within-session analyses. The participants were 50 individuals with intellectual disabilities who were referred for an evaluation and treatment of SIB or aggression. All sessions were conducted in a therapy room at a state residential facility. Full functional analyses were implemented as described by Iwata et al. (1982/1994) including attention, tangible, demand, alone, and play condition. A multielement design was employed and sessions lasted from 10 to 15 minutes in length. The brief functional analyses were formed based on data from the first session of each condition. The within-session analyses were developed by replotting data from the first session of each condition to graph minute-by-minute changes in behavior during a session. Results from the brief and within-session functional analyses were compared to those obtained from the full analyses. Results showed that there was relatively high

correspondence between outcomes from the brief and within-session analyses and full analyses. Correspondence percentage between the brief and full analyses was 66%, and correspondence between the within session and full analyses was 68%.

Wallace and Iwata (1999) investigated the extent to which different session duration (briefer vs. longer exposure to the test condition) influenced the results of functional analyses. The participants were 46 individuals diagnosed with intellectual disability. They were referred for an evaluation and treatment of self-injurious behavior or aggression. All sessions were conducted in a therapy room at a residential facility. Functional analysis sessions were conducted as described by Iwata et al. (1982/1994) using a multielement design. Each condition lasted 15 minutes in length. The outcomes of 15-min FA sessions were utilized to create new data sets by deleting the last 5 min and the last 10 min from each session, resulting in three different data sets based on 5 min, 10 min, and 15 min session durations. The authors compared the results of functional analyses based on the 5 min and 10 min data sets to those based on the 15 min data sets. Results showed that interpretations based on 10 min sessions corresponded with those based on 15 min sessions for 100% of the 46 data sets, and interpretations based on 5-min corresponded with those based on 15-min sessions with just three discrepancies. The average time to complete a functional analysis was 6.1 hr, 4.1 hr, and 2.1 hr, respectively, for the 15-min, 10-min, and 5-min session duration sets. These findings suggested that the duration of functional analysis conditions could be reduced to 10 min or 5 min durations and maintain the integrity of assessment results. The results also suggested that brief session duration of functional analysis sessions may be effective in identifying functional relationships.

Wallace and Knights (2003) compared results obtained from both brief and extended functional analyses of problem behavior. The participants were 3 individuals with developmental

disabilities. All sessions were conducted in the participants' vocational setting. The participants' target behavior included disruptive behavior such as yelling and physical aggression. During brief functional analysis, sessions were conducted as described by Iwata et al. (1982/1994) using a pairwise design. All sessions lasted 2 minutes in length. During the extended functional analysis, a multielement design was used and all sessions lasted 10 minutes. Results showed that in 2 of the 3 cases, the results of the brief functional analysis corresponded with those of the extended functional analysis. The third participant showed the highest rates of disruptive behavior during the ignore condition (M = 16.3) of the brief functional analysis, but showed lower rates of problem behavior during the extended functional analysis with the highest levels of disruptive behavior occurring during the ignore (M = 8.7) and demand (M = 7.0) conditions. Total session time averaged 36 minutes for the brief functional analysis and 310 minutes for the extended functional analysis. These results suggested that correspondence between the results of a brief and extended functional analysis could vary but this might be acceptable in view of the time saved.

Perrin, Perrin, Hill, and DiNovi (2008) investigated the effectiveness of a brief functional analysis to identify the function of a dangerous behavior (i.e., elopement) in two 3-year old males with autism. Target behavior for both participants was elopement from their pre-school, which resulted in their exiting the building through doors. All sessions lasted 5 minutes in duration. The functional analysis included free play, attention, tangible, escape, and ignore conditions. The results of the brief functional analyses indicated that elopement was maintained by multiple functions for both participants. In a second phase of the study, these results were used to create a function-based treatment that resulted in a significant decrease in elopement

during treatment sessions. The amount of time required to complete the brief functional analysis and treatment was less than 3 hours for both participants.

Conducting Functional Analyses in the Home. Several attempts have been made to conduct functional analysis in the homes of children who show problem behavior. For example, Wacker and his colleagues reported that functional analysis procedures can be implemented in the home settings by primary caregivers with on-site coaching from trained behavior analysts (Berg et al., 2007; Derby et al., 1997; Wacker et al., 1998, 2005).

Wacker et al. (1998) trained primary caregivers to implement functional analysis and functional communication training with 28 children diagnosed with developmental delays or multiple disabilities. The children all displayed challenging behaviors such as aggression against others, SIB, and destructive behaviors. All sessions were conducted in the participants' homes by their parents with consultation from the investigators. A multielement design was employed to compare the results of an extended functional analysis based on the procedures described in Iwata et al. (1982/1994) with the addition of a tangible condition. Results showed that sources of reinforcement for problem behavior were identified for 24 cases (86%). Problem behavior was maintained by positive reinforcement in the form of attention or tangible functions for six cases (21%), whereas negative reinforcement (escape from demands) accounted for 13 cases (46%). Five children (18%) displayed problem behavior maintained by both positive and negative reinforcement. The functional analysis results for one child were undifferentiated. One child did not exhibit any problem behavior during the conditions. Following functional analyses, FCT was implemented by parents who had no formal training in behavioral assessment and treatment. Among 28 families, 22 parents implemented FCT for 3 months. FCT resulted in an average reduction in problem behavior of 87% across 22 children. Appropriate requests for the

reinforcers identified within the functional analysis increased an average of 69% across 22 children. The functional analysis and FCT procedures were rated as very acceptable by parents. These findings suggested that parents could conduct functional analysis procedures in their homes with direct consultation and could conduct functional communication training in their homes with intermittent consultation. These results also showed that FCT matched to the results of a functional analysis could be effective in decreasing the occurrence of problem behavior while increasing the use of appropriate requests for reinforcers (i.e., mands).

The results of Wacker et al. (1998) were limited to the training contexts in which FCT were implemented. Wacker et al. (2005) extended previous findings by evaluating stimulus generalization of FCT results. The primary purpose of Wacker et al. (2005) was to establish further the external validity of FCT, thus the authors replicated the Wacker et al. (1998) study with a second cohort of 26 children diagnosed with developmental delays or multiple disabilities who displayed destructive behavior. They trained parents to implement FA plus FCT procedures in their homes. The authors evaluated the occurrence of stimulus generalization following FCT treatment. In order to evaluate stimulus generalization following training, pre-treatment and post-treatment probes were conducted across persons, settings, and tasks. This study consisted of 5 phases: a) functional analysis using a multielement design, b) pre-treatment probes (baseline) across persons, settings, and tasks, c) FCT on a weekly or monthly basis for an average of 4.6 months, d) post-treatment probes across selected untrained stimulus conditions, and e) FCT with a second task for children who displayed destructive behavior during Phase 4. Results showed that the reinforcers maintaining problem behavior were identified for 21 cases (84%). Problem behavior was maintained by positive reinforcement in the form of attention or tangible for five cases (20%), whereas negative reinforcement (escape from demands) accounted for two cases

(8%). Fourteen children (56%) displayed problem behavior maintained by both positive and negative reinforcement. Functional analysis results for four children (16%) were undifferentiated. Following FCT treatment, reductions of 83% in total problem behavior were observed. Substantial reductions in total problem behavior across all stimulus conditions were reported (average reduction of 87% across persons, 91% across settings, and 49% across tasks). The results of treatment acceptability ratings measured by parents indicated that the procedures of FA plus FCT were rated as acceptable. The results showed that FA plus FCT could be an effective procedure for reducing problem behavior and increasing appropriate communication.

Summary

Experimental functional analyses involve the systematic manipulation of antecedent and consequence stimuli and direct observation of the target behavior (Horner & Carr 1997; Iwata et al., 1982/1994). Functional analyses allow for the identification of functional relations between challenging behavior and environmental events (Hanley et al., 2003). Results from a number of studies have demonstrated that social functions of problem behaviors can be successfully identified through the implementation of functional analysis methodology (Iwata et al., 1982/1994; Iwata, Pace, Dorsey, Zarcone, Vollmer, Smith, Rodgers, Lerman, Shore, Mazaleski, Goh, Cowdery, Kalsher, McCosh, & Willis, 1994; Pelios, Morren, Tesch, & Axelrod, 1999). For example, the results from Iwata, Pace, Dorsey et al. (1994)'s epidemiological study demonstrated that behavioral functions of problem behavior were identified in 145 (95%) cases through the implementation of functional analysis. The authors concluded that the functional analysis was effective in identifying sources of reinforcement that maintained problem behaviors. Overall,

functional analysis is viewed as a powerful tool in identifying environmental events that maintain the challenging behaviors (Hanley et al., 2003).

Research Studies on Functional Communication Training (FCT)

Carr and Durand (1985) introduced FCT as a treatment for problem behavior. They described a form of behavioral assessment (Experiment 1) and showed how inappropriate behaviors could be replaced with appropriate communicative response (Experiment 2). In both experiments, the participants were four children with developmental disabilities who displayed problem behavior. In Experiment 1, a behavioral assessment was conducted to identify environmental situations under which problem behavior was likely to occur. Three conditions (i.e., easy 100, easy 33, and difficult 100) were developed using two levels of task difficulty (i.e., easy and difficult) and two levels of attention (attention delivered for 100% of the session and attention delivered for 33% of the session). Three distinct patters of problem behavior were observed. For two children, higher levels of problem behavior occurred when difficult task demands (i.e., difficult 100) were presented, even though attention was available throughout the session, low levels of problem behavior occurred during the two easy task conditions (i.e., easy 100, easy 33). One participant showed higher levels of problem behavior during the low attention sessions (i.e., easy 33 and difficult 33). The final participant displayed higher levels of problem behavior during both difficult task and decreased attention conditions (i.e., difficult 100, difficult 33, and easy 33). In Experiment 2, two types of FCT were conducted for 4 participants: 1) relevant communicative response, and 2) irrelevant communicative response. During the irrelevant response condition, children who displayed problem behavior in the difficult task condition were taught to use a vocal response (“Am I doing good work?”) that resulted in adult

attention, and children who engaged in problem behavior in the reduced attention condition were taught to use the phrase ("I don't understand") that resulted in adult assistance. During the relevant response condition, children whose problem behavior was occasioned by reduced attention were taught to use a vocal response ("Am I doing good work?") that resulted in adult attention. The children whose problem behavior was occasioned by the difficult task were taught to use appropriate communication ("I don't understand") that resulted in adult assistance. Results showed that when a child was taught to use a relevant communicative response, a reduction in problem behavior was observed, whereas when a child was taught to use an irrelevant communicative response, the child engaged in higher levels of problem behavior than during relevant responses. These findings demonstrated that the communicative response which was functionally related to the reinforcers maintaining problem behavior could result in substantial reductions in the problem behavior; however, when the communicative response was functionally unrelated to the reinforcers, it might not reduce the problem behavior.

Kurtz, Boelter, Jarmolowicz, Chin, and Hagopian (2011) conducted a meta-analysis on the use of FCT for problem behavior exhibited by individuals with ID using 29 studies on FCT. The researchers used the criteria for evaluating the empirical support for treatments that was developed by Divisions 12 and 16 of APA and the additional criteria for single-case designs developed by Jannett and Hagopian (2008). The results showed that sufficient empirical support was available to designate FCT as a well-established treatment for problem behavior displayed by individuals with ID and individuals with ASD.

Response Efficiency. As Tiger et al. (2008) suggested, when selecting communicative response topography, response effort should be considered. Horner and Day (1991) investigated the effects of response efficiency in functional communication training. In experiment 1, the

participant displayed aggression maintained by escape from demands. In one condition, sentence sign phase, the participant was taught to sign "I want to go, please" to request a break. The participant showed a substantial reduction in the use of sign "I want to go, please" and increase in aggression during this phase. In a second condition, word sign phase, the participant learned to sign the word "break." After learning the less effortful mand, the participant showed a gradual increase in manding (*M* = 88% of the trials), and a substantial reduction in aggression. These findings suggest that more efficient mand topographies may compete with problem behavior better than mands that are less efficient. Thus, the effort required to acquire and emit the mand should be considered when developing an FCT program.

Richman, Wacker, and Winborn (2001) extended previous findings by evaluating the effects of response efficiency on aggression maintained by access to tangibles. The participant was a 3-year-old male diagnosed with pervasive developmental disorder and was referred to an inpatient clinic for an evaluation and treatment of aggression. All sessions were conducted by the participant's mother with coaching from therapists. The results of functional analysis suggested that his aggression was maintained by access to preferred items. During a two phase mand analysis, the use of a communication card was compared to instances of aggression (Phase 1) and signing "please" (Phase 2). A concurrent schedule assessment was employed using a reversal design to complete the mand analysis. The results of Phase 1 showed that participant use of the communication card occurred more often than he engaged in aggression. During Phase 2, the participant signed "please" more often than he used the communication card. Richman et al. (2001) concluded that making the manual sign for please was a more efficient way to obtain the preferred toy than handing the picture card to his mother. These results provided support to

Horner and Day's (1991) study by providing another demonstration of the effects of mand efficiency on the participant's selection between available mands and problem behavior.

Social Recognition of the Response. As Tiger et al. (2008) suggested, the social recognition of the mand should be considered when developing an FCT treatment package. Durand (1999) evaluated the effectiveness of using a voice output device as a mand topography for use in community settings with unfamiliar people. The participants were five students with developmental disabilities who displayed problem behavior such as self-injury, aggression, or tantrums. All sessions were conducted by the participants' teachers. Functional analyses identified social functions for all students: two students showed an escape function, two students showed a tangible function, and one student showed an attention function for problem behavior. Data from the functional analyses were utilized to select a message that matched the function of problem behavior for each participant. Functional communication training involved teaching the five students to emit a mand using a voice-output device as an alternative to destructive behavior at school and in the community. All functional communication training was conducted in the classroom during this phase of the study. Results showed that FCT resulted in substantial reductions in problem behavior for each participant. Following FCT training in the classrooms, the use of assistive communication devices were generalized to community settings such as a food court, library, movie theatre, or store. The voice-output device was put within reach of the students throughout the sessions in the community. The result indicated that all students used their devices successfully under untrained conditions and that untrained members of their communities responded appropriately to the students' communicative responses. The results of this study suggest that the voice output devices provided a recognizable mand that was effective for reducing problem behavior in the classroom and effective in obtaining desired responses

from unfamiliar people in community settings. These findings extended previous findings (Durand & Carr, 1991, 1992) by documenting the effects of FCT on problem behavior beyond the specific training settings.

FCT with Extinction and Punishment. As Tiger et al. (2008) suggested, when developing FCT intervention, two consequences for problem behavior can be considered: extinction and punishment. A number of studies suggested that FCT without extinction may not be effective for reducing problem behavior (Fisher et al., 1993; Hagopian et al., 1998; Wacker et al., 1990). Hagopian et al. (1998) examined the efficacy of FCT with and without extinction and punishment for treating problem behavior. The participants were 21 individuals with intellectual disability and a severe behavior disorder who displayed problem behavior such as aggression, self-injury, and/or property destruction. Functional analyses identified social functions for all participants (nine with an attention function, seven with an escape function, one with a tangible function, and four with multiple functions). FCT without extinction was conducted across 11 applications and FCT with extinction was conducted in 25 applications. Results showed that FCT without extinction failed to reduce problem behavior below 90% of baseline levels. FCT with extinction resulted in at least a 90% reduction in problem behavior in 11 of the 25 applications (44%). After FCT with extinction was not effective for some participants, a punishment contingency (i.e., time-out, presentation of additional demands) was added during 17 applications. FCT with punishment resulted in at least a 90% reduction in problem behavior in all applications. These findings support previous findings (Lalli, Casey, & Kates, 1995; Shirley, Iwata, Kahng, Mazaleski, & Lerman, 1997) in showing that FCT with extinction was more effective in reducing problem behavior than FCT without extinction, and the addition of a

punishment procedure resulted in reductions of problem behavior for participants who continued to show problem behavior during the FCT plus extinction condition.

Hanley, Piazza, Fisher, and Maglieri (2005) evaluated the efficacy of FCT with and without punishment for treating problem behavior. The participants were two children with intellectual disability and severe behavior disorders. The target behaviors included aggression, self-injury, and disruption. The results of function analyses suggested that the problem behavior for both children was maintained by social positive reinforcement. Following functional analyses, FCT and FCT plus punishment were implemented using a reversal design. The results of the treatment analyses suggested that both FCT and FCT plus punishment resulted in reductions in problem behavior; however, the effectiveness of FCT was increased when a punishment component was added to FCT. The results showed that adding a punishment component to the function-based intervention resulted in the largest reductions in problem behavior. During FCT, high rates of problem behavior were frequently reported. By contrast, during FCT plus punishment, low rates of problem behavior were observed consistently throughout the sessions. The results of this study were consistent with Hagopian et al. (1998)'s previous findings that adding a punishing consequence may be necessary for reducing problem behavior.

Delay Fading. One limitation of FCT is that at times it may not be possible to reinforce each instance of the communicative response in natural settings (Fisher et al., 1993). Reinforcement for communicative responses can be delayed or denied for several reasons: 1) the reinforcer is not available immediately, 2) it is improper to deliver the reinforcer, and 3) the communicative response may occur frequently or at times when it is impractical for caregivers to deliver the requested reinforcer (Fisher, Thompson, Hagopian, Bowman, & Krug, 2000). The

delay or denial of reinforcement following appropriate mands may weaken the communicative response and increase the chance of reemergence of problem behavior (Fisher et al., 2000). A strategy such as demand fading (or response chaining) can be used to address this limitation of FCT.

Lalli et al. (1995) investigated the effects of response chaining on three children whose problem behavior was maintained by escape from demands. Following functional analysis, FCT plus extinction was implemented; participants could escape from a task for 30-seconds contingent on a verbal response. During the response chaining condition, each child was required to complete a specific number of steps in the task before requesting a break. The therapist gradually increased the number of steps that the participant had to complete before asking for a break. Results suggested that FCT plus extinction with response chaining resulted in substantial reductions in problem behavior for each child. Although the task requirements were increased, the participant's rates of problem behavior remained low throughout the response chaining phases and task completion increased across sessions. These findings suggest that a response chaining procedure may be effective in both reducing problem behavior and increasing task participation. The chaining procedure also can be used to facilitate tolerance for periods of wait time when reinforcement is delayed.

Fisher et al. (2000) evaluated the effects of three techniques involving 1) reinforcement delay fading, 2) punishment, and 3) presentation of an alternative activity to facilitate tolerance of delayed reinforcement during FCT. The participants were three individuals who displayed destructive behavior. In Experiment 1, during FCT plus extinction with fading condition, the participant whose destructive behavior was maintained by attention was taught to wait for reinforcement using a technique described by Fisher et al. (1993). Initially a delay between

communication and reinforcement was inserted and gradually extended to 30 seconds. Results of Experiment 1 showed that rates of destructive behavior decreased quickly and stayed low while the delay was increased to 30 seconds. These findings suggested that providing reinforcement for tolerating delays alone can be effective for maintaining low rates of problem behavior as the task and delay to reinforcement are increased.

In Experiment 2, the participant was a 7-year-old child whose destructive behavior was maintained mainly by tangible reinforcement. Experiment 2 was designed to assess the effects of FCT plus punishment when reinforcement for a communication response was delayed. Results indicated that when reinforcement for the communication response was not delivered immediately (i.e., 1 minute delay), high rates of destructive behavior were observed during FCT plus extinction. Once a punishment component was added to FCT, destructive behavior decreased quickly and appropriate communication increased. The length of the reinforcement delay was gradually increased from 1 minute to 10 minutes during the FCT plus punishment phase. These findings indicated that when reinforcement for the communication response may not be delivered immediately, FCT plus extinction may not be sufficient to reduce destructive behavior, and adding a punishment component may result in reductions in destructive behavior.

Experiment 3 included a participant whose destructive behavior was maintained by tangible reinforcement. The purpose of Experiment 3 was to evaluate the effects of providing an alternative activity during the reinforcement delay. During the FCT plus extinction with work condition, the participant was prompted to engage in a work task during the wait period. During the FCT plus extinction with waiting, a work task was removed from the participant during the wait period. Results suggested that prompting the participant to complete a work task during the wait period resulted in substantial reductions in destructive behavior and facilitated delay fading.

FCT in Home Settings. A couple of studies have evaluated the long-term effects of FCT on problem behavior (Derby et al., 1997; Wacker et al., 1998). For example, Derby et al. (1997) evaluated the long-term effects of FCT in home settings. The study consisted of 4 phases: a) descriptive assessment, b) experimental analysis, c) FCT treatment, and d) follow-up. Participants were four children with developmental delay who displayed destructive behavior including self-injury, aggression, and destruction. All sessions were conducted in the home setting (with the exception of a classroom for one participant) by the child's parent with intermittent consultation from a behavior analyst. Through Phases 1 and 2, social functions of destructive behavior were identified for each participant. The results of the study suggested that the FCT treatment was effective in decreasing problem behavior for all children. Long-term suppression of destructive behavior was maintained over a 2-year period while manding and other positive social responding (i.e., toy play) increased. These findings showed that successful long-term maintenance can be achieved if FA plus FCT treatment is conducted in home settings by parents with intermittent consultation. Anecdotal reports obtained from parents indicated that successful suppression of destructive behavior was observed in school setting.

Stimulus Generalization. Several studies have shown that FCT treatment can be successfully transferred to different stimulus contexts (Berg et al., 2007; Durand & Carr, 1991; Wacker et al., 2005).

Durand and Carr (1991) evaluated the effects of FCT on problem behavior across non-trained stimuli. The participants were 3 children with developmental disabilities who displayed challenging behavior. The results of functional analysis indicated that the challenging behaviors were maintained by escape from demands for all participants. Results suggested that FCT resulted in substantial reductions in challenging behavior and gradual increases in appropriate

communication. The results of follow-up observations showed that the reductions in problem behavior and increases in appropriate communication were maintained across non-trained contexts (i.e., teachers, classrooms) for up to 24 months for two of the three participants. These findings suggested that the FCT treatment can be successfully transferred to untrained antecedent stimuli such as novel persons and settings. This study also showed positive long-term effects of FCT.

Wacker et al. (2005) investigated stimulus generalization following FCT training in 12 children (ages 1 to 6 years) who displayed challenging behavior. Pre and post treatment probes were administered across different settings (e.g., home, school), people (e.g., parents, teachers), and tasks (e.g., bath task, academic work). FCT was then conducted by the participant's mother in the family living room with a specific activity. Once a reduction in problem behavior was observed, probes across the untrained conditions were conducted. Results showed that FCT resulted in an average reduction in problem behavior of 93% within the treatment setting, an 81% reduction across persons, a 90% reduction across settings, and a 73% reduction across tasks. These findings extended previous findings (e.g., Derby et al., 1997; Durand, 1999) by evaluating stimulus generalization across persons, settings, and tasks.

Berg et al. (2007) evaluated the effects of FCT on problem behavior across three stimulus dimensions including tasks, settings, and persons. Four children (ages 4 to 5) whose problem behavior was maintained by escape from demands participated in the study. Pretreatment generalization stimuli probes were conducted across different tasks, settings, and persons. FCT sessions were conducted in the home setting by each child's mother with consultation from a behavior analyst. Post treatment stimulus condition probes were conducted across all generalization sets of stimuli that were associated with problem behavior during the

pretreatment probes. Results indicated that FCT with the training stimuli resulted in 90% or greater reduction in problem behavior and increases in manding and task completion. Problem behavior was observed for 29 of the 37 pretreatment generalization stimulus sets, but was not observed for the remaining sets. Reductions in problem behavior occurred for 70% of the stimulus sets during post treatment. Increased task completion was observed for 78% of the stimulus sets during post treatment probes.

Summary

There have been many studies since the Carr and Durand (1985) study that have investigated the effectiveness of FCT as a treatment for reducing problem behavior across settings (e.g., Northup, Wacker, Berg, Kelly, Sasso, & DeRaad, 1994; Waker et al., 2005), topographies of problem behaviors (e.g., Kurtz et al., 2003; Rooker, Jessel, Kurtz, & Hagopian, 2013), and subgroups (e.g., Hagopian et al., 1998). A number of studies have shown that FA plus FCT can result in clinically significant reductions in the challenging behavior of children with developmental disabilities and increases in prosocial behaviors across various settings including clinic settings, schools, and home settings (Asmus et al., 2004; Kurtz et al., 2003; Berg et al., 2007; Derby et al., 1997; Wacker et al., 1998; Wacker et al., 2005; Northup et al., 1994). FCT is one of most commonly used treatments for reducing problem behavior (Tiger et al., 2008) and is a well-established treatment (Kurtz, et al., 2011).

Research Studies on the Use of Telehealth in Behavioral Assessment and Treatment

Barretto et al. (2006) conducted functional analyses of problem behavior with two children via the use of telehealth. The participants were a 5-year-old boy with autism and a 1-

year-old girl with developmental disabilities. The participants were referred for challenging behavior including self-injury and disruptive behavior. The evaluations were conducted in either a local school by a classroom teacher with coaching from a school psychologist or in a social service agency by a primary caregiver and a physical therapist. The consultants were located in the telemedicine studio at the University of Iowa Children's Hospital, while the child and local service staff were located at remote sites in Iowa. The results indicated that problem behaviors were maintained by negative reinforcement for both participants. These findings indicated that functional analysis could be conducted by local staff and the child's primary caregivers with intermittent consultation through telehealth. These results extended previous demonstrations of the adaptation of FA procedures to home settings by successfully implementing FAs via telehealth.

Frieder, Peterson, Woodward, Crane, and Garner (2009) examined the effects of web-based telehealth for conducting a functional analysis in a school setting. The participant was a 4-year-old boy with developmental delays who engaged in problem behavior including aggression and tantrums. All functional analysis procedures were conducted by school staff in a classroom via telehealth. The school was located approximately 100 miles away from the university where behavior analysts were housed. A functional analysis was implemented as described by Iwata et al. (1982/1994) including attention, tangible, demand, and play conditions. Web-based live coaching was provided from behavior analysts located at the university setting during sessions. Results suggested that the participant's problem behavior was maintained by access to tangible reinforcers. The authors reported that the school staff implemented the FA procedures with high fidelity. The results of this case study supports the previous findings of Barretto et al. (2006) that

functional analyses can be conducted by individuals with little experience in functional analysis when consultation from behavior analysts is provided via telehealth.

Machalicek et al. (2009) showed that functional analysis could be conducted using telehealth with two girls (7 years old and 11 years old) diagnosed with autism and moderate intellectual disability. The children were evaluated by graduate students who had no training in functional analysis in an assessment room in a school setting. Consultation and supervision were provided by advanced graduate students with extensive experience implementing functional analyses in a separate room at the same building via telehealth. Results indicated that clear social functions were identified for both participants. The two participants' target behaviors including aggression, destruction, SIB, and tantrums were maintained by escape from demands and access to attention. The authors developed an intervention based on the results of the FA for both participants. Results showed that the classroom intervention derived from the findings of the FA led to substantial reductions in problem behavior and increased engagement in classroom activities for both participants. These findings supported previous studies (Barretto et al., 2006; Frieder et al., 2009) by successfully conducting functional analyses via telehealth. The results of these studies indicate that telehealth is an effective way to implement behavioral evaluation.

Gibson et al. (2010) investigated whether functional communication training could be implemented effectively to reduce the elopement of a 4-year-old boy with autism via telehealth. A brief functional analysis was conducted by a preschool teacher with coaching from a behavior consultant prior to the implementation of FCT. The FA data indicated that the participant's elopement was maintained by access to tangible reinforcers. Following the functional analysis, all sessions including planning, teacher training, and data collection were conducted via Skype. An FCT treatment that matched the FA results (i.e., resulted in the preferred tangible item) was

implemented by the classroom teacher with feedback from the consultant via Skype. The results showed that FCT produced substantial reductions in elopement for the student. These findings also suggested that school staff supervised by experienced behavioral consultants via Skype could implement the FCT procedures with a high degree of fidelity. The FCT procedures via Skype were rated as acceptable by school staff.

Wacker et al. (2013a) used telehealth technology to conduct functional analyses with children with ASD. The participants were 20 children (ages 2 to 6) with ASD who displayed problem behaviors. Two trained behavior analysts located at tertiary hospital provided coaching, via telehealth, to participants' parents located at regional pediatric clinics to conduct FA procedures. Behavior analysts also trained parent assistants who provided on-site support to the parents during the telehealth consultation. All FA procedures were conducted by the participants' parents with coaching from the consultant via telehealth. The number of 1-hr weekly telehealth visits was 4.9 on average (range 4 to 8), and the number of FA sessions was 18.1 on average (range 14 to 35). The weekly cost of conducting FAs via telehealth was approximately 1/6 of the cost for sending a behavior analyst to the participants' homes to conduct an FA. The FA procedures identified social functions of challenging behavior for 18 participants (90%). This research also showed that functional analyses could be conducted effectively via telehealth with parents.

Wacker et al. (2013b) showed that FCT could be implemented by parents of 17 children with ASD via telehealth when coaching was provided by experienced behavior analysts. The participants were 17 young children (ages 2 to 6) whose problem behavior was maintained by positive and/or negative reinforcement. Nineteen FCT treatments matched to the identified function of problem behavior were provided for 17 participants. All sessions were conducted by

the participants' parents with coaching from behavior analysts via telehealth. They used the same regional clinics and the telehealth center at the tertiary level hospital as described in Wacker et al. (2013a). The number of FCT sessions averaged 21 visits per participant (range 6 to 42) and the average total time to complete treatment was 13 weeks (range 4 to 21 weeks). Results indicated that FCT treatments produced substantial reductions in problem behavior (M = 93.5% reduction from baseline levels). In addition, the cost of delivering FCT treatment via telehealth was about 80% less than in-vivo behavioral therapy in the caregivers' homes. The authors reported that telehealth consultation can be an effective way to deliver behavioral intervention and can be used as part of early intervention for children with ASD who show problem behaviors. The participants' parents rated the FCT procedures via telehealth as highly acceptable on the TARF-R (Reimers and Wacker, 1988).

Most recently, Suess et al. (2014a) evaluated the treatment fidelity of parents who implemented FCT with coaching through telehealth. The participants were three children diagnosed with autism (ages 2 to 3). During weekly 1-hour coached sessions, the behavior consultant coached the parents on FCT procedures via telehealth. During practice sessions, the parents recorded treatment sessions during which they conducted the FCT procedures independent of coaching. All FCT sessions were conducted in the child's home by their parents. The telehealth center was the same as described in Wacker et al. (2013a and 2013b). The level of fidelity during coached and practice sessions was evaluated using a multielement design. The omission and commission errors during both coached and practice sessions were recorded throughout the treatment. Results demonstrated that no consistent differences between the coached and practice trials occurred for the participants. In addition, there were no strong relationship between fidelity errors and treatment outcomes. The results of the study indicated

that the parents conducted FCT with acceptable fidelity and that substantial reductions in children's problem behavior were achieved by the end of treatment. These results suggested that telehealth was an effective way to train parents to conduct FCT within their homes. These findings provide support for the use of telehealth to deliver behavioral treatment.

Summary

As discussed by Wacker et al. (2013a), the demand for applied behavior analysis (ABA) assessment and intervention is frequently greater than the availability of these services, despite the success of in-clinic and in-home services. The use of telehealth consultation appears to be a viable way to solve the problem of limited access to health service providers and trained applied behavior analysts who could conduct FA plus FCT (Wacker et al., 2013a and 2013b).

One problem that many Korean families encounter is not having access to trained applied behavior analysts. There is only one behavior clinic in Korea (e.g., Seoul Municipal Children's Hospital). There are fewer than 20 Korean Board Certified Behavior Analysts listed in the Korea certificant registry (Behavior Analysis Certification Board, 2015). The use of telehealth services could be one solution to the limited access to ABA services in Korea. Wacker et al. (2013a) evaluated the application of telehealth to teach parents in rural areas of Iowa to conduct behavioral treatments with their children in their home. An evaluation of the effectiveness of this telehealth ABA service model in an underserved country is needed to determine if this is a viable approach for service delivery for another country like Korea.

The current study extended previous studies (Barretto et al., 2006; Suess et al., 2014a; Wacker et al., 2013a and 2013b) by demonstrating the application of telehealth between a setting with expertise in applied behavior analysis in the U.S. and the home of a child who shows severe

challenging behaviors living in a country with limited access to ABA services. This study can serve as a model for extending evaluations from one country to another country with limited access to the ABA services. This study also extended previous research by using reliable, relatively low cost, readily accessible smart phones for the video connection in the participant's homes.

Table 1. Research Studies on the Use of Telehealth in Behavioral Assessment and Treatment

Study	Population	Setting	Evaluation	Therapist	Results
Barretto et al. (2006)	Five-year-old boy with autism and a one-year-old girl with developmental disabilities	Telemedicine studio (UIHC) Classroom 92 miles away from the UIHC	FA	Classroom teacher Primary caregiver/ Physical therapist	Escape functions for both participants
Frieder et al. (2009)	Four-year-old boy with developmental delays	University setting Classroom 100 miles away from the university	FA	School staff	Tangible function
Machalicek et al. (2009)	Two girls diagnosed with autism and ID	Assessment room in a school A separate room in the same building	FA	Graduate students	Escape and attention functions
Gibson et al. (2010)	Four-year-old boy with autism	University setting Preschool classroom 80 miles away from the university	FCT	Classroom teacher	Elopement was significantly reduced.

Table 1. Continued.

Wacker et al. (2013a)	20 children with ASD (under 6 years old)	Teleconsultation center at UIHC Regional clinics	FA	Parents and on-site parent assistants	Functional analysis procedures identified social functions for challenging behavior for 18 participants (90%).
Wacker et al. (2013b)	17 children with ASD (under 6 years old)	Teleconsultation center at UIHC Regional clinics	FCT	Parents and on-site parent assistants	Functional communication training reduced problem behavior by an average of 93.5%.
Suess et al. (2014a)	Three children with ASD	Teleconsultation center at UIHC Participants' homes	FCT fidelity	Parents	Parents conducted FCT with acceptable fidelity and that substantial reductions in children's problem behavior were achieved by the end of treatment

CHAPTER III

METHODOLOGY

Experiment 1

Participants

Five young children from Korea who were diagnosed with ASD and engaged in challenging behavior and their mothers participated in the study. The researcher put a note about the study on Korean websites related to ASD support groups for Korean parents of children with ASD. The participants were self-referred to the researcher and each child met the following criteria: (a) ranged in age from 2 to 6 years old, (b) had ASD according to parent report and/or medical records, (c) displayed challenging behavior (e.g., aggression, property destruction, self-injury, and/or noncompliance), (d) had a high-speed internet connection in their home, and (e) lived in Korea. Three participants lived in Seoul and two lived in a suburban area of Seoul.

Sun was a 4-year-old male diagnosed with ASD who engaged in problem behavior. Sun's mother reported that his problem behavior included aggression (e.g., hitting, kicking, pushing) and property destruction (e.g., throwing items). Sun's problem behavior limited the ability of his family to participate in social activities including eating out at a restaurant and going shopping at a mall. His primary mode of communication consisted of vocal language (phrase speech). Sun attended preschool and received academic instruction in a general education classroom. He received speech therapy and behavior therapy.

Ana was a 3-year-old female diagnosed with ASD who engaged in problem behavior. Ana's problem behavior included aggression (e.g., hitting, kicking, and pushing), self-injury (e.g., gagging, hitting head, head banging), and property destruction (e.g., throwing items). Ana's problem behavior limited the ability of her family to have social activities including eating out at

a restaurant, going shopping at a mall or going to church. Her primary mode of communication consisted of some vocalizations (e.g., “please”, “snack”). Ana attended preschool and received academic instruction in a general education classroom. She received private speech therapy, play therapy, music therapy, and sensory therapy.

Kim was a 4-year-old male diagnosed with ASD who engaged in problem behavior. His mother reported that his problem behavior was property destruction (e.g., throwing items, tearing work tasks) and aggression (e.g., hitting, kicking, throwing items at people, and pushing). Kim’s problem behavior limited his family’s ability to participate in social activities including eating out at a restaurant, going shopping at a mall, or going to church. His primary mode of communication was vocal language (phrase speech). Kim attended preschool and received academic instruction in both general and special education classrooms. He received private speech therapy, occupational therapy, and sensory therapy.

Tran was a 6-year-old male diagnosed with ASD and moderate intellectual disability who engaged in problem behavior. Primary problem behaviors were aggression (e.g., hitting, pushing, pulling, and kicking), destruction (e.g., throwing items), and self-injury (e.g., head hitting and chin hitting) within home, community, and school settings. Tran’s problem behavior interfered with his family’s ability to participate in social activities including eating out at a restaurant and going shopping at a mall. His primary modes of communication consisted of pointing, gestures, and some signs with no spoken words. He was placed in an inclusive kindergarten classroom. He received academic instruction in the general education classroom with pull-out special education services.

Doll was a 4-year-old female diagnosed with ASD who engaged in problem behavior. Doll’s destructive behavior included aggression (e.g., hitting, kicking, pushing, and pulling hair),

self-injury (e.g., throwing herself on the floor, hitting and slapping herself), and property destruction (e.g., throwing items). Doll's problem behavior limited the ability of her family to participate in social activities including eating out at a restaurant and going shopping at a mall. Her primary mode of communication consisted of some vocalizations (e.g., "please", "mom", and "dad"). Doll attended preschool and received academic instruction in a general education classroom. She received private speech therapy, play therapy, and music therapy.

Parent Demographic Information. The participant's mothers conducted all FA sessions with coaching from the behavior consultant. The mothers were all married and four had completed a degree beyond a high school diploma (i.e., three mothers had a bachelor's degree, one had an associate's degree, and one had a high school diploma). None of the mothers had formal training in behavioral assessment prior to their participation in the study.

Behavior Consultant. The author served as the behavior consultant. He is a native of Korea and a doctoral candidate in the School Psychology program at the University of Iowa. He is a trained behavior specialist with 3 years of experience conducting FA and FCT in clinical settings. The behavior consultant provided behavioral coaching to the parents via telehealth to complete FA and FCT procedures.

Settings and Materials

Participant Homes. The study was conducted in the participants' homes during weekly 1 hour visits. All information was communicated in the Korean language. The leisure items were selected by the parents from toys and other activities in the home. The work tasks were selected based on the parent's report of tasks that were associated with problem behavior at home. Three

mothers used their smart phone for the Skype sessions. One used her tablet (i.e., iPad mini 2) and the final mother used her desktop.

Sun's sessions were conducted in his bedroom. The bedroom was approximately 2m x 2m and included one small table, desktop computer, a desk, and a chair. Tangibles for Sun included a cellular phone toy, doctor's kit, fish toys, ball, keyboard, music toy, action figures, iPad, and animal toys. Work tasks for Sun included putting toys in a bucket and a tracing task. A desktop computer (Intel I7 3870), monitor (Samsung S32D85), and web camera (Microsoft LifeCam VX5500) were used to connect to Skype to conduct telehealth sessions.

Ana's sessions were conducted in the family's living room. The living room was approximately 4m x 6m and included one small table, TV set, several drawers, and couches. Tangibles for Ana included a doll, photos, number tiles, calendar, TV, books, play dishes, snacks, and animal toys. The work task for Ana was putting toys in a bucket. A smart phone (Samsung Galaxy s5) and Bluetooth headset (Motorola HK 200) were used to connect to Skype to conduct the telehealth sessions.

For Kim, all sessions were conducted in the family's living room or his bedroom. The living room was approximately 6m x 7m and included a small table and several couches. The bedroom was approximately 2m x 4m and included a small table, several book shelves, and a chair. Tangibles for Kim included Lego® blocks, books, crayons, animal toys, sketch book, cars, smart phone, train, and balls. Work tasks for Kim included putting toys in a bucket and a tracing task. A smart phone (Samsung Galaxy s3) and a Bluetooth headset (Britz Be-M2) were used to connect to Skype to conduct telehealth sessions.

For Tran, all sessions were conducted in the family's living room. The living room was approximately 4m x 5m and included one small table, several chairs, and couches. Tangibles for

Tran included Lego® blocks, steering wheel, music toy, animal toy, dolls, play food, cups, balls, and a trampoline. The work task for Tran was putting toys in a bucket. For the Skype connection, a tablet was present on a dinner table during all visits in the room. The tablet (Apple iPad mini 2) and a Bluetooth headset (Samsung MF210) were used to connect to Skype to conduct telehealth sessions.

For Doll, all sessions were conducted in her parents' bedroom. The bedroom was approximately 3m x 3m and included one small table, TV set, several drawers, and a chair. Tangibles for Doll included play food, iPad, TV, cars, animal toy, and Play Doh. The work task for Doll was putting toys in a bucket. A smart phone (Samsung Galaxy Note2) and Bluetooth headset (LG Tone Pro HBS-750) were used to connect to Skype to conduct telehealth sessions.

Telehealth Center. The behavior consultant provided coaching to parents via Skype during the FA and FCT sessions from one of four work stations located in the Teleconsultation Center located at the Center for Disabilities and Development at the University of Iowa Children's Hospital. Each station contained a Window-based PC (Dell Windows XP) and a video monitor (32-in.-flat-panel LC D monitor). A webcam (Logitech 600) and headset (Logitech G330) were attached to each PC. One of the most widely used teleconferencing software, Skype, was used in this study.

Response Definitions

Data were collected on child behavior and task completion.

Child Behavior. Child behavior included target problem behavior, nontargeted problem behavior, and independent mands. Only target problem behavior was reinforced during the FA. Child behavior was defined individually based on parent report. Sun's target problem behavior

included aggression (e.g., hitting, kicking, and pushing), and property destruction (e.g., throwing items). Ana's target problem behavior included aggression (e.g., hitting, kicking, and pushing), self-injury (e.g., gagging, hitting head, and head banging), and property destruction (e.g., throwing items). Kim's target problem behavior included aggression (e.g., hitting, kicking, throwing items at people, and pushing), and property destruction (e.g., throwing items). Tran's target problem behavior included self-injury (e.g., head hitting and chin hitting), aggression (e.g., hitting, kicking, and pushing), and property destruction (e.g., throwing items). Doll's target problem behavior included aggression (e.g., hitting, kicking, pushing, and pulling hair), self-injury (e.g., throwing self on floor, hitting and slapping herself), and property destruction (e.g., throwing items). For all participants, nontargeted problem behavior included noncompliance (e.g., task refusal), tantrums (e.g., screaming and crying), dangerous behavior (e.g., climbing), and elopement (e.g., attempting to leave the room). Repetitive behavior (e.g., body rocking, dropping objects) was only shown by Tran. Independent manding was defined as the child emitting an appropriate request for reinforcement without physical guidance or verbal prompt. For Kim, Ana, and Sun, independent manding included vocalizing appropriately (e.g., saying "please, the name of item") to request reinforcement. For Doll and Tran, independent manding included signing (e.g., more) and gesturing (e.g., pointing) to request reinforcement.

Task Completion. Independent task completion was defined as placing a block into the bucket (i.e., Tran, Kim, Ana, Doll, and Sun) or completing a tracing worksheet (i.e., Kim, Sun) without physical guidance. Each task was coded when completed independently without hand over hand guidance.

Data Collection

All data were collected during the weekly visits. All sessions were digitally recorded using Debut Video Capture Software Professional. Data were individually coded by the researcher and a second observer during the research session or at a later time via digital-recordings. A 6-s partial-interval recording system was used to code data on child behavior. In this system, if a response was observed at any point during the 6-s interval, the occurrence of the behavior was coded. These data are shown as percentage of intervals with child behavior. An event recording data collection system was used to record task completion. Data on task completion were coded as frequency of task completion divided by the number of tasks presented and multiplying by 100. Data were also recorded on the number of assessment sessions and the number of telehealth visits required to complete the FA as described in Wacker et al. (2013a). The function of problem behavior was determined by visual inspection and then with the criteria described in Roane et al. (2013) which was developed to interpret functional analysis outcomes.

Interobserver Agreement for Child Behavior and Task Completion

Two observers (i.e., researcher and a second observer) independently coded data during the research sessions or at a later time via the video record to collect interobserver agreement data (IOA). When two independent observers coded the occurrence of the same behavior during the same interval, an agreement was scored. A disagreement was scored if only one observer recorded a behavior during an interval. Interobserver agreement was calculated by dividing the number of agreements by the number of agreements and disagreements and multiplying the result by 100%. Interobserver agreement for task completion was calculated by dividing the low

number of completed tasks by the high number of completed tasks and multiplying the result by 100%.

For Sun, IOA for child behavior was calculated on 59% of the FA sessions and averaged 95% agreement across test conditions (range, 68% to 100%). Interobserver agreement for task completion was completed for 40% (2 sessions) of the ES sessions (5 sessions) and averaged 100%. For Ana, interobserver agreement for child behavior was calculated on 50% of the FA sessions and agreement averaged 96% across test conditions (range, 85% to 100%). Interobserver agreement for task completion was completed for 33% (2 sessions) of the ES sessions (6 sessions) and averaged 94% (range, 88% to 100%). Interobserver agreement for child behavior for Kim was calculated on 38% of the FA sessions and agreement averaged 98% across test conditions (range, 88% to 100%). Interobserver agreement for task completion was completed for 33% (2 sessions) of ES sessions (6 sessions) and averaged 100%. For Tran, interobserver agreement for child behavior was calculated on 50% of the FA sessions and agreement averaged 90% across test conditions (range, 75% to 100%). Interobserver agreement for task completion was completed for 50% (2 sessions) of ES sessions (4 sessions) and averaged 93% (range, 91% to 94%). For Doll, interobserver agreement for problem behavior was calculated on 61% of the FA sessions and agreement averaged 97% across test conditions (range, 89% to 100%). Interobserver agreement for task completion was completed for 50% (2 sessions) of ES sessions (4 sessions) and averaged 97% (range, 94% to 100%).

Two independent researchers examined the FA data to identify the function of problem behavior and to confirm the number of sessions and visits conducted during the FA. Initially, two independent observers determined the function of the problem behavior using visual inspection of the data and one of them then used procedures described by Roane et al. (2013) to confirm the

function. Interobserver agreement for FA outcomes based on visual examination was obtained at 100% for each participant.

Procedural Integrity

Procedural integrity was scored when the following three conditions were all met during any FA condition: (a) the correct establishing operation (EO) was set up during the trial (i.e., a demand was presented during an escape condition, attention was removed during an attention condition, preferred tangible item was removed during a tangible session, and attention and tangible item were available and no demand was presented during free play); (b) presenting the correct reinforcer contingent upon problem behavior during each FA test condition and providing no consequences to problem behavior during the FA play condition; and (c) no consequences for nontargeted problem behaviors were provided during free play and test conditions. Each time any of these three conditions was not met, an integrity error was coded.

For procedural integrity, sessions of the midpoint of the FA conditions were selected using the procedure described in Wacker et al. (2013a). The definition of the start of a trial during test conditions (i.e., attention, tangible, escape) was the presentation of the relevant EO (Wacker et al., 2013a). The trials for test conditions ended when the reinforcement period and re-presentation of the EO were completed. When a target behavior was not followed by a consequence, a new trial started when the appropriate EO was still presented. For free play sessions, a total of 10 trials were done during each 5-min session. Procedural integrity was reported after the digital recordings of each participant were examined.

For Sun, procedural integrity was recorded for 50% (2 sessions) of the tangible condition, 40% (2 sessions) of the escape condition, 50% (2 session) of the attention condition, and 29% (4

sessions) of free play condition. Procedural integrity was 90% for Sun. For Ana, procedural integrity was recorded for 40% (2 sessions) of the tangible condition, 33% (2 sessions) of the escape condition, 50% (2 sessions) of the attention condition, and 31% (4 sessions) of free play condition. Procedural integrity was 97% for Ana. For Kim, procedural integrity was recorded for 33% (2 sessions) of the tangible condition, 33% (3 sessions) of the escape condition, 33% (2 sessions) of the attention condition, and 33% (6 sessions) of free play condition. Procedural integrity was 100% for Kim. For Tran, procedural integrity was recorded for 40% (2 sessions) of the tangible condition, 50% (2 sessions) of the escape condition, 33% (1 session) of the attention condition, and 33% (4 sessions) of free play condition. Procedural integrity was 100% for Tran. For Doll, procedural integrity was recorded for 40% (2 sessions) of the tangible condition, 50% (2 sessions) of the escape condition, 50% (2 sessions) of the attention condition, and 20% (2 sessions) of free play condition. Procedural integrity was 99% for Doll.

Interobserver Agreement for Procedural Integrity

Interobserver agreement on procedural integrity was obtained using a trial-by-trial comparison by dividing the number of agreements during procedural integrity sessions by the number of agreements plus disagreements. For Sun, interobserver agreement of procedural integrity was coded across 40% (4 sessions) of the sessions (10 sessions). Interobserver agreement of procedural integrity was 100%. For Ana, interobserver agreement of procedural integrity was coded across 40% (4 sessions) of the sessions (10 sessions). Interobserver agreement of procedural integrity was 98%. For Kim, interobserver agreement of procedural integrity was coded across 33% (4 sessions) of the sessions (13 sessions). Interobserver agreement of procedural integrity was 100%. For Tran, interobserver agreement of procedural

integrity was coded across 33% (3 sessions) of the sessions (9 sessions). Interobserver agreement of procedural integrity was 100%. For Doll, interobserver agreement of procedural integrity was coded across 50% (4 sessions) of the sessions (8 sessions). Interobserver agreement of procedural integrity was 100%.

Design

The functional analysis was conducted within a multielement design using the procedures described in Iwata et al. (1982/1994) with the addition of a tangible condition. At least three free-play sessions were conducted prior to any test conditions as described in Wacker et al. (2013a). The purpose of this was to identify tangible items that were relatively more preferred and less preferred (Roane, Vollmer, Ringdahl, & Marcus, 1998). All conditions including free play, attention, tangible, and escape were conducted in a counterbalanced order.

Procedures

Parent Training. The author went to Korea to meet individually with each participant's parents to obtain informed consent and to provide a brief introduction about the study. During the meeting, the researcher reviewed the study including the purpose, length of involvement, procedures etc. The author also provided each participant's parents with a 16-page procedural manual during the meeting. The same manual used in the study described by Wacker et al. (2013a) was translated into Korean by the author. The manual summarized the following: 1) the behavior assessment and intervention procedures (i.e., descriptive assessment, preference assessment, FA, and FCT) including details of the procedures and a rationale for the procedure; 2) appendices that consisted of two forms (i.e., daily behavior record and preference assessment

form); and 3) a glossary to assist parents in getting used to the ABA terms used by the researchers. Each participant's parents reviewed the manual prior to the assessment to become familiar with the steps. They also could email the researcher if any concerns or questions about the study or procedures arose.

Descriptive Assessment. In addition to parent training, the researcher interviewed the parents while in Korea. The researcher had two objectives in mind. First, the researcher interviewed the parent to recruit information about their child's problem behavior and communication skills. Based on the interview, the researcher created an operational definition for the target behaviors. Second, the parents were asked to complete a daily behavior record for 1 week to help develop hypotheses about the function of problem behavior for their child. After the parents emailed these documents to the researcher, the researcher and the parents discussed the data via telehealth and decided on target and nontarget behaviors.

Telehealth Sessions. At the beginning of each Skype visit, the researcher greeted the participant's parents. Initially, the researcher spoke with the parent about the plans for the visit for approximately 5 minutes. A typical conversation would be the following: "Hi Ms. An! How are you doing? First of all, we are going to run the tangible condition. You will be asked to take away your child's preferred toy (e.g., iPad) and give him or her a less preferred toy. If he or she engages in any of the problem behavior we discussed, please give the preferred toy back to him or her for 20s. Following 20s, you will be asked to repeat the sequence." At the end of the visit, the results of the FA sessions conducted during the visit were shared with the parent and the researcher gave her time to ask questions when necessary. After all of the parent's questions were addressed, the researcher disconnected the Skype.

Functional Analysis. Participant's parents conducted four FA conditions: (a) free play, (b) attention, (c) escape, and (d) tangible. Prior to each session, the researcher provided a description of the session to the parents including a review of how to respond to target behavior, nontarget behavior, and appropriate behavior. The researcher also reviewed the materials needed for the session.

During free play, the child was presented with preferred toys to play with and was given parent attention. Parents were instructed to play with their child and to allow their child to play as he or she wanted with any toy the child chose during the free play sessions. Instances of target or nontarget problem behavior were to be ignored.

During the escape condition, the parent was instructed to deliver a work task (e.g., picking up toys, academic task) to the child using a three-step (i.e., say, show, do) prompting sequence. Initially, the parent vocally instructed the child to complete the task (e.g., "Pick up the blocks"). If the child did not complete the task, the parent modeled how to complete the task. If the child did not follow the directions after these prompts, the child was physically guided by the parent to complete the task. Contingent upon any occurrence of target problem behavior, the task was removed and the child was provided a brief break of approximately 20-30s. After the break period, the parent prompted the child to complete a new task.

During the attention condition, the parent was instructed to divert her attention from the child. The parent told the child to play with toys. Contingent upon any occurrence of target problem behavior, the parent provided the child with 20-30s attention in the form of reprimands and redirection to play with toys. After the reinforcement period, the parent was instructed to divert their attention from the child.

During the tangible condition, the parent initially let the child play with a preferred item for approximately 30s. After the play period, the preferred item was taken away and a less preferred item was given to the child. Contingent upon any occurrence of target problem behavior, the preferred item was returned to the child for 20-30s. After the reinforcement period, the parent took away the preferred item from the child.

Experiment 2

Participants

The participants, parents, and behavior consultant were the same people described in Experiment 1.

Settings and Materials

The telehealth center and participants' home were the same as described in Experiment 1. The researcher provided coaching to parents via Skype for the FCT sessions from the Teleconsultation Center located at the Center for Disabilities and Development at the University of Iowa Children's Hospital.

For Sun, all sessions were conducted in his bedroom. The tangibles for Sun was an iPad. For Ana, all sessions were conducted in her living room. Tangibles for Ana included television and snacks. For Kim, all sessions were conducted in his bedroom. Tangibles for Kim included a smart phone and cars. Work tasks for Kim included letter and number tracing worksheets. For Tran, all FCT sessions were conducted in his living room. The tangibles for Tran were a trampoline and Lego® blocks. For Doll, all sessions were conducted in her bedroom. The tangible for Doll was her iPad.

Response Definitions

Child Behavior. The definitions for child behavior for each participant were the same as those described in Experiment 1, except for manding. Independent manding was defined as requesting reinforcement appropriately by saying a word "please, the name of item" (Kim, Ana, and Sun) independently or handing over a picture card to the parent independently (Tran and Doll). A prompted mand was defined as requesting reinforcement following a vocal prompt (e.g., "If you want to play with iPad, say 'please iPad'") or physical prompt (e.g., "If you want to play with iPad, hand the card over to me" while the parent physically guided the child to hand over the card).

Task Completion. Task completion data were collected for Kim only. Task completion was defined as completing a tracing worksheet. The other participants did not have work tasks during FCT. Task completion was coded when Kim completed a worksheet independently without hand over hand guidance.

Data Collection

All data were collected during the weekly visits. All sessions were digitally recorded using Debut Video Capture Software Professional. Data were collected by the researcher and a second observer via in-vivo and via digital-recordings. A 6-s partial-interval recording system was used to code data on problem behavior and mands. In this system, an occurrence of a behavior was coded if the behavior occurred anytime during the 6-sec interval. An event recording data collection system was used to record task completion during FCT sessions. Data on task completion were coded as frequency of task completion.

Interoberver Agreement for Child Behavior and Task Completion

When two independent observers scored the occurrence of the same behavior within the same interval, an agreement occurred. A disagreement was scored when only one observer recorded the occurrence of the behavior during the interval. Interobserver agreement was calculated by dividing the number of agreements by the number of agreements and disagreements and then multiplying by 100%.

For Sun, interobserver agreement for child behavior was calculated on 30% of the sessions and agreement averaged 99% (range, 91% to 100%). For Ana, interobserver agreement for child behavior was calculated on 33% of the sessions and agreement averaged 100%. For Kim, interobserver agreement for child behavior was calculated on 31% of the sessions and agreement averaged 97% (range, 70% to 100%). For Tran, interobserver agreement for child behavior was calculated on 37% of the sessions and agreement averaged 96% (range, 80% to 100%). For Doll, interobserver agreement for child behavior was calculated on 35% of the sessions and agreement averaged 99% (range, 94% to 100%).

Interobserver agreement for task completion was calculated by dividing the low number of completed tasks by the high number of completed tasks and multiplying the result by 100%. For Kim, interobserver agreement for task completion was calculated on 31% (9 sessions) of FCT sessions (29 sessions) and agreement averaged 98% (range, 86% to 100%). The mean reduction in problem behavior was obtained using the following calculation: 1) the mean percentage of intervals of problem behavior during the final three treatment sessions was subtracted from the mean percentage of intervals of problem behavior at baseline, 2) that result was divided by the baseline percentage and multiplied by 100%. IOA for the reduction of

problem behavior was collected by two independent raters and averaged 100% across all participants.

IOA for additional measures was conducted by two independent raters on the following measures: 1) type of FCT programs each child received, 2) the baseline and last three treatment sessions for each child, and 3) the treatment acceptability ratings by parents.

Procedural Integrity

FCT trial task analyses were used to measure parent fidelity (Suess et al., 2014a). Each step of the task analysis was coded as correct, incorrect, or not applicable. If the parent implemented the step of the task analysis correctly as outlined in the FCT trial task analysis, a "correct response" was obtained. An "incorrect response" was scored when the parent implemented the step incorrectly or omitted the step on the task analysis. A "not applicable response" was scored when the step was not applicable during the FCT trial. Not applicable responses were not included in the integrity calculations. Two independent observers evaluated whether the parent implemented each step of the FCT procedures correctly or incorrectly. Procedural integrity was obtained by dividing the total number of correct responses by the total number of correct and incorrect responses for each trial. Procedural integrity was evaluated for 30% (7 sessions) of FCT trials (23 sessions) for Sun. The mean percentage of task analysis steps completed correctly was 99%. Procedural integrity was evaluated for 33% (21 sessions) of FCT trials (63 sessions) for Ana. The mean percentage of task analysis steps completed correctly was 100%. Procedural integrity was evaluated for 31% (9 sessions) of FCT trials (29 sessions) for Kim. The mean percentage of task analysis steps completed correctly was 97%. Procedural integrity was evaluated for 37% (18 sessions) of FCT trials (45 sessions) for Tran. The mean

percentage of task analysis steps completed correctly was 98%. Procedural integrity was evaluated for 34% (23 sessions) of FCT trials (63 sessions) for Doll. The mean percentage of task analysis steps completed correctly was 99%.

Interobserver Agreement for Procedural Integrity

Interobserver agreement on procedural integrity was obtained based on point-by-point comparisons of each step of the task analysis. An agreement was scored when both observers coded the same score on a step of the task analysis. A disagreement was scored if one of the observers coded a different score on a step of the task analysis. Interobserver agreement was calculated by dividing the number of agreements by the number of agreements and disagreements and then multiplying by 100%. For Sun, interobserver agreement was calculated for 33% (7 sessions) of trials (23 sessions) and averaged 99%. For Ana, interobserver agreement was calculated for 30% (21 sessions) of trials (63 sessions) and averaged 100%. For Kim, interobserver agreement was calculated for 31% (9 sessions) of trials (29 sessions) and averaged 97%. For Tran, interobserver agreement was calculated for 33% (10 sessions) of trials (30 sessions) and averaged 95%. For Doll, interobserver agreement was calculated for 33% (7 sessions) of trials (23 sessions) and averaged 100%.

Design

FCT sessions followed the completion of the FA for each participant. Parents served as therapists during all FCT sessions. FCT was conducted within a concurrent multiple baseline (across participants) design. Baseline was derived from the child's FA sessions which ranged

from four to nine sessions. All of the participants began FA sessions within the same 2 week period.

Procedures

FCT procedures consisted of two treatments: FCT escape (Kim) and FCT tangible (Sun, Ana, Tran, and Doll). Kim received an FCT escape treatment. FCT escape consisted of a two-step chain: task completion led to the opportunity to mand and appropriate manding led to a playtime with parent attention and preferred toys. At the beginning of each session, Kim was allowed to play with preferred toys for approximately 2 minutes. After this playtime, Kim's mother told him, "It's time to work. When you're done, you can play again." Kim was directed to the work area. Kim was required to put his toy on the safe spot. The parent presented the demand to Kim and also provided him with verbal instructions (e.g., "trace this square"). When Kim did not try the task, hand-over-hand guidance was presented. At the beginning of FCT, Kim was instructed to complete two work tasks (FCT 2) per session (i.e., one task per trial). As Kim was successful without problem behavior over 4 consecutive sessions, the work requirement was increased to ten work tasks (FCT 10) per session (i.e., ten tasks per trial).

As soon as Kim completed the work task, the parent asked him to say "play please" if he wanted to play. If Kim said "play please", or a similar phrase, the parent provided him with a brief break to play with toys. If Kim did not emit a vocal mand, the parent prompted him to ask for the toy. When targeted problem behavior occurred during work activities, the parent was instructed to block all problem behavior in a neutral way. All problem behavior was put on extinction. The parent was also instructed to ignore nontargeted problem behavior.

Sun, Ana, Tran, and Doll received the FCT tangible treatment. FCT tangible consisted of a two-step chain: appropriate waiting led to the opportunity to mand and appropriate manding led to brief access to preferred toys. At the beginning of a session, the child was allowed to play with preferred toys for a brief period. After the brief playtime, the parent restricted access to the preferred toys and told the child he or she could ask for the toys after the wait time finished. The child had access to parent attention during the wait time. The length of the wait time was signaled by an electronic timer. When the timer sounded, the child was required to mand to obtain the toys back by saying "play please" or a similar phrase (i.e., Sun and Ana) or handing a "play" picture card to the parent (i.e., Tran and Doll). As FCT progressed, the wait time was gradually increased to a specified amount of time chosen by the parent (e.g., 1 min). For Sun, Tran, and Doll, the wait requirement started with 0 sec and was increased to 1 min. For Ana, the wait time started with 0 sec and was increased to 30 sec. When targeted problem behavior occurred during the wait times, the parent was instructed to block all problem behavior in a neutral way. All problem behavior was put on extinction. The parent was also instructed to ignore nontargeted problem behavior.

CHAPTER IV

RESULTS

Experiment 1

An FA of problem behavior was conducted to address the first research question "Can functional analyses conducted via telehealth identify the social functions of problem behavior in children with ASD living in Korea?" The FA results are presented individually for each participant in Figures 1, 2, 3, 4, and 5. The results are shown as the percentage of intervals with problem behavior for each FA session.

Sun showed consistently elevated levels of problem behavior during the tangible condition (*M* = 15.5%; range = 14% to 16%) in comparison to the other FA conditions. See Figure 1. During the escape condition, the mean percentage of intervals with problem behavior was 6.4% (range = 0% to 16%). There was very little problem behavior during the attention condition (*M* = 0.5%) and free play condition (*M* = 0.9%). Using the criteria proposed by Roane et al. (2013), the FA results identified only a tangible function for Sun's problem behaviors. Sun's FA was conducted in twenty-seven sessions that occurred over five telehealth visits. The total time spent to complete the FA was approximately 290 minutes.

Ana's results showed consistently high levels of problem behavior during the tangible condition (*M* = 16.8%; range = 12% to 26%) and variable levels of problem behavior during the escape condition (*M* = 3.7%; range = 0% to 8%). See Figure 2. No problem behavior occurred during attention and free play conditions. Using the criteria proposed by Roane et al. (2013), the FA results identified tangible and escape functions for Ana's problem behaviors. The number of FA sessions conducted was twenty-eight and these sessions were conducted over five telehealth visits. Additionally, total time spent to complete the FA was approximately 310 minutes.

The results of Kim's functional analysis show variable but elevated levels of problem behavior during the escape and tangible conditions. See Figure 3. Problem behavior occurred during a mean of 11.2% of the intervals (range = 0% to 22%) during the escape condition and during a mean of 9.7% of the intervals (range = 0% to 16%) during the tangible condition. Problem behavior occurred at very low levels during the attention condition (*M* = 1.0%; range = 0% to 6%) and free play condition (*M* = 0.1%; range = 0% to 2%). Based on the criteria described by Roane et al. (2013), escape and tangible functions were identified for Kim's problem behaviors. Forty FA sessions were conducted over eight telehealth visits. The total time spent to complete the FA was approximately 470 minutes.

The results for Tran's FA are shown in Figure 4. Tran showed the highest levels of problem behavior during the tangible condition (*M* = 16%; range = 0% to 26%). During the escape condition, the mean percentage of intervals with problem behavior was 2.5% (range = 0% to 8%). No problem behavior occurred during the attention condition (*M* = 0%), and very little problem behavior occurred during the free play condition (*M* = 0.5%). Using the criteria proposed by Roane et al. (2013), the FA results identified only a tangible function for Tran's problem behavior. The number of FA sessions was twenty-four and these sessions were conducted during four telehealth visits. The total time spent to complete the FA was approximately 260 minutes.

Doll's FA results also showed that problem behavior occurred at the highest levels during the tangible condition (*M* = 22%; range = 0% to 42%). See Figure 5. Problem behavior occurred for a mean of 5% of the intervals (range = 0% to 12%) during the escape condition, and no problem behavior occurred during the attention condition. There was one instance of problem behavior during the free play condition (*M* = 0.2%; range = 0% to 2%). Using the criteria

proposed by Roane et al. (2013), the functional analysis results identified only a tangible function for Doll's problem behaviors. Twenty-three FA sessions were conducted over four telehealth visits. Additionally, total time spent to complete the FA was approximately 260 minutes.

The functional analysis identified social functions (i.e., negative and/or positive reinforcement) for each participant.

Experiment 2

Functional Communication Training (FCT) was conducted with each participant to address the second research question "Can functional communication training conducted via telehealth be effective in decreasing challenging behavior displayed by children with ASD living in Korea?" Figures 6 and 7 show the FCT treatment results within a concurrent multiple baseline design across the five participants. Baseline data are the results from the relevant FA condition for each participant. The results from the FA tangible condition are the baseline data for the four children (e.g., Sun, Ana, Tran, and Doll) whose problem behavior was primarily maintained by access to tangible items (e.g., Sun, Ana, Tran, and Doll). The results of the FA escape condition are the baseline data for Kim whose problem behavior was primarily maintained by escape from demands.

Sun showed a decrease in problem behavior from a mean of 15.5% during baseline to zero occurrences during the first three treatment sessions (top panel of Figure 6). A 10-second wait time was introduced at Session 11 and no problem behavior occurred. A 15-second wait time was introduced at Session 14 for three sessions and problem behavior increased to 4% of the intervals but decreased back to zero occurrences during the third session (i.e., Session 16).

The wait time was increased to 20 seconds, 25 seconds and then 1 minute (Session 27) which was the duration of wait-time selected by his parent. Sun showed problem behavior during only one session with the 20-second wait time (Session 21), one session with the 25-second wait time (Session 24), and one session during the 1-minute wait time (Session 27). Overall, Sun engaged in zero or near zero levels of problem behavior during the FCT treatment (*M* = 0.6%; range = 0% to 4% during Sessions 6 to 30). Independent mands occurred during all but one of the FCT sessions (*M* = 4.6%; range = 0% to 8% during Sessions 6 to 30). Sun showed a significant reduction in problem behavior, with no problem behavior observed during eighteen of the twenty-three FCT sessions. No problem behavior occurred during the final three treatment sessions for a 100% reduction in problem behavior from the tangible baseline condition. The number of FCT sessions was twenty three and the number of telehealth visits was seven. The total time spent to complete the FCT treatment was approximately 310 minutes.

Ana engaged in problem behavior during all of the initial tangible baseline sessions (*M* = 16.8%; range = 12% to 26%). See middle panel of Figure 6. Snacks were used as the tangible reinforcer during Sessions 9 to 38 and watching television was used as the tangible reinforcer for the remaining FCT sessions. Elevated levels of problem behavior occurred during the first five FCT sessions and problem behavior decreased to low levels for the remainder of the FCT sessions (*M* = 4.3%; range = 0% to 22% during Sessions 9 to 47). A 2-second wait time was introduced at Session 48 and the wait time was increased to 4-seconds during Session 53 to 62. Ana engaged in variable levels of problem behavior (*M* = 1.7%; range = 0% to 10%) during Sessions 48 to 62, with zero occurrences during the last three sessions. An 8-second wait time was introduced at Session 63 and problem behavior remained at zero occurrences for the remainder of the FCT sessions (*M* = 0% during Sessions 63 to 85). The wait time was gradually

increased to 30 seconds (Session 80), which was the duration of wait-time selected by her parent. Overall, problem behavior occurred for a mean of 2% of the intervals during the FCT treatment (range = 0% to 22% during Sessions 9 to 84). Independent mands were observed during only one of the first eleven treatment sessions, but occurred consistently during the remaining FCT sessions for an overall mean of 6.6% of the intervals (range = 0% to 18% during Sessions 9 to 84). Ana showed a significant reduction in problem behavior, with no problem behavior observed during the majority of FCT sessions. No problem behavior occurred during the final three treatment sessions for a 100% reduction in problem behavior from the tangible baseline condition. The number of FCT sessions was sixty three and the number of telehealth visits was fifteen. The total time spent to complete the FCT treatment was approximately 830 minutes.

Kim engaged in problem behavior during all but two of the initial escape baseline sessions (*M* = 11.2%; range = 0% to 22%). See bottom panel of Figure 6. When FCT was introduced at Session 19, Kim was required to finish two work tasks (i.e., FCT [2]). Problem behavior occurred during only one FCT [2] session (*M* = 0.8%; range = 0% to 4% during Sessions 19 to 23) and Kim completed 100% of the work tasks. The amount of work increased to ten work tasks (FCT [10]) at Session 24. Variable levels of problem behavior occurred during the first fifteen sessions of FCT [10] before decreasing to zero occurrences for the remaining FCT sessions for an overall mean of 1.6% (range = 0% to 10% of the intervals during Sessions 24 to 48). Task completion remained at 100% throughout the FCT [10] treatment sessions. Overall, problem behavior occurred for a mean of 1.5% of the intervals during the FCT treatment (range = 0% to 10% during Sessions 19 to 48). Independent mands occurred at low and variable levels during the FCT sessions (*M* = 1.3%; range = 0% to 4%). No problem behavior occurred during the final three treatment sessions for a 100% reduction in problem behavior from the escape

baseline condition. The number of FCT sessions was forty two and the number of telehealth visits was six. Additionally, the total time spent to complete the FCT was approximately 300 minutes.

Tran engaged in problem behavior during all but one of the initial tangible baseline sessions (*M* = 16%; range = 0% to 26%). See top panel of Figure 7. Problem behavior continued to occur at variable levels with the introduction of the FCT treatment (*M* = 2.9%; range = 0% to 20% during Sessions 7 to 26) and decreased across FCT sessions. Following five consecutive sessions with zero occurrences of problem behavior, a 2-second wait time was introduced at Session 27. Problem behavior increased during Session 27, but returned to zero occurrences and remained at low levels during the remainder of the FCT treatment sessions for an overall mean of 0.6% of the intervals (range = 0% to 12% during sessions 27 to 78). The wait time was gradually increased to 1 minute which was the duration of wait-time selected by his parent. Overall, problem behavior occurred for a mean of 1.2% of the intervals during the FCT treatment (range = 0% to 20% during Sessions 7 to 78). Independent mands occurred during all but one FCT session (*M* = 5.8%; range = 0% to 20% during Sessions 7 to 78). Tran showed a significant reduction in problem behavior, with no problem behavior observed during most of the FCT sessions. No problem behavior occurred during the final three treatment sessions for a 100% reduction in problem behavior from the tangible baseline condition. The number of FCT sessions was forty-nine and the number of telehealth visits was ten. Additionally, the total time spent to complete the FCT was approximately 470 minutes.

Doll engaged in problem behavior during all but one of the initial tangible baseline sessions (*M* = 22%; range = 0% to 42%). See second panel of Figure 7. Problem behavior decreased to 0% during the first two FCT treatment sessions but then increased to high levels

during the next nine treatment sessions before decreasing to zero occurrences. A 2-second wait time was introduced at Session 27 and a 4-second wait was introduced at Session 33, with zero to near zero occurrences of problem behavior. An 8-second wait time was introduced at Session 40 with a brief increase in problem behavior during Sessions 47, 50, and 52 followed by a return to zero occurrences. The wait time was gradually increased to 1 minute (Session 82), which was the duration of wait-time selected by her parent. Problem behavior remained at zero occurrences for the remainder of the FCT sessions (*M* = 0.3%; range = 0% to 2% during sessions 53 to 86). Overall, problem behavior occurred for a mean of 5.6% of the intervals during the FCT treatment (range = 0% to 66% during Sessions 9 to 86). Similar to Ana's results, independent mands were observed during only one of the first eleven FCT treatment sessions for Doll. Independent mands occurred at consistent but low levels for the remainder of the FCT treatment sessions for an overall mean of 4.5% of intervals (range = 0% to 8% during Sessions 9 to 86). Doll showed a significant reduction in problem behavior with the introduction of FCT, with no problem behavior observed during the majority of the FCT sessions. No problem behavior occurred during the final three treatment sessions for a 100% reduction in problem behavior from the tangible baseline condition. The number of FCT sessions was sixty-three and the number of telehealth visits was ten. The total time spent to complete the FCT was approximately 590 minutes.

The results for the percentage reduction in problem behavior for FCT are shown Table 2. Each of the five participants showed a 100% reduction in problem behavior from the FA baseline sessions to the final three treatment sessions. Total time averaged 12 weeks, ranging from 7 to 17 weeks. The FCT treatment results obtained for this study are similar to those reported by Wacker et al. (2013b). Wacker et al. (2013b) reported an average reduction in problem behavior of

93.5% across nineteen children with ASD. Total time averaged 13 weeks, ranging from 4 to 21 weeks.

Treatment Acceptability

A treatment acceptability questionnaire was used to address the third research question "What is the acceptability level of FA plus FCT package for parents?" After all procedures were completed, parents were asked to rate the acceptability of the FA plus FCT procedures using the TARF-R (Reimers and Wacker, 1988). Treatment acceptability was measured via the question. "How acceptable do you find the treatment to be regarding your concerns about your child?" A 7-point Likert scale was used ranging from (1) very unacceptable and (7) very acceptable. The ratings from the five parents were: Sun 7, Ana 6, Kim 6, Tran 7and Doll 6, respectively. The average rating for the five participants was 6.40. The results obtained from this study were similar to those (M = 6.47) obtained from Wacker et al. (2013b).

Figure 1

Results of functional analysis for Sun

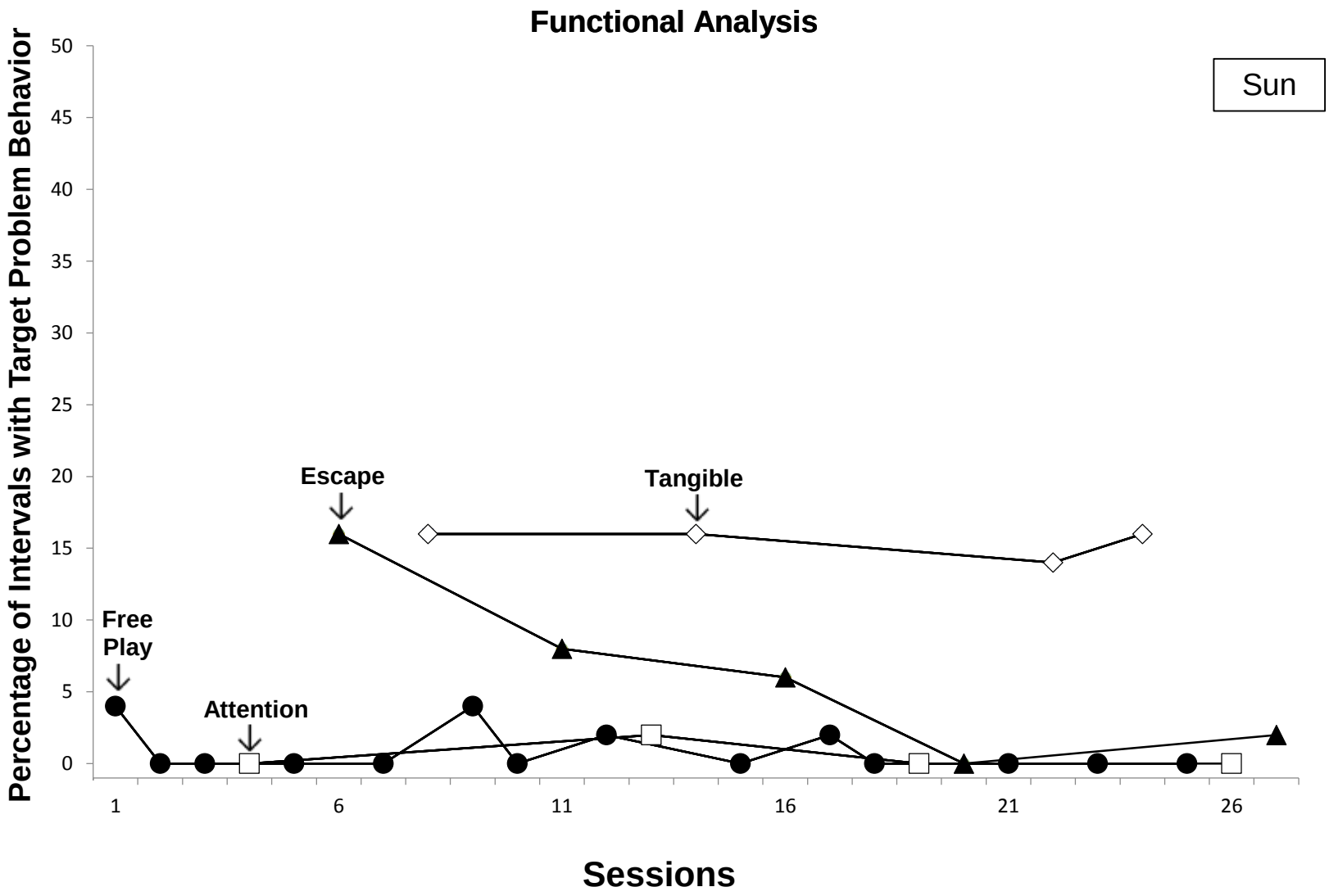
Functional Analysis
Sun
Percentage of Intervals with Target Problem Behavior
50
45
40
35
30
25
20
15
10
5
0
Escape
Tangible
Free Play
Attention
1
6
11
16
21
26
Sessions

Figure 2

Results of functional analysis for Ana

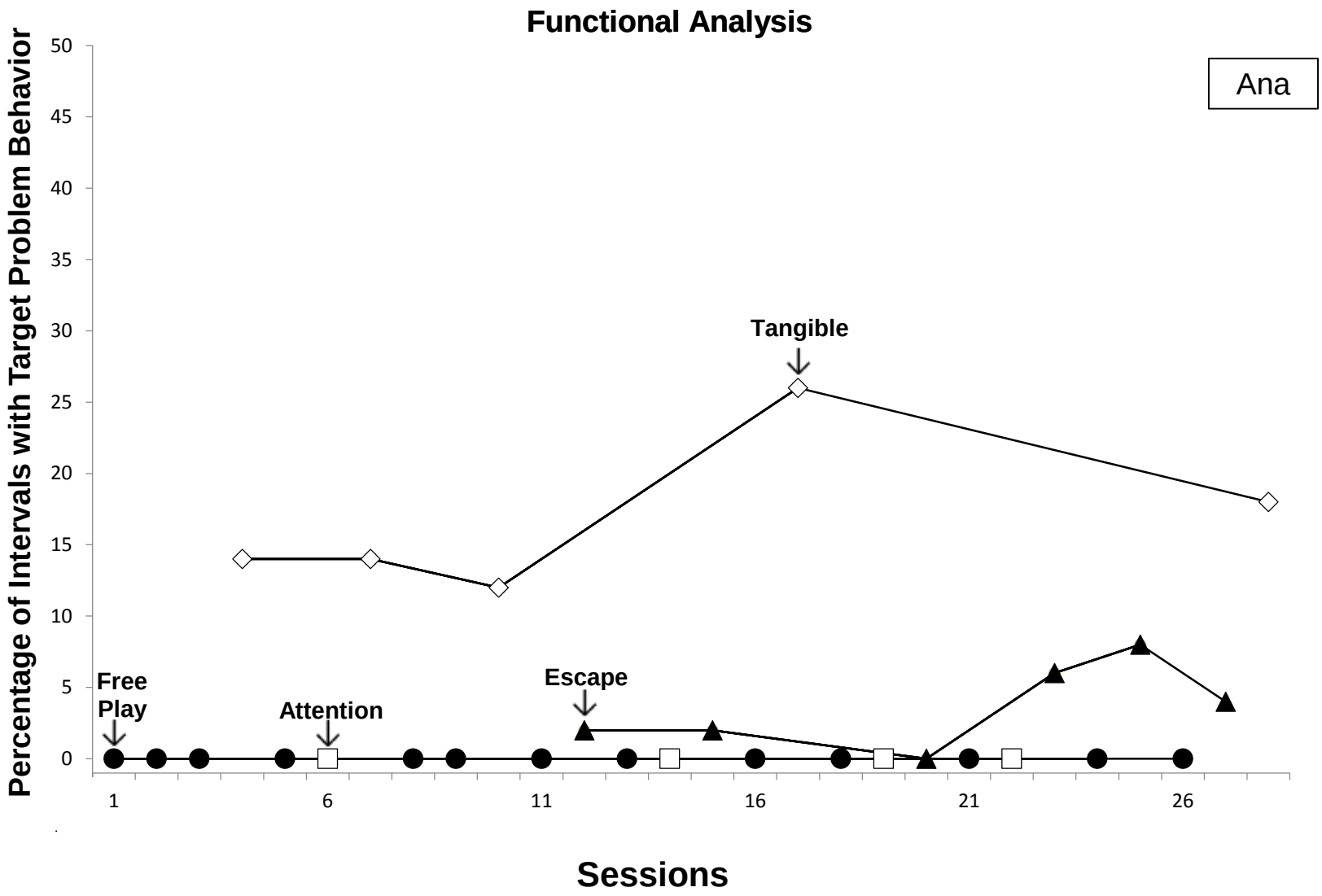
Functional Analysis
Ana
Percentage of Intervals with Target Problem Behavior
50
45
40
35
30
25
20
15
10
5
0
Tangible
Free Play
Attention
Escape
1
6
11
16
21
26
Sessions

Figure 3

Results of functional analysis for Kim

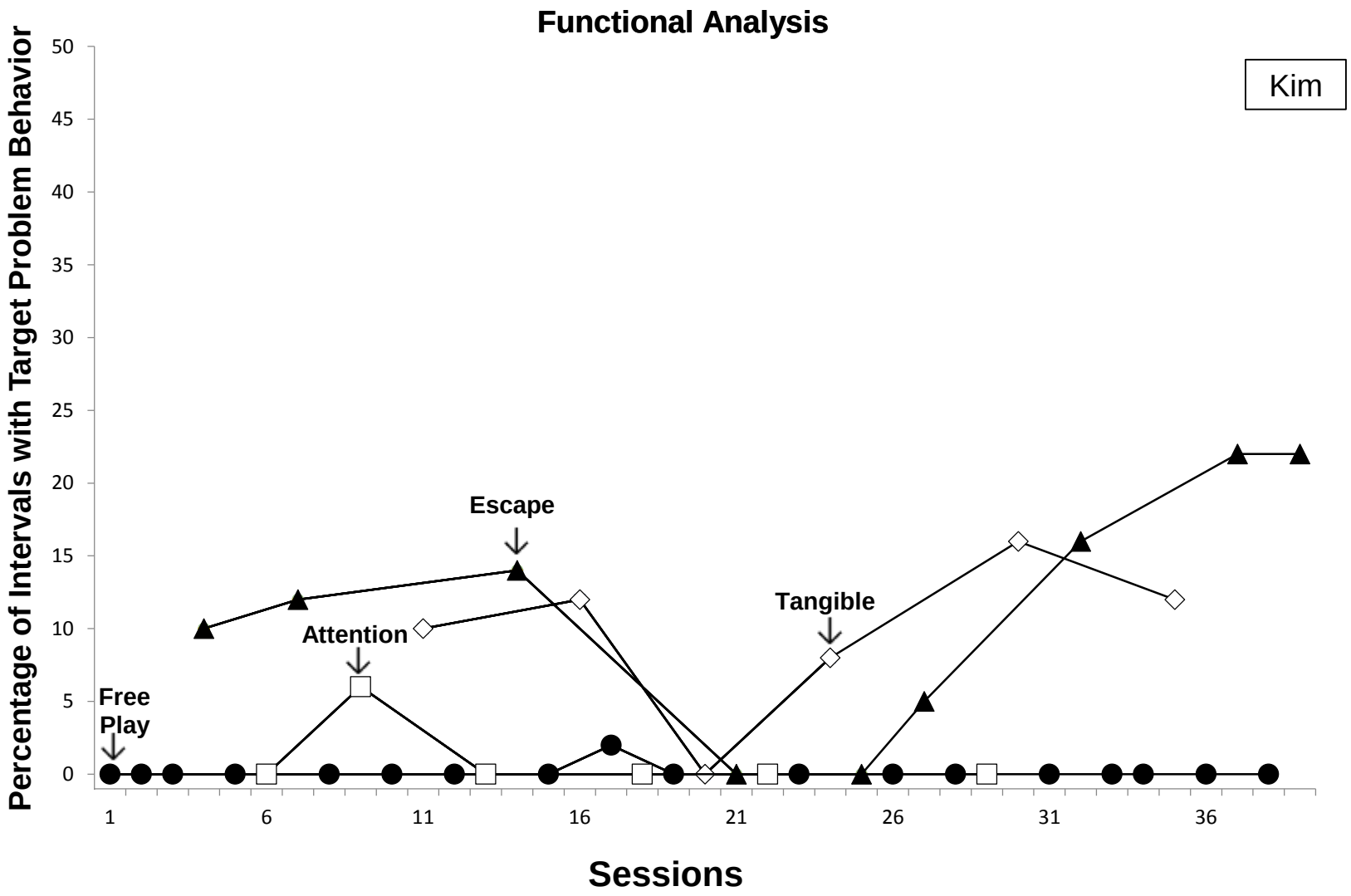
Functional Analysis
Kim
Percentage of Intervals with Target Problem Behavior
50
45
40
35
30
25
20
15
10
5
0
Escape
Tangible
Attention
Free Play
1
6
11
16
21
26
31
36
Sessions

Figure 4

Results of functional analysis for Tran

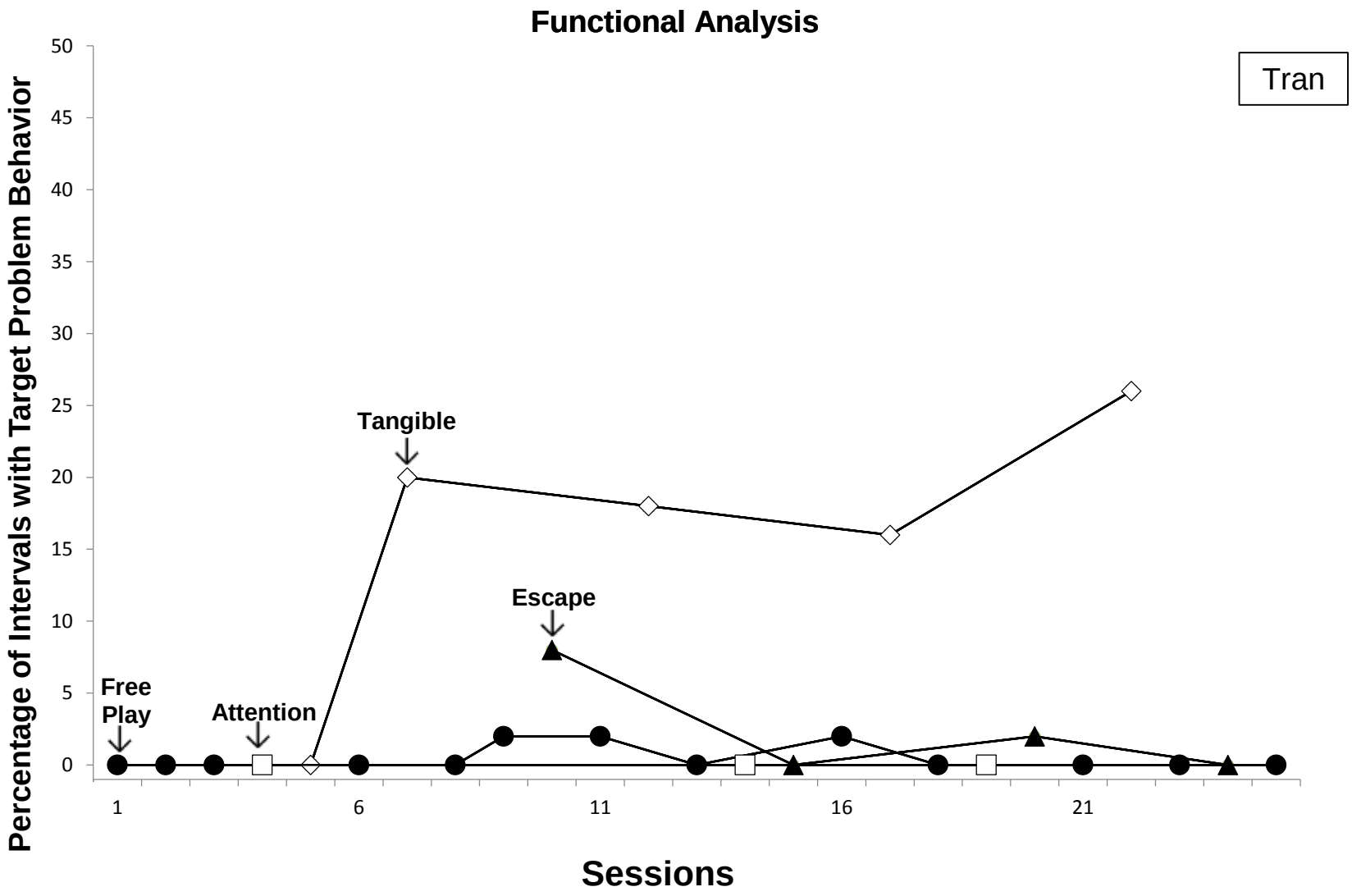
Functional Analysis
Tran
Percentage of Intervals with Target Problem Behavior
50
45
40
35
30
25
20
15
10
5
0
Tangible
Escape
Free Play
Attention
1
6
11
16
21
Sessions

Figure 5

Results of functional analysis for Doll

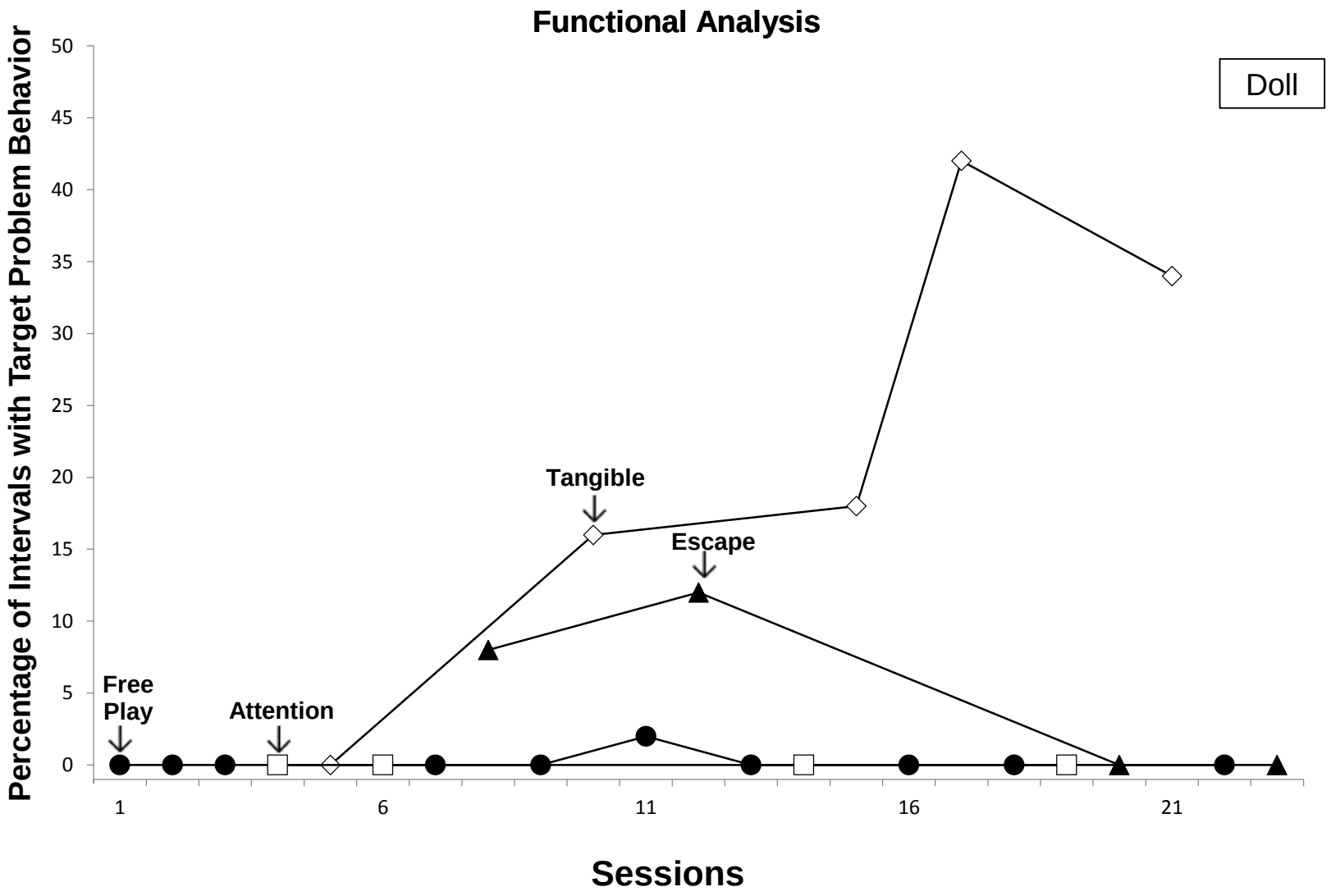
Functional Analysis
Doll
Percentage of Intervals with Target Problem Behavior
50
45
40
35
30
25
20
15
10
5
0
Tangible
Escape
Free Play
Attention
1
6
11
16
21
Sessions

Figure 6

The results of FCT for Sun, Ana, and Kim. The closed diamonds represent problem behavior during the FCT tangible sessions for Sun and Ana. The closed triangles represent problem behavior during FCT escape for Kim. The open circles represent mands during the same sessions.

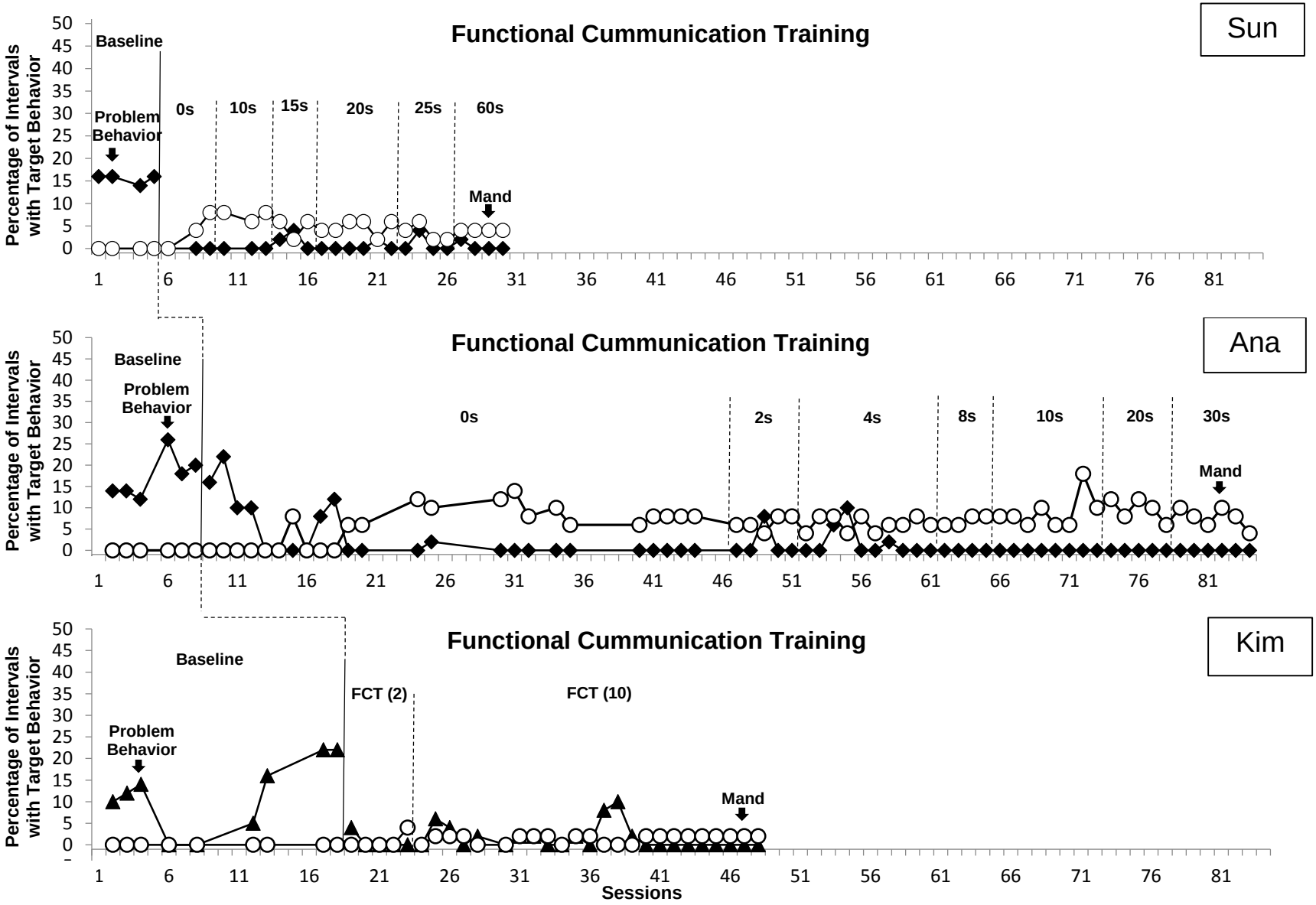
Functional Cummunication Training
Sun
Percentage of Intervals with Target Behavior
Baseline
Problem Behavior
0s
10s
15s
20s
25s
60s
Mand
Functional Cummunication Training
Ana
Baseline
Problem Behavior
0s
2s
4s
8s
10s
20s
30s
Mand
Functional Cummunication Training
Kim
Baseline
FCT (2)
FCT (10)
Problem Behavior
Mand
Sessions

Figure 7

The results of FCT tangible for Tran and Doll. The closed diamonds represent problem behavior during the FCT tangible sessions and the open circles represent mands during the same sessions.

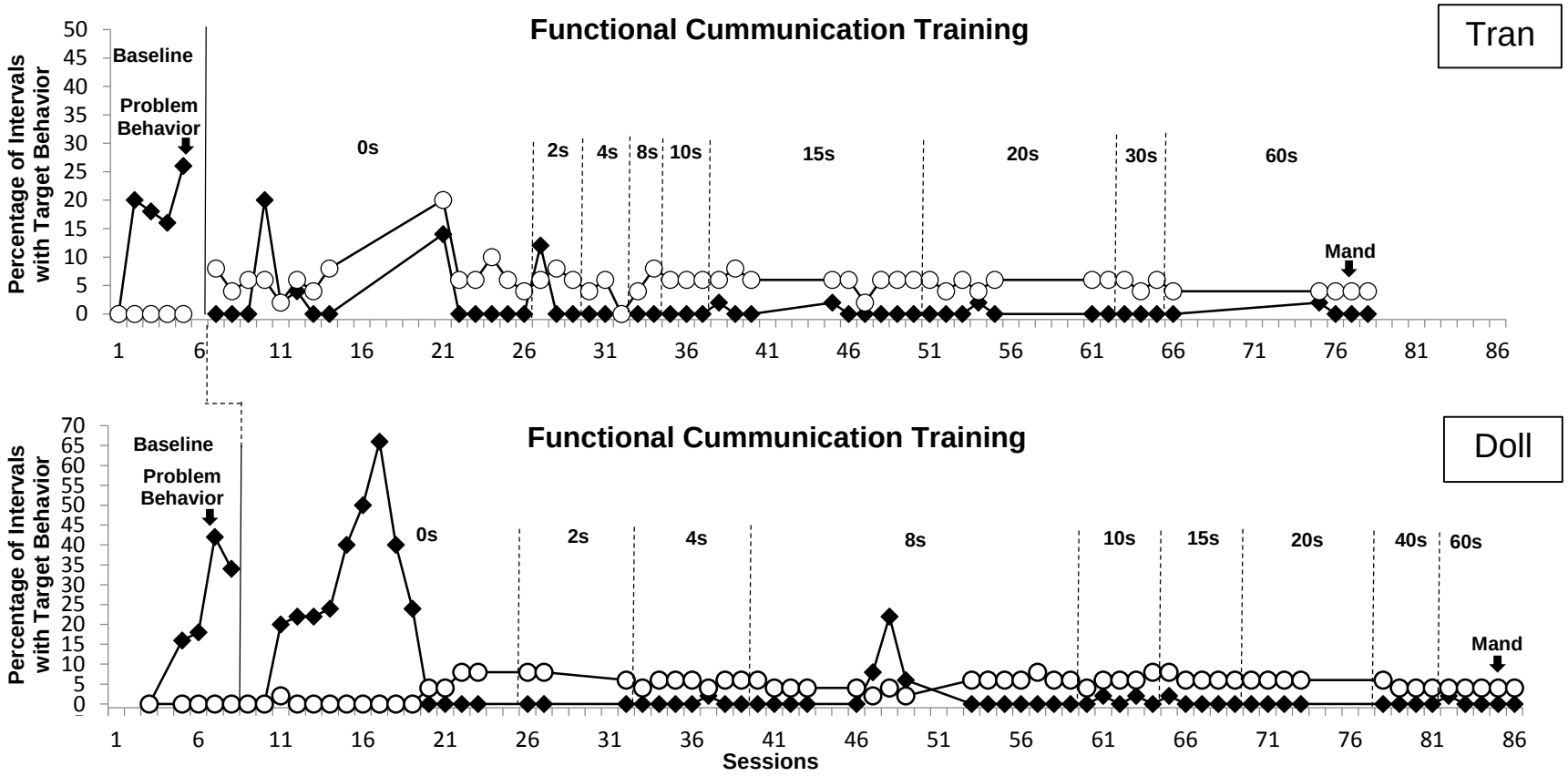
Functional Cummunication Training
Tran
Baseline
Problem Behavior
0s
2s
4s
8s
10s
15s
20s
30s
60s
Mand
Percentage of Intervals with Target Behavior
Functional Cummunication Training
Doll
Baseline
Problem Behavior
0s
2s
4s
8s
10s
15s
20s
40s
60s
Mand
Percentage of Intervals with Target Behavior
Sessions

Table 2 Percentage Reduction Results of FCT for the Five Participants

Name	Identified function	Treatment	Mean percentage of intervals with problem behavior at baseline	Mean percentage of intervals with problem behavior during the final three treatment sessions	Percent reduction in problem behavior
Tran	Tangible	FCT-tangible	16	0	100
Sun	Tangible	FCT-tangible	16	0	100
Doll	Tangible	FCT-tangible	22	0	100
Ana	Tangible Escape	FCT-tangible	17	0	100
Kim	Escape Tangible	FCT-escape	11	0	100
Mean					100

CHAPTER V

DISCUSSION

General Discussion

Telehealth technology has been shown to be an effective vehicle for conducting behavioral assessments and treatments (Gibson et al., 2010; Frieder et al., 2009; Machalicek et al., 2009). Wacker and his colleagues have shown that telehealth consultation can be an effective and efficient method of conducting FA and implementing FCT for children with challenging behaviors who live in underserved areas of a rural state (Barretto et al., 2006; Suess et al., 2014a; Wacker et al., 2013a and 2013b). Previous studies regarding telehealth were initiated due to practical needs. For example, Barretto et al. (2006) study was conducted in Iowa, which is largely a rural state. Barretto et al. (2006) reported that the average travel distance from patient homes to a behavioral clinic was 145 km one way, which may be problematic due to time and financial expenses for the families. For example, the parents may need to take the day off work and children may miss school, and some families may not have access to a vehicle or money for gasoline to travel to a clinic setting. Telehealth may be an effective technology to address difficulties that many families encounter in underserved areas with limited access to behavioral services. The current study was designed to replicate Wacker et al.'s (2013a and 2013b) work by showing similar effects on assessment and treatment outcomes from country to country. Therefore, the current study focused on the use of telehealth technology to conduct FA plus FCT from the U.S. to persons in another country with limited access to ABA services (i.e., Korea).

The results of the current study (Experiment 1) indicated that functional analyses conducted via telehealth from the United States to the participants' homes in Korea were effective in identifying the function of problem behavior for each participant. Moreover, the

results of Experiment 2 showed that FCT procedures could be conducted effectively via telehealth with families living in Korea. The children's parents, who had no previous experience in FA and FCT procedures, implemented all assessment and treatment procedures with good integrity with coaching from the therapist during assessment and treatment sessions.

In this study, the FA procedures conducted by Korean parents via telehealth identified social functions of challenging behavior for all participants. In addition, FCT treatments implemented by Korean parents via telehealth produced substantial reductions in problem behavior by the end of treatment for all participants. These results suggest that telehealth can be an effective and efficient way to deliver behavioral assessment and treatment for underserved populations in countries like Korea. The results of this study are consistent with the results of Wacker et al.'s (2013a and 2013b) work that showed that FA procedures conducted via telehealth identified social functions for challenging behavior for 18 participants (90%) and FCT treatments conducted via telehealth produced substantial reductions in problem behavior (M = 93.5% reduction) for 17 children with ASD.

Overall, the current study extended the applied behavior analysis literature by: (1) demonstrating the application of telehealth between a setting with expertise in applied behavior analysis and the home of a child who shows severe challenging behaviors but lives in a country with limited access to ABA services such as Korea, (2) showing the acceptability of the FA plus FCT procedures to a different culture, and (3) using parent's smart phones for the video connection in the participant's homes.

Treatment Effectiveness (Research Question 1 & 2)

Wacker et al. (2013a) showed that the FA results completed via telehealth were comparable to those completed in the home (Wacker, Berg, & Harding, 2004; Wacker, Harding, Berg, Lee, Schieltz, Padilla, et al., 2011). Wacker et al. (2004)'s study identified social functions for five of seven participants with ASD when all FA procedures were completed in the home. Similarly, Wacker et al. (2013a) showed that the FA procedures via telehealth identified social functions for 18 of 20 participants with ASD. Barretto et al. (2006) also reported that social functions were identified for two participants via telehealth-delivered FA procedures. In the current study, social functions were identified for all five participants with ASD (100%). The results obtained from the current study support Wacker and colleagues' work (Barretto et al., 2006; Wacker et al., 2013a) in showing that functional analysis could be completed effectively regardless of whether the FA was conducted in the home setting with on-site coaching or via telehealth.

Wacker et al. (2013b) also reported that the outcomes of FCT treatments completed via telehealth were comparable to those conducted in the home setting. Wacker et al. (1998, 2005) showed that FCT programs resulted in a reduction in problem behavior of over 90% when conducted in the home setting. Wacker et al. (2013b) showed similar reductions in problem behavior (93.5% from baseline levels) for 17 children with ASD who received FCT treatments via telehealth. Suess et al. (2014a) also showed that FCT programs via telehealth produced similar reductions in problem behavior for three children with ASD. The treatment results obtained from the current study were similar to those obtained from Wacker et al. (2013b) and Suess et al. (2014a). The current study showed that an average reduction of 100% was obtained with the five children with ASD. The results obtained from the current study support previous

literature (Suess et al., 2014a; Wacker et al., 2013b) in showing that FCT can be conducted effectively via telehealth.

Pros and Cons of Telehealth

Cost in Time and Money. Telehealth is not only effective for conducting FA plus FCT from country to country, but there are also advantages to using telehealth. As Machalicek et al. (2009) suggested, one of the benefits telehealth technology has is that it does not require the behavior therapist to be physically present in the therapy room. This may allow behavior analysts to minimize the costs of providing services and the need for travel (Gibson et al., 2010). As Gibson et al. (2010) suggested, telehealth technology can remove travel time, resulting in increased time for the behavior analyst to work with clients. Eliminating travel time and costs addresses major barriers to U.S. behavior analysts providing face-to-face services to families in other countries. Alternatives to face-to-face service delivery to underserved countries need to be examined.

In regards to financial costs, the current study did not include an economic analysis; however, Wacker et al. (2013a and 2013b) showed that the weekly cost of providing behavior analytic services via telehealth to a regional clinic cost less (i.e., $58 per child) than the therapist providing the same services in the child's home (i.e., $335 per child). To complete the FAs with each child via telehealth, each parent spent approximately 1.5 hours per week, including travel time to the clinic, and the behavior consultant spent approximately 1 hour per week. Similarly, Wacker et al. (2013b) estimated that the average cost of conducting FA plus FCT procedures via telehealth in the child's home was $60 per visit in comparison to an estimated cost of $291 per visit for the therapist to provide the same assessment and treatment package in-vivo in the child's

home. In addition to the financial savings, telehealth resulted in substantial reductions in the time required for the therapist to conduct the assessment and treatment sessions. Wacker et al. (2013b) estimated that therapists would have driven more than 1,100 hours to conduct in-vivo behavior therapy for the 192 weekly visits. These studies suggest that the cost of conducting behavioral treatment via telehealth was much less than the cost of conducting in-vivo therapy.

In the current study, the physical distance between the child and the behavior analyst was approximately 6,300 miles, making service delivery in the participants' home unfeasible. Many countries lack access to applied behavior analysis (ABA) services due to a lack of trained behavior analysts. Anecdotally, I met a family from an Arab country who wanted a behavior analyst at the University of Iowa Children's Hospital to come to their home in their country and provide behavioral treatment for their child with challenging behavior. Because of the limited access to trained behavior analysts in their country, the family traveled to the U.S. and sought ABA services despite significant cost. The outcomes of the current study suggest that telehealth would be an efficient and relatively inexpensive way to deliver behavioral therapy to those in need in underserved countries.

Telehealth also offers the advantage of providing an opportunity to observe a participant's behavior under the antecedent conditions typically associated with problem behavior. For example, play materials and therapists in clinical settings are often novel to the child. In the case of toys, the novelty may increase the child's interest in the toys and decrease the child's motivation to gain access to parent attention, or the opportunity to earn access to the novel task may increase the child's willingness to perform a nonpreferred activity to earn play time with the toy. In contrast, the toys available in the home setting are likely to be familiar to the child and not as likely to maintain the child's interest. The presence of novel therapists in a

clinical setting may result in anxiety and agitation for some children that is not typical in the home setting. Other children may refrain from showing problem behavior in the presence of an unfamiliar person. The absence of siblings who might compete for access to preferred items and parental attention may reduce the child's motivation to engage in problem behavior in the clinic setting.

Cons. There may be some situations in which providing services via telehealth could be challenging in terms of practicality, safety, or privacy. For example, testing for automatic functions for problem behavior (i.e., the behavior provides its own reinforcement; Hanley, Iwata, & McCord, 2003) typically includes an alone condition to determine if the behavior occurs when no one is available to respond to the behavior (Kuhn, DeLeon, Fisher, & Wilke, 1999; Piazza, Adelinis, Hanley, Goh, & Delia, 2000; Richman, Wacker, Asmus, & Casey, 1998; Roscoe, Iwata, & Goh, 1998). During the alone condition, the participant is left alone in a room without access to leisure or work materials. In clinical settings, rooms are available that do not include furniture or other materials that could injure the child and a therapist is able to view the room from an observation window or via an in-house camera system. It is unlikely that a home would have a room void of items that the child could manipulate nor a room with a one-way observation window or in-home camera system that would allow the parent to enter the room in sufficient time to prevent potential injuries and keep the child safe.

Cases in which the participant's challenging behavior cannot be handled safely by the parents without support from therapists may also preclude the use of telehealth as a means of assessment or treatment. For example, if a participant is larger or stronger than the parent, telehealth may not be advisable unless other people were immediately available to support the parent. Another example would be a participant who engages in severe destructive behaviors

when thwarted in obtaining something they want or required to perform a nonpreferred activity. Clinic rooms and materials can be manipulated to allow a participant to show intense challenging behavior without injury, but homes typically cannot.

Providing telehealth services in public settings such as classrooms or day cares may also pose challenges to telehealth in terms of privacy. The availability of equipment to conduct telehealth in public settings may result in evaluations being conducted in settings that do not offer the appropriate level of privacy for the participant or family. In addition to concerns with the participant's privacy, there could be concerns about the privacy of other children. Children and adults who are not targeted for the evaluation may be in view of the camera or their voices may be heard.

Parent Training

Like previous studies (Wacker et al., 2013a and 2013b), all procedures were conducted successfully by parents who had no previous experience in behavioral assessment and treatment. In this study, all parents received only 1 hour of brief didactic training at their home about the procedures prior to the start of the project. The successful outcomes of the study support the Wacker et al. (2013a and 2013b) studies by showing that a brief introduction to the FA and FCT procedures before conducting the behavioral package was sufficient for the delivery of behavior analytic services via telehealth because a behavior consultant provided direct coaching to the parents throughout assessment and treatment.

Anecdotal comments from the parents suggested that the brief face-to-face training was helpful for the parents in several ways. Initially, the parents reported that they were overwhelmed by the FA and FCT procedures. Following the face-to-face training, feelings of intimidation were

lessened and feelings of trust were established by providing time for the parents to ask questions during the training, which may have helped them feel more comfortable with the procedures. During telehealth sessions, the verbal directions were given to parents who were expected to follow them. The rapport built through face-to-face training may have helped build trust between the behavior consultant and parents. Future studies are needed to determine how rapport built via face-to-face training or interviews affects the dynamics of treatment. For example, it would be interesting to investigate whether assessment and treatment results differ between families who do and those who do not receive face to face time with a therapist.

Treatment Fidelity

Several studies indicated that poor treatment integrity may negatively affect treatment effects (Arkoosh, Derby, Wacker, Berg, McLaughlin, & Barretto 2007; Carroll, Kodak, & Fisher, 2013; Fryling, Wallace, & Yassine, 2012; St. Peter-Pipkin, Vollmer, & Sloman, 2010). For example, Arkoosh et al. (2007) explored the relationship between the degree of treatment integrity and treatment outcomes and concluded that a higher degree of treatment fidelity was more likely to result in better treatment results.

As discussed by Suess et al. (2014a), the treatment fidelity of parents conducting treatment becomes an important issue in telehealth studies, because the behavior analyst does not provide the parents with direct modeling or physical assistance during telehealth sessions. The telehealth model requires parents to follow verbal instructions and feedback given prior to and during the sessions to obtain good treatment results (Suess et al., 2014a). As discussed by Wacker et al. (2013b), highly structured procedures such as FA and FCT can be conducted via telehealth with good fidelity. Suess et al. (2014a) evaluated the fidelity of parents implementing

FCT procedures during coached sessions via telehealth and practice sessions outside of telehealth visits. Suess et al. (2014a) reported that all parents had good fidelity during the telehealth sessions with coaching from the therapist. The parents also implemented the FCT procedures with good fidelity during practice sessions conducted between telehealth visits. In addition, all participants showed substantial reductions in problem behavior by the end of treatment. These results suggest that the use of telehealth itself did not negatively impact the effects of treatment. The current results also showed that parents from another country with a different culture could follow the FA plus FCT procedures correctly.

Similarly, as discussed by Suess et al. (2014a), most of the parents in the current study had a strong educational background (i.e., three mothers had a bachelor's degree, one had an associate's degree, and one had high school diploma). The parents were also able to follow verbal instructions without direct demonstrations of the procedures. Future studies could explore how the use of telehealth may disrupt the efficacy of treatment when the FA plus FCT are conducted by parents who have more variable skills and/or may need direct demonstrations of the procedures. These results support the telehealth treatment fidelity literature (e.g., Suess et al., 2014a) by showing that behavioral treatment via telehealth can be conducted by certain kinds of caregivers with good fidelity.

Treatment Acceptability (Research Question 3)

In the current study, the parent of each participant (N = 5) rated the FA plus FCT procedures as highly acceptable (*M* = 6.40 on a 7-point Likert scale) on the TARF-R. Wacker et al. (2013b) reported that 16 parents rated the acceptability of the procedures as highly acceptable (average rating 6.47 in 7-point Likert scale). Suess et al. (2014a) also reported that the average

rating from three parents was 6.67. These results suggest that the parents of the five children in the current study perceived the ABA service delivered via telehealth technology as highly acceptable. Similar to Wacker et al. (2013b), the parents voluntarily participated in the current study, thereby likely resulting in more positive acceptability of the treatment than if the parents had been assigned to the study. In addition, the acceptability of the treatment procedure might have been affected by the fact that the behavior analyst came from the same cultural background (i.e., Korean culture) and had face-to-face connection to build rapport with the parents.

In regard to the cultural difference, the behavior consultant is Korean and spoke Korean throughout the sessions with the families. This fact might have reduced the cultural barriers between two parties although the behavior consultant was located in the U.S. while doing the telehealth sessions. Although applied behavior analysis in Korea is not as popular as in the U.S., the families were open to the ABA services. Parents in Korea frequently seek out behavioral treatments for their children, but it is often difficult to find affordable and available treatments of the type provided in this study. This fact might have positively affected the acceptability of treatment. Future studies could investigate how culture difference and rapport building affect the treatment acceptability.

Equipment (Research Question 4)

Another purpose of this study was to evaluate the use of readily available equipment requiring minimal cost. In the current study, three mothers used their smartphone for the Skype sessions (i.e., Samsung Galaxy s5, Samsung Galaxy s3, and Samsung Galaxy Note2). There were several advantages to using smart phones for telehealth such as less expense, ease of accessibility, less expertise required than when running the traditional equipment, and more

flexibility in placement of the phone. Therefore, the current study also examined if the use of readily available electronic devices (i.e., smart phones) could be as effective for delivering coaching via telehealth as the use of computers, webcams, and designated monitors.

Previous telehealth studies used laptop computers for family or classroom use (Gibson et al., 2010; Machalicek et al., 2009; Suess et al., 2014a; Wacker et al., 2013a and 2013b). Families who did not have home computers or had old home computers were provided with laptop computers equipped with audio and visual hardware (Suess et al., 2014a; Wacker et al., 2013a and 2013b).

Generally, when parents use a desktop or laptop computer for videoconferencing, audio and visual hardware need to be installed in the computer. But, smart phones are equipped with audio and visual hardware and no additional hardware and software are needed to conduct videoconferencing. Smart phones can be especially useful because most are equipped with an integrated webcam. The use of smart phones resulted in reduced costs for preparing the equipment in comparison to the costs associated with previous studies (Wacker et al., 2013a and 2013b). Lee, Schieltz, Suess, Wacker, Romani, Lindgren, Kopelman, and Padilla (2015) reported that integrated webcams were not recommended due to the limited field of view and reduced video quality. However, in the current investigation, the integrated webcam was sufficient to provide a view of the full room and the video quality was adequate for conducting videoconferencing. Frieder et al. (2007) reported that technology equipment cost about $5,000 for their pilot study. They used two cameras (i.e., Ganz ZC-D600tm series) which had camera control functions such as zoom and pan features (Frieder et al., 2007). Generally, pan- and zoom-capable cameras are much more expensive than a typical web-camera. The outcomes of the current study suggest that expensive cameras may not be needed to obtain acceptable outcomes.

Most of the parents, except Sun's parent, used Bluetooth headsets so that the behavior consultant could communicate with the parent without the child hearing the conversation. Using Bluetooth headsets was different than the Wacker et al. (2013a and 2013b) studies where the behavior consultant interacted with the child and parent while coaching the parent during FA and FCT sessions. In the current study, all of the instruction came from the parent; the child did not hear the therapist tell the parent what to say or hear the therapist's praise. This may have made the evaluation more naturalistic.

Generally, smart phones are relatively small and light and can be placed on furniture or TVs. In the current study, a mini tripod or cellular phone holder was used to place the phone above eye level on the top of the furniture to get a wider field of view. For example, the smart phones of Doll and Ana's parents were placed on top of the TV above eye level. Kim's parent smart phone was placed on a tripod on the top of a bookshelf. This allowed the parents to manipulate the location of the phone. This also increased the flexibility to place the phone where needed to get a good view of the room.

Traditional telehealth has typically involved the use of relatively expensive electronic equipment (e.g., computers, dedicated monitors, and cameras) at both settings, which may increase the costs of providing telehealth care. The positive outcomes of the current study support the utility of relatively low cost and readily accessible electronic devices such as smart phones for the video connection in the participant's homes. The results of this study suggested that this use of smart phones could remove one of the cost barriers to providing services.

In the current study, Skype was used for videoconferencing sessions. Skype is a free software for both desktop computers and smart phones, and provides acceptable video quality for observing and coding research sessions. As discussed by Lee et al. (2015), the cost of using

traditional videoconferencing hardware and software solutions is expensive for widespread use. Skype may be a reasonable option for telehealth sessions. The current study supports the previous research by Wacker et al. (2013a and 2013b), showing that publicly used videoconferencing software (e.g., Skype) can be used to deliver telehealth sessions for the family.

Implications

The findings from this study contribute to the literature on ABA services from a practical and clinical standpoint. First, from a practical standpoint, a telehealth service delivery model such as the one used in Wacker et al. (2013a and 2013b) and the current study could provide a model for addressing severe problem behavior with young children living in countries with very limited access to qualified behavior analysts. For example, there are fewer than 20 Board Certified Behavior Analysts listed in the Korea certificant registry (Behavior Analysis Certification Board, 2015). Other countries such as China and Japan have similar shortages in ABA service providers. In China, there are fewer than 40 BCBAs and in Japan there are fewer than 14 BCBAs (Behavior Analysis Certification Board, 2015). So far, previous studies on telehealth showed that FA and FCT can be conducted effectively via telehealth for children within the United States (Barretto et al., 2006; Suess et al., 2014a; Wacker et al., 2013a and 2013b). Few telehealth studies have been conducted for families living in underserved country with limited access to the behavioral services. The current study was one of the first attempts to replicate the previous telehealth studies over greater physical distances as well as across different cultures. In this study, the participants' homes were located in Korea, approximately 6,300 miles away from Iowa, where the telehealth office is located. This research attempted to extend

treatment access to an underserved country like Korea by systematically evaluating the effects of in-home telehealth services. The outcomes of the study suggested that telehealth can increase the accessibility of behavioral treatment for underserved children with ASD in Korea because it can decrease obstacles in regard to travel cost and access to trained professionals.

Second, from a clinical perspective, the results from the current study extends the previous telehealth literature by showing that behavioral assessment and treatment delivered across countries via telehealth can be effective for reducing problem behavior. The current investigation provided a model for the use of telehealth technology to conduct FA plus FCT from the U.S. to another country with limited access to ABA services. In addition, a telehealth service delivery model would be a good approach for some children because all sessions occur at the child's home. In a clinic, a child is required to come into the therapy room to receive behavioral services and may need a certain amount of time to adjust to the new environment including therapists and toys. In an extreme case, a child may suppress problem behavior in a new environment during behavior assessment. However, when delivering behavior service via telehealth, these issues may be minimized because all sessions occur in the home, which is a more naturalistic setting, and the family can use the child's own toys. In the future, it would be interesting to test if telehealth procedure would be more effective in conducting FA and FCT for a child who may not display problem behavior in a clinic.

Challenges and Limitations

There were several challenges in conducting telehealth between two countries with the time difference between the U.S Midwest and Korea being one of the most difficult challenges. The time in Korea is 14 hours ahead of Central Standard Time. For example, when it is 7:00am

in Korea, it is 5:00pm in the Midwest, U.S. The session times were scheduled to accommodate the families' schedules, which resulted in the behavior analysts conducting sessions between 5:00pm and 8:30pm on weekdays. For example, the earliest session was 7:00am in Korean Time which is 5:00pm Central Standard Time. Some parents had difficulty running sessions on a few days because 7am was a busy time for the families. Furthermore, all of the participants had other siblings who occasionally entered the treatment area and requested their mother's attention during the telehealth sessions.

There are several limitations with the current study. First, in front of the camera, children may have a tendency to change their behavior when they are aware of being observed by someone. This was the case for Kim. Kim showed fewer problem behaviors after he noticed the phone screen during the FA sessions (e.g., Session 20, 21, and 25). As a result, the phone screen, except for the integrated camera, was covered by a paper. After the phone was covered, he displayed problem behavior at levels similar to the levels observed during previous sessions when he was not aware of the camera. To reduce observer effects on participant behavior, the use of screen cover might be needed for some telehealth sessions.

Second, the participants' parents who conducted the sessions were all from middle class status in Korea and had good educational backgrounds. All parents had the skills to follow instructions given from the behavior analyst. This fact may have resulted in more successful implementation of the FA plus FCT package than might be observed in homes with families with lower levels of education.

Third, unexpected events occurred in the home, which could not be controlled by the behavior analyst through telehealth (Suess, Kopelman, Wacker, Lindgren, Lee, Romani, & Schieltz, 2014b). For example, during the FCT sessions for Ana and Sun, their siblings entered

the sessions and talked to the parent and to the participant. Doll tried to leave the work area and eloped out of the camera's view several times. Kim approached his toys while his mother presented the work task. These unexpected events could affect treatment integrity as well as treatment outcomes (Suess et al., 2014b), but did not prevent the parents from showing good treatment integrity and achieving desired changes in behavior in the current study.

Finally, technical challenges did occur. Video and audio transmission problems were observed from time to time. Technology difficulties were most prevalent during sessions using smart phones (i.e., Kim, Ana, and Doll). For example, on a few occasions the smart phone battery died prior to or during the telehealth session and the behavior consultant could not see the participant. Similar problems arose when the Bluetooth headset's battery died during sessions. When the Bluetooth headset's battery died, the behavior consultant could not hear the parent talking. Doll's mother used her smart phone for work and the video conference was disrupted when a client called her during treatment sessions. Telehealth sessions were resumed after troubleshooting these problems. These technology issues may affect the treatment fidelity as noted by Lee et al. (2015).

Overall, the smart phones provided acceptable views to observe the assessment and treatment sessions and acceptable sound to hear the parent's and child's voices. However, Korea has more advanced technology for internet connection than is currently available in the U.S. Therefore, we cannot assume the technology used in the current study would be sufficient for conducting telehealth sessions in the U.S. or other counties. Finally, although it is cost effective and convenient to use cell phones, the level of security is not clear.

Future Directions

There are several things to consider when implementing future studies. First, future researchers may need to examine the role of rapport. In the current study, the face-to-face interview and didactic training were conducted at the families' homes prior to the telehealth sessions. Rapport building prior to a session may have helped parents feel more comfortable when conducting sessions and could have influenced the parent's willingness to follow the behavior analyst's instructions. This question was not addressed in the current investigation. Future studies may determine if rapport building via a face-to-face interview influences treatment fidelity.

Second, the current study evaluated the use of smart phones for the telehealth sessions. The use of smart phones may present unique technology difficulties for providing telehealth services. For example, the smart phones may disconnect or freeze when receiving an external call, and the battery life of a smart phone varies across brands and age of the phones. Furthermore, the adequacy of conducting telehealth via smart phones across sites within the U.S. has not been established. Additional research is needed to determine the adequacy and acceptability of using smart phones to provide telehealth services across sites. Further research is also needed to determine the type of hardware equipment and software that is needed to provide sufficient, secure, yet low cost, and accessible technology for conducting telehealth services in the U.S.

Third, the study only evaluated the use of telehealth between U.S. and Korea. Overall the study procedures were successful for delivering behavior analytic services to families living in Korea via telehealth. Future studies could replicate the procedures with children from other culturally and linguistically diverse populations. Future researchers could also evaluate the

applicability of a telehealth model for delivering services in settings other than the child's home in other countries. For example, some children may engage in problem behavior at school, but not at home. In this case, behavioral assessment and treatment might be conducted in the school setting. Future research could include school teachers and replicate the use of telehealth technology in coaching teachers to conduct behavioral assessment and treatment. Considerations for the privacy of other students, as discussed previously, would be needed or a consent to videotape each child could be requested from the other children's parents.

Moreover, schools in other countries may have different levels of support, different types of structure and culture, all of which could affect the acceptability and integrity of providing behavioral services across countries. Finally the acceptability of challenging behavior differs across cultures and these differences could influence the acceptability of providing services, such as telehealth, outside of clinical settings.

Fourth, as discussed by Suess (2015), when delivering behavioral services via telehealth, some parents may have difficulty following verbal instructions from a consultant. As Suess (2015) suggested, for these families, it may be beneficial if the therapist provided modeling or used gestures to supplement spoken and written words. Future researchers could evaluate the utility of modeling and gestures to coach parents via telehealth. Future studies could also evaluate the effects of using training videos during training sessions to demonstrate how to handle problem behaviors, block problem behavior, present demands, and use picture card etc., as noted by Suess (2015).

Finally, the current study did not evaluate long term treatment effects. Future studies could include follow-up sessions to determine if the treatment effects achieved via telehealth are maintained over time.

Conclusion

In summary, the purpose of the current study was to evaluate the effectiveness of delivering behavioral assessment and treatment to reduce problem behavior shown by Korean children who have ASD by using in-home telehealth from another country (i.e., U.S.). Results showed that the functional analysis conducted via telehealth identified social functions (i.e., negative and/or positive reinforcement) across all participants. Based on the results of the FA, an FCT treatment package that matched the function of the FA was developed for each child. FCT treatments implemented via telehealth produced substantial reductions in problem behavior for all participants. This study extends the telehealth literature by showing that behavior analytic service delivered across countries via telehealth can be effective for reducing problem behavior. In the current study, three of the families used smart phones for the internet connections and the procedures were successfully completed. The use of smart phones as telehealth hardware may be warranted because the phones are one of the most cost effective options when delivering behavior analytic services via telehealth.

In short, the current study provided an initial attempt of delivering behavior analytic services to culturally and linguistically diverse families who lived in another country (i.e., Korea) and the results were positive. More research is always needed and it will be important to determine how to further expand the delivery of behavior analytic services to underserved populations.

This study provided a model for other underserved countries in how to increase access to ABA services. This study also served as a model for extending evaluations from one country to another country with limited access to the specific discipline. By providing treatment to children

at an early age via telehealth, it should be possible to reduce problem behavior of children with ASD in underserved country.

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APPENDIX

DATA COLLECTION FORM

Name: _____ Date: _____ Condition: _____ Session #: _____ Therapist: _____ Coder: _____ P/R

CO1: _____ CO2: _____ 1:_____ 2: _____ 3: _____ 4: _____ 5: _____ 6: _____

6		12		18		24		30		36		42		48		54		60		
EO SR	+ - 0	EO SR	+ - 0	EO SR	+ - 0	EO SR	+ - 0	EO SR	+ - 0	EO SR	+ - 0	EO SR	+ - 0	EO SR	+ - 0	EO SR	+ - 0	EO SR	+ - 0	
P	S A D	P	S A D	P	S A D	P	S A D	P	S A D	P	S A D	P	S A D	P	S A D	P	S A D	P	S A D	
C1 C2	EL NC	C1 C2	EL NC	C1 C2	EL NC	C1 C2	EL NC	C1 C2	EL NC	C1 C2	EL NC	C1 C2	EL NC	C1 C2	EL NC	C1 C2	EL NC	C1 C2	EL NC	**1**
1 2 3	DB RB	1 2 3	DB RB	1 2 3	DB RB	1 2 3	DB RB	1 2 3	DB RB	1 2 3	DB RB	1 2 3	DB RB	1 2 3	DB RB	1 2 3	DB RB	1 2 3	DB RB	
4 5 6	T CI CP	4 5 6	T CI CP	4 5 6	T CI CP	4 5 6	T CI CP	4 5 6	T CI CP	4 5 6	T CI CP	4 5 6	T CI CP	4 5 6	T CI CP	4 5 6	T CI CP	4 5 6	T CI CP	

6		12		18		24		30		36		42		48		54		60		
EO SR	+ - 0	EO SR	+ - 0	EO SR	+ - 0	EO SR	+ - 0	EO SR	+ - 0	EO SR	+ - 0	EO SR	+ - 0	EO SR	+ - 0	EO SR	+ - 0	EO SR	+ - 0	
P	S A D	P	S A D	P	S A D	P	S A D	P	S A D	P	S A D	P	S A D	P	S A D	P	S A D	P	S A D	
C1 C2	EL NC	C1 C2	EL NC	C1 C2	EL NC	C1 C2	EL NC	C1 C2	EL NC	C1 C2	EL NC	C1 C2	EL NC	C1 C2	EL NC	C1 C2	EL NC	C1 C2	EL NC	**2**
1 2 3	DB RB	1 2 3	DB RB	1 2 3	DB RB	1 2 3	DB RB	1 2 3	DB RB	1 2 3	DB RB	1 2 3	DB RB	1 2 3	DB RB	1 2 3	DB RB	1 2 3	DB RB	
4 5 6	T CI CP	4 5 6	T CI CP	4 5 6	T CI CP	4 5 6	T CI CP	4 5 6	T CI CP	4 5 6	T CI CP	4 5 6	T CI CP	4 5 6	T CI CP	4 5 6	T CI CP	4 5 6	T CI CP	

6		12		18		24		30		36		42		48		54		60		
EO SR	+ - 0	EO SR	+ - 0	EO SR	+ - 0	EO SR	+ - 0	EO SR	+ - 0	EO SR	+ - 0	EO SR	+ - 0	EO SR	+ - 0	EO SR	+ - 0	EO SR	+ - 0	
P	S A D	P	S A D	P	S A D	P	S A D	P	S A D	P	S A D	P	S A D	P	S A D	P	S A D	P	S A D	
C1 C2	EL NC	C1 C2	EL NC	C1 C2	EL NC	C1 C2	EL NC	C1 C2	EL NC	C1 C2	EL NC	C1 C2	EL NC	C1 C2	EL NC	C1 C2	EL NC	C1 C2	EL NC	**3**
1 2 3	DB RB	1 2 3	DB RB	1 2 3	DB RB	1 2 3	DB RB	1 2 3	DB RB	1 2 3	DB RB	1 2 3	DB RB	1 2 3	DB RB	1 2 3	DB RB	1 2 3	DB RB	
4 5 6	T CI CP	4 5 6	T CI CP	4 5 6	T CI CP	4 5 6	T CI CP	4 5 6	T CI CP	4 5 6	T CI CP	4 5 6	T CI CP	4 5 6	T CI CP	4 5 6	T CI CP	4 5 6	T CI CP	

6		12		18		24		30		36		42		48		54		60		
EO SR	+ - 0	EO SR	+ - 0	EO SR	+ - 0	EO SR	+ - 0	EO SR	+ - 0	EO SR	+ - 0	EO SR	+ - 0	EO SR	+ - 0	EO SR	+ - 0	EO SR	+ - 0	
P	S A D	P	S A D	P	S A D	P	S A D	P	S A D	P	S A D	P	S A D	P	S A D	P	S A D	P	S A D	
C1 C2	EL NC	C1 C2	EL NC	C1 C2	EL NC	C1 C2	EL NC	C1 C2	EL NC	C1 C2	EL NC	C1 C2	EL NC	C1 C2	EL NC	C1 C2	EL NC	C1 C2	EL NC	**4**
1 2 3	DB RB	1 2 3	DB RB	1 2 3	DB RB	1 2 3	DB RB	1 2 3	DB RB	1 2 3	DB RB	1 2 3	DB RB	1 2 3	DB RB	1 2 3	DB RB	1 2 3	DB RB	
4 5 6	T CI CP	4 5 6	T CI CP	4 5 6	T CI CP	4 5 6	T CI CP	4 5 6	T CI CP	4 5 6	T CI CP	4 5 6	T CI CP	4 5 6	T CI CP	4 5 6	T CI CP	4 5 6	T CI CP	

6		12		18		24		30		36		42		48		54		60		
EO SR	+ - 0	EO SR	+ - 0	EO SR	+ - 0	EO SR	+ - 0	EO SR	+ - 0	EO SR	+ - 0	EO SR	+ - 0	EO SR	+ - 0	EO SR	+ - 0	EO SR	+ - 0	
P	S A D	P	S A D	P	S A D	P	S A D	P	S A D	P	S A D	P	S A D	P	S A D	P	S A D	P	S A D	
C1 C2	EL NC	C1 C2	EL NC	C1 C2	EL NC	C1 C2	EL NC	C1 C2	EL NC	C1 C2	EL NC	C1 C2	EL NC	C1 C2	EL NC	C1 C2	EL NC	C1 C2	EL NC	**5**
1 2 3	DB RB	1 2 3	DB RB	1 2 3	DB RB	1 2 3	DB RB	1 2 3	DB RB	1 2 3	DB RB	1 2 3	DB RB	1 2 3	DB RB	1 2 3	DB RB	1 2 3	DB RB	
4 5 6	T CI CP	4 5 6	T CI CP	4 5 6	T CI CP	4 5 6	T CI CP	4 5 6	T CI CP	4 5 6	T CI CP	4 5 6	T CI CP	4 5 6	T CI CP	4 5 6	T CI CP	4 5 6	T CI CP	