The Effects of a Technology-Based Self-Monitoring Intervention on On-Task, Disruptive, and Task-Completion Behaviors for Adolescents with Autism

By

Raia Rosenbloom

Submitted to the graduate degree program in Applied Behavioral Science and the Graduate Faculty of the University of Kansas in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

Chair: Charles R. Greenwood, Ph.D.

Florence D. DiGennaro Reed, Ph.D., BCBA-D

Howard P. Wills, Ph.D.

Glen W. White, Ph.D.

Judith J. Carta, Ph.D.

Date Defended: September 6, 2017

The dissertation committee for Raia N. Rosenbloom certifies that this is the approved version of the following dissertation:

The Effects of a Technology-Based Self-Monitoring Intervention on
On-Task, Disruptive, and Task-Completion Behaviors for Adolescents with Autism

____

Chair: Charles Greenwood, Ph.D.

Date Approved: September 13, 2017

Abstract

Individuals with autism spectrum disorders (ASD) often present with difficulty in sustaining engagement and attention, and display disruptive behavior in classroom settings. Without appropriate intervention, these challenging behaviors often persist and negatively impact educational outcomes. Self-monitoring is a well-supported evidence-based practice for addressing challenging behaviors and improving pro-social behaviors for individuals with ASD. The use of self-monitoring procedures with the aid of handheld computer-based technology is an unobtrusive and innovative way of implementing an intervention. A withdrawal design was employed in order to assess the effectiveness of a technologically delivered, self-monitoring intervention called I-Connect in improving on-task and task completion behaviors and decreasing disruptive behavior with four adolescents with ASD. Results demonstrated improvements in on-task and task completion behaviors across all four participants, and disruptive behavior improved for two participants.

Acknowledgements

I would like to first thank Drs. Charles Greenwood, Howard Wills, Florence DiGennaro Reed, Glen White, and Judy Carta for dedicating their time and expertise while serving on my dissertation committee. You have enriched both my dissertation research experience and overall experience at the University of Kansas.

I am forever grateful to my advisor, Dr. Howard Wills. His endless support, patience, and mentorship resulted in me being the student, researcher, and practitioner I always dreamed of being. I will never forget interviewing for the student hourly research position at Juniper Gardens Children's Project and thinking to myself that if I got this job I was going to learn more than I ever imagined under Howard. Howard taught me the importance conducting rigorous research that also aims to improve the quality of life for others. Howard was also my biggest advocate throughout the most difficult parts of my graduate school experience, and for that I will never have enough words to thank him. I can confidently say that Howard has forever impacted my life for the better.

My mentor, Dr. Rose Mason took me under her wing when she became a principal investigator at Juniper Gardens Children's Project. She knew that I had a passion for helping individuals with autism spectrum disorders and made it her mission to make sure that I learned everything about conducting research with that population. She spent countless hours helping me with my writing and research. She was also my biggest advocate and confidant when I was struggling academically and personally. She allowed me to step back and reassess when I needed to, but also pushed me when I was giving up. I am so grateful that I was able to have a boss, mentor, and friend guiding me throughout my graduate school experience.

This study could not have been complete without the help of my colleagues and research assistants at Juniper Gardens Children's Project: Dr. Debra Kamps, Jonathan Huffman, Dr. Alana Schnitz, Tiffany Ward, and Leslie Bross. Their support, guidance, and, of course, reliability data, has been pivotal. Thank you so much for taking the time to help me. Next, I would like to thank all my colleagues and close friends, particularly Alyson Buck, Kelsey Dachman, and Heather Skinner for always being there for me and supporting me throughout my graduate school experience. They single-handedly got me through every class, test, and paper. I am so grateful that I was able to have wonderful classmates and friends like Alyson, Kelsey, and Heather.

Last, I would like to thank my wonderful family for everything they have done for me. My parents have been right beside me ready to offer any support I need and without hesitation. I would especially like to thank my brother Joey for being the best friend I could ask for, and supporting me in my mission to help others with autism. Finally, I could not have gotten through graduate school without the love and support I received from Nick Ginther. His steadfast confidence in me was so appreciated.

Table of Contents

Abstract.........iii

Acknowledgements.........iv-v

Table of Contents.........vi

Introduction.........1-10

Literature Review.........10-32

Methodology.........10-15

Results.........15-25

Discussion.........25-32

Study.........33-65

Methodology.........33-51

Results.........52-61

Discussion.........61-65

Figures.........66-72

Tables.........73-74

References.........75-87

Appendices.........88-94

Introduction

Autism Spectrum Disorder (ASD) is a neurodevelopmental disorder defined by having difficulties in social interaction, communication, stereotypic behavior, and restricted interests (American Psychiatric Association, 2013). Individuals with ASD may also struggle with learning or processing problems such as retrieving information, focusing and sustaining attention, managing time effectively, and self-correcting after errors (Bjorkland, 2012; Finn, Ramasamy, Dukes, & Scott 2015). According to the Centers of Disease Control and Prevention (2016) the prevalence of ASD has risen to 1 in 68 children. This rapid increase in prevalence and the complex symptoms of ASD have presented challenges for behavior analysts and special educators (Crosland & Dunlap, 2012). These symptoms may be exacerbated in school settings with increased demands, presenting as difficulty in sustaining academic engagement, attention problems, and disruptive behavior (Heflin & Alaimo, 2007). Without appropriate intervention, these challenging behaviors often persist and negatively impact educational outcomes (Machalicek, O'Reilly, Beretvas, Sigafoos, & Lancioni, 2007).

To decrease problem behavior and promote educational progress, students with ASD often require repeated intervention using evidence-based practices (EBPs; Browder, Wood, Thompson, & Ribuffo, 2014; Odom, Cox, & Brock, 2013). The National Professional Development Center (NPDC, 2014) defined EBPs as strategies professionals use to promote specific outcomes for individuals with ASD. Research has shown when EBPs are implemented consistently and with high procedural fidelity, individuals with ASD demonstrate progress on academic, behavioral, and adaptive skills (Browder et al., 2014). The National Autism Center (NAC; National ASD Center, 2015) identified 11 EBPs and the NPDC identified 27 EBPs, which are all grounded in principles of applied behavior analysis (ABA; Cooper, Heron, &

Heward, 2007) (e.g., differential reinforcement, prompting, discrete trial training, modeling, self-management; Odom, Collet-Klingenberg, Rogers, & Hatton, 2010).

These EBPs often involve the manipulation of antecedents and consequences to address targeted classroom behavior (Conroy, Asmus, & Sellers, 2005; Gresham, 2004; Stage & Quiroz, 1997) and although research supports the use of such interventions, most do not promote independence and generalization, as they are dependent on an outside agent (i.e., adult mediator, paraprofessional, behavioral implementer; McCloskey, Perkins, & Van Divner, 2008; Morrison, Kamps, Garcia, & Parker, 2001). Such interventions require frequent adult prompting throughout a task or upon the occurrence of a target behavior, and repeated reinforcement upon the completion of a demand (Smith, 2001). A stimulus control is often established during initial teaching and skill acquisition phases that can reinforce unplanned prompt dependency and increase overreliance on the outside agent (i.e., discriminative stimulus; Hume, Loftin, & Lantz, 2009). This is a challenge because individuals with ASD fail to demonstrate independent use of targeted skills upon the removal or fading of an outside agent's support, prompts, or contingencies (Dunlap & Johnson, 1985; Stahmer & Schriebman, 1992). Removal of an outside agent may also result in decreases in engagement and productivity (Hume et al., 2009). Overreliance on outside agents can contribute to potential long-term implications for individuals with ASD in employment, independent living, and relationship development (Hume et al., 2009). For example, individuals who are dependent on adult prompting to complete tasks may face difficulties when additional staff are not available in future settings (e.g., residential, job sites) (Giangreco & Broer, 2007).

Interventions that promote independent functioning skills of individuals with ASD and decrease dependency on others are urgently needed (Hume, Boyd, Hamm, & Kucharczyk, 2014;

Hume et al., 2009). Giangreco and Broer (2007) conducted a widespread survey of 700 service providers who work with individuals with disabilities, including ASD, in school settings. Results demonstrated that a service provider was within three feet of the respective individual for more than 86% of their day. These results provide evidence that a greater emphasis on increasing independent functioning for individuals with ASD is needed. Additionally, research indicates that individuals with ASD who demonstrate greater independence during secondary school are more likely to be employed and live independently after graduation as compared to those who are more dependent on staff or caregivers (Hume, et al., 2014; Wehmeyer & Palmer, 2003). Binder (1993) suggested that strategies that allow individuals to practice a skill behavior without interruptions (e.g., waiting for reinforcement delivery, pausing for prompting, correction or feedback from outside agent) must be implemented in order to ensure increased independence and success for individuals with ASD. As the ASD population ages and as the prevalence of ASD continues to increase, interventions that promote independent responding and require less adult support are needed to ensure positive outcomes (Hume et al., 2009; Hume et al., 2014).

Self-Management

Self-management interventions aim to address these problems (i.e., lack of independence and generalization of skills) and have been identified as an EBP for individuals with disabilities (Odom, et al., 2010). Self-management incorporates several components (self-monitoring, self-recording, goal setting, and self-evaluation) (Aljadeff-Abergel et al., 2015) that are often used to improve challenging behavior in classrooms, generalize adaptive behavior, promote autonomy, and promote behavior improvements across a variety of settings (Alberto & Troutman, 2013; Hoff & DuPaul, 1998; Nelson, Smith, Young, & Dodd, 1991; Peterson, Young, Salzberg, West, & Hill, 2006; Wilkinson, 2008). Self-management interventions typically address a specific target behavior and utilize a specific self-management procedure (self-monitoring) (Smith & Sugai, 2000).

Several systematic reviews concluded self-management interventions can improve social, academic, and functional behaviors in individuals with ASD (Aljadeff-Abergel et al., 2015; Carr, Moore, & Anderson, 2014; Lee, Simpson, & Shogren, 2007; Southall & Gast, 2011). For example, Carr et al. (2014) examined 29 single-subject self-management interventions focused on skill acquisition and/or improving behavior with students with ASD utilizing the What Works Clearinghouse (WWC) (2016) quality assessment guidelines to evaluate the quality and rigor of the research base. The results demonstrated that in 25 of the 29 studies, 86%, met the WWC standards and provided ample evidence that self-management effectively improved target behaviors (e.g., social skills, daily living skills, academic skills, and problem behavior) for students with ASD. Lee and colleagues (2007) conducted a systematic review and meta-analysis on the effects of self-management interventions for students with ASD. Eleven articles were identified and the results indicated that self-management was a highly effective intervention for increasing appropriate behaviors for individuals with ASD across participants, settings, and conditions. Additionally, the authors reported that self-monitoring had a higher mean percentage of non-overlapping data (PND) value ($M = 87\%$) as compared to self-reinforcement (82.6%) and self-management packages ($M = 72.4\%$).

Self-Monitoring

Self-monitoring is a specific self-management component that involves an individual observing and recording the presence or absence of a target behavior (Hallahan & Kauffman, 2000; Rutherford, Quinn, & Mathur, 1996; Vaughn, Bos, & Schumm, 2000; Wilkinson, 2008). This intervention provides an alternative approach to therapist or outside-agent directed techniques (Hume et al., 2014) and aims to increase the skills that allow individuals with ASD to be more independent and less reliant on external control and supervision. Self-monitoring creates an opportunity to shift stimulus control from an outside agent (e.g., adult mediator) to an alternative stimulus (e.g., timer, buzzer, checklist). The alternative stimulus cues the individual and provides information regarding expectations related to the targeted behavior or skill (Hume et al., 2009). Self-monitoring has been shown to (a) increase independence (Bouck, Savage, Meter, Taber-Doughty, & Hunley, 2014; Hume et al., 2009), (b) decrease prompt dependency on an outside agent (Hume et al., 2014), (c) increase instructional time (Wehmeyer, Hughes, Agran, Garner, & Yeager, 2003), and (d) improve overall quality of life (Bouck et al., 2014; Lee, et al., 2007). Self-monitoring has also been shown to reduce the presence of problem behaviors and increase desired behaviors (Crutchfield, Mason, Chambers, Wills, & Mason, 2015; Zirpoli, 2012).

Research on the effects of self-monitoring procedures for students with ASD has reported positive outcomes across a variety of behaviors including: social skills (Koegel, Park, & Koegel, 2014; Parker & Kamps, 2011; Reynolds, Urrela, & Devine, 2013), daily living skills (Pierce & Schriebman, 1994), stereotypic behaviors (Crutchfield et al., 2015; Koegel & Koegel, 1990), socials skills (e.g., Koegel et al., 1992), academic productivity (Callahan & Rademacher, 1999), and on-task behaviors (Callahan & Rademacher, 1999). Additionally, self-monitoring has been identified as an EBP for individuals with ASD to improve academic outcomes (Iovanne, Dunlap, Huber, & Kincaid, 2003; Koegel, Matos-Fredeen, Lang, & Koegel, 2011; Lerman, Vorndran, Addison, & Kuhn, 2004) and reduce challenging behaviors (Buschbacher & Fox, 2003; Strain, Wilson, Wilson, & Dunlap, 2011).

One meta-analysis (Davis, Mason, Davis, Mason, & Crutchfield, 2016) evaluated self-monitoring interventions implemented specifically within the context of a public school setting to decrease challenging behaviors for students with ASD across all ages. The authors summarized participant and study characteristics (setting, intervention components, and outcomes), and evaluated intervention effects for each of the variables. Results indicated that self-monitoring was a highly efficacious intervention for decreasing challenging behaviors and increasing socially appropriate behaviors for students with ASD. The results support previous findings that more basic and streamlined interventions, such as self-monitoring alone, can be just as effective as more complex interventions that include steps beyond self-assessment and self-recording (Briesch & Chafouleas, 2009; Davis et al., 2016; Fantuzzo & Polite, 1990).

The majority of the research on self-monitoring utilizes low-tech strategies which typically require the individual to use a writing utensil (e.g., pen or pencil) to record (e.g., write, circle, or check response) the presence or absence of the target behavior on a self-monitoring sheet upon the presentation of a cue (e.g., timer or buzzer) (Cooper, et al., 2007). There is a significant literature base to support the use of low-tech self-monitoring strategies for individuals with ASD (e.g., Ganz & Sigafoos, 2005; Koegel & Koegel, 1990; Stahmer & Schriebman, 1992). Parker and Kamps (2011), for example, evaluated the use of paper and pencil self-monitoring across three social tasks with typically developing peers to increase independent task completion and verbal interactions. The results showed an increase in the number of steps that each student was able to perform independently for three social activities and an increase in verbal interactions for both participants.

High-tech self-monitoring procedures incorporate technology (e.g., MotivAider®, Timex Watch) as a way to prompt or cue the individual and have been demonstrated effective for individuals with ASD (e.g., Bouck et al., 2014; Legge, Debar, & Alber-Morgan, 2010; Cihak, Wright, & Ayres, 2010). For example, Legge, Debar, and Alber-Morgan (2010) utilized a vibrating pager, the MotivAider®, to cue individuals with ASD to self-monitor on-task behaviors on their self-monitoring sheet. Cihak, Wright, and Ayres (2010) utilized an iPad to present static pictures of appropriate on-task behaviors while the individuals with ASD self-monitored their on-task behaviors on an index card. Although these studies demonstrated the positive effects of self-monitoring strategies utilizing a technological cue on increasing target behaviors or ameliorating challenging behaviors, the individuals with ASD were still required to record their behavior via paper and pencil format. Utilizing such strategies can be time-consuming and create some challenges in terms of independent functioning (Crutchfield et al., 2015). Paper and pencil formats can also be difficult for individuals with ASD to master due to difficulties with fine motor functioning (Bouck et al., 2014; Dawson & Watling, 2000). Additionally, such strategies can be socially stigmatizing and obtrusive as compared to paper and pencil formats (Gulchak, 2008; Rosenbloom et al., 2016). One solution is to utilize technology to install applications that have the capabilities to record and store data, cue individuals, and customize prompts all in one device. Research has also shown that individuals with disabilities find mobile computing and handheld technology easy to use and are more motivated to use them as compared to low-tech options, leading to high social validity (Gulchak, 2008). Furthermore, the research indicates that students are more likely to use handhelds to reliably record their behavior versus having to use paper and pencil to enter data (Palermo, Valenzuela, & Stork, 2003).

I-Connect Self-Monitoring Intervention

The I-Connect Self-Monitoring (SM) intervention is one such technology-delivered application that is a single component system (i.e., a tablet) to deliver interval self-monitoring prompts and record data. The I-Connect SM intervention has increasing empirical support as an effective self-monitoring intervention (Clemons et al., 2016, Crutchfield et al., 2015; Rosenbloom et al., 2016; Wills & Mason, 2014). Wills and Mason (2014) developed the I-Connect SM intervention to provide a non-obtrusive, self-monitoring delivery format. I-Connect SM intervention is (a) fast and easy to use, (b) allows for specific individual customizations (e.g., custom prompt intervals, notification ringtones, and type of prompts), and (c) reduces teacher data collection by electronically storing student responses. The intervention is programmed to not only deliver a prompt at a given interval but to also require a response from the target student indicating whether he/she is engaged in the target behavior. This dual feature is significant because most self-monitoring interventions typically do not have a dual prompt and response format. The research indicates this intervention is effective for individuals with specific learning disabilities (Clemons, et al., 2016; Wills & Mason, 2014), attention-deficit hyperactivity disorder (ADHD; Wills & Mason, 2014), intellectual disability (Clemons et al., 2016), and ASD (Crutchfield et al., 2015; Rosenbloom et al., 2015). The I-Connect SM intervention has successfully been used to increase classroom engagement (Clemons et al., 2016; Rosenbloom et al., 2015, Wills & Mason, 2014); and decrease disruptive behavior (Rosenbloom et al., 2015) and stereotypic behaviors (Crutchfield, et al., 2015). Although the four self-monitoring studies thus far provide initial evidence supporting the use of the I-Connect SM intervention on targeted behaviors with individuals with ASD, additional research is needed on the use of the intervention for adolescents with ASD.

Summary

While many studies on self-monitoring have shown positive findings, the majority of meta-analyses and reviews that have evaluated self-monitoring intervention studies did so as either part of a review of self-management interventions (Carr et. al., 2014; Lee et. al., 2007) or a review of interventions that reduce problem behavior (Machalicek, et al., 2007) for individuals with ASD. Few researchers have reviewed the literature on self-monitoring interventions for individuals with ASD of any age and no reviews exist specifically for adolescent-age participants.

Although Davis and colleagues' (2016) meta-analysis adds to the literature base regarding self-monitoring interventions, the analysis did not differentiate based on age of the participants and most of the participants in the included studies were elementary aged. While Davis et al. (2016) and other reviews (Carr et. al., 2014; Lee et. al., 2007) reported intervention effects across each age category, intervention setting and outcome variables were not summarized for specific age groups. Therefore, it is unclear which setting and target behaviors were addressed across specific age groups. Given the potential differences in response to intervention based on age, additional information is needed to determine applicability of self-monitoring for specific age groups. Additionally, few studies have focused on self-monitoring conducted in alternative settings, and evaluated whether or not social validity or maintenance data were collected. Additional studies are needed with this pertinent information to accurately assess the efficacy of SM interventions.

Overall, the self-monitoring review literature focusing on the adolescent ASD population is scarce. Identifying the literature supporting the use of self-monitoring for adolescents with ASD would help practitioners understand for which target behaviors self-monitoring is appropriate as well as the type of self-monitoring that is most effective. As such, the purpose of this systematic review was to review the current literature of self-monitoring interventions for adolescents with ASD. This review aims to summarize (a) participant characteristics, (b) setting characteristics, (c) study characteristics, (d) targeted behaviors, (e) types of self-monitoring procedures used, and (f) whether or not social validity and maintenance data were collected for each included study. An additional purpose of this review is to identify consistent gaps and limitations presented in the current literature.

Review of the Literature

As noted, the research base for implementation of self-monitoring with individuals with ASD is rather extensive; however, participant characteristics, study characteristics, self-monitoring procedures, and target skills are diverse. Although empirical evidence indicates strong support for the use of self-monitoring to address a variety of needs for individuals in diverse settings, it can be difficult to ascertain for whom and under what circumstances self-monitoring is most effective. A systematic review of literature is one method to assimilate what is known regarding a given intervention, providing a clearer picture of the breadth and depth of the research while also exposing gaps and areas for future research. The purpose of this systematic review is to assimilate and summarize the current literature of self-monitoring interventions for adolescents with ASD. Specifically, this review aims to summarize (a) participant characteristics (i.e., number of participants, age, gender, and diagnosis), (b) setting characteristics, (c), study design, (d) targeted behaviors, (e) self-monitoring procedures, and (f) whether or not social validity and maintenance data were collected for each included study. An additional purpose of this review is to identify gaps and limitations presented in the current literature.

Method

Study Identification

Search procedures. A computerized bibliographic search was conducted in peer-reviewed journals utilizing the Academic Search Complete, Google Scholar, JSTOR, PsycINFO, PubMed, Web of Science and WorldCat databases on March 23, 2017 to identify studies that met inclusion criteria. In addition, hand searches of the reference lists of all studies meeting inclusionary criteria were completed. The following keyword descriptors were used: *"autism spectrum disorders", "adolescent",* and/or *"self-monitoring".* The search resulted in 460 studies.

Inclusion criteria. Each of the 460 studies identified in the initial search was evaluated to determine if it met the following inclusion criteria: (a) the study was published in an English-language, peer-reviewed journal; (b) at least one participant was identified as having diagnosis of ASD (i.e., autistic disorder, ASD spectrum disorder, Asperger's syndrome, high-functioning ASD); (c) at least one of the participants with ASD was adolescent aged (i.e., 10-19 years); (d) the study presented empirical treatment data; (e) the study utilized rigorous experimental design, (f) the independent variable utilized self-monitoring procedures; (g) the study was conducted in school or behavioral clinic-based settings (i.e., hospitals, home-based, mental institutions were not included).

Results of the literature search process procedures are visually displayed in Appendix A. A total of 460 studies were identified through the initial database search. A total of seven duplicates were removed (n=453). All 453 records were screened to determine if they met inclusion criteria, and 368 studies were excluded in this initial screening process (n=85). Full-text articles were then assessed for eligibility and 70 studies were excluded in this process due to not meeting inclusion criteria (e.g., non-ASD, not adolescent age, rigorous experimental design not used). A total of 15 studies were included in qualitative synthesis and were assessed to determine if additional records could be identified. This was done by going through the refrences of the included studies to identify studies that were not included. Four additional records were identified and included in quantitative synthesis of studies meeting inclusion criteria (n=19).

Data Extraction

Following the literature search process, the 19 articles that met inclusion criteria were summarized into study variables. Variables included participant characteristics, setting characteristics, study characteristics, targeted skill(s), self-monitoring procedure, and the absence or presence of social validity and/or maintenance data.

Participant characteristics. Total number of participants and total number of participants with ASD were coded for each study. In addition, participant characteristics were coded in terms of age, gender, and diagnosis. *Age* was coded as the exact age (e.g., 13) reported in the study. *Gender* was coded male, female, or not indicated. For *diagnosis,* specific ASD diagnosis was coded (i.e., autistic disorder, autism spectrum disorder, Asperger's syndrome, high-functioning ASD) as well as any secondary diagnoses that were reported (e.g., ADHD, intellectual disability (ID), emotional behavior disorder (EBD)).

Setting characteristics. The type of *setting* was coded based on the specific place in which the self-monitoring intervention took place including: (1) general education classroom, (2) special education/self-contained classroom, (3) alternative setting (e.g., ABA clinic therapy, resource classroom, speech-therapy room), or (4) community setting. A study was coded as general education classroom if the self-monitoring intervention occurred within a classroom serving predominantly nondisabled students. Studies conducted in classrooms serving individuals that met eligibility criteria for special education services were coded as special education/self-contained classrooms. Interventions that occurred in settings that were distinct from general education or special education/self-contained classrooms were coded as alternative setting. Potential examples of alternative settings included day-programs, ABA clinics, resource classroom, and speech therapy rooms. A study was coded as community if intervention procedures were conducted in a community setting arranged by the participant's school (e.g., grocery store, restaurant).

Study design. Study characteristics included *experimental design* and only single-case designs (Horner, Carr, Halle, & McGee, 2005) were included for the purposes of this review. The type of *experimental design* included the following criteria: (1) withdrawal/reversal design, (2) alternating treatment, (3) changing criterion, (4) multiple-baseline and/or probe across students, tasks, and/or behavior.

Targeted behavior. Targeted behaviors were coded into five categories that placed similar behaviors into one response class: (1) engagement (included: on-task behavior, off-task behavior, academic engagement); (2) disruptive behavior (included stereotypic behaviors, scripting, inappropriate vocalizations, hitting, grabbing, making noise); (3) task completion (included: academic tasks, task analysis steps); (4) social skills (included: appropriate social exchanges, inappropriate social interactions, functional communication); or (5) self-injurious behavior (SIB) (included: self-harm in the form of hitting or slapping, head-banging, skin-picking).

Self-monitoring procedure. The types of self-monitoring procedures utilized in the included studies were coded as paper and pencil self-monitoring, self-monitoring plus technological cue, or computer based self-monitoring. A study was coded as paper-and-pencil self-monitoring if the intervention consisted of the individual using a paper and pencil format (i.e., no technology used) to observe and record the behavior. Studies were coded as paper-pencil self-monitoring plus technological cue if technological prompting device (e.g., iPad, MotivAider® watch, digital watch) was used, but still required the individual to record their behavior on paper. Studies that included technology for both cueing and recording behavior were coded as technology based self-monitoring.

Study characteristics. *Social validity* and *maintenance* were coded. The purpose of *social validity* is to evaluate the acceptability, viability, appropriateness of procedures, and importance of effects of a given intervention based on end users' perception (Kazdin, 1977; Ledford, Hall, Conder, & Lane, 2015; Wolf, 1978). *Maintenance* data is collected in order to evaluate the individual's ability to demonstrate previously acquired skills over time (Cooper et al., 2007). Maintenance was coded dichotomously, yes or no, based on whether or not the study included maintenance data. For the purposes of this review social validity was coded as: (1) teacher social validity collected, (2) participant social validity collected, (3) both teacher and participant social validity collected, or (4) no social validity data collected.

Interrater reliability.

Study inclusion. Two researchers, the first author and a graduate student trained in the coding procedures for inclusion criteria procedures, independently coded 30% of the initial 460 studies to ensure reliability. The first author trained the graduate student by first discussing the inclusion criteria and then coding three articles independently until at least 100% agreement was obtained. Percentage agreement was calculated by dividing the number of agreements by the number of agreements plus disagreements and multiplying by 100. Percentage agreement was 99.2%. The reliability observer discovered one study during the initial search that was not included in the primary researcher's list of included studies. After consultation, the study was added into the final list of included studies.

Data extraction. Inter-observer agreement was calculated for a random sample of 30% of included studies. Percentage agreement for each category (i.e., participant characteristics, setting characteristics, study characteristics, experimental, targeted behaviors, self-monitoring procedures, social validity, and maintenance data) was calculated by dividing the number of agreements by the number of agreements plus disagreements and multiplying by 100. Percentage agreement was 100% for each category.

Results

Table 1 summarizes each study in terms of participant characteristics, setting characteristics, study characteristics, type of self-monitoring, and whether or not social validity and/or maintenance data was collected for each study.

Participant characteristics. A total of 56 participants participated in the 19 studies, 29 (51.8%) of whom met the ASD diagnosis and age inclusion criteria. The mean *age* of the participants with ASD was 13 (range 10-20). Eighteen of the 19 studies reported participant gender. Of the 29 participants, 26 were male (83.9%; Agran et al., 2005; Cihak et al., 2010; Clemons, et al., 2016; Coyle & Cole, 2004; Crutchfield, et al., 2015; Ganz & Sigafoos, 2005; Hughes, et al., 2002; Legge et al., 2010; Rock, 2005; Rouse et al., 2014; Soares et al., 2009; State & Kern, 2012; Tiger et al., 2009) and only four were female (9.6%; Bouck et al., 2014; Mancina et al., 2000; Morrison et al., 2001; Rock & Thead, 2007). Koegel and Koegel (1990) did not specify the genders of the four participants. Five of the 29 (17.2%) participants had a secondary diagnosis, including ID (Ganz & Sigafoos, 2005; Hughes et al., 2002, Mancina et al., 2000; Rock & Thead, 2007), and ADHD (Crutchfield, et al., 2015).

Setting characteristics. *Settings* included general education classrooms, special education classrooms, and alternative settings. General education was the most frequently utilized (42.1%) setting for implementing self-monitoring in the reviewed studies (Agran et al., 2005; Cihak et al., 2010; Clemons, et al., 2016; Hughes, et al., 2002; Morrison et al., 2001; Rock, 2005; Rock & Thead, 2007; State & Kern, 2012). Six studies were implemented in special education classrooms (31.6%%; Bouck et al., 2014; Coyle & Cole, 2004; Crutchfield, et al., 2015; Legge et al., 2010; Mancina, et al., 2000; Rouse et al., 2014). Alternative settings were utilized for five of the 19 included studies (26.3%). Alternative settings included a classroom in a self-contained vocational public school for students with disabilities (i.e., Ganz & Sigafoos, 2005), a clinic observation room (i.e., Stahmer & Schreibman, 1992), resource classroom (i.e., Soares et al., 2009), and a day treatment program (i.e., Tiger et al., 2009). One study (5.3%; Koegel & Koegel, 1990) implemented self-monitoring intervention procedures for one of the participants in two community settings, a grocery store and a restaurant.

Design characteristics. All studies that met inclusion criteria for this review utilized a single-subject experimental design. The most commonly used experimental design across the 19 studies was a multiple-baseline/probe design (57.9%, n=11; Agran et al., 2005; Cihak et al., 2010; Crutchfield, et al., 2015; Hughes, et al., 2002; Legge et al., 2010; Mancina et al., 2000; Morrison et al., 2001; Rock, 2005; Rouse et al., 2014). A total of six (31.6%) studies employed a withdraw design study (Clemons, et al., 2016; Coyle & Cole, 2004; Soares et al., 2009; Rock & Thead, 2007; State & Kern, 2012, Tiger et al., 2009). Two of these studies utilized a withdrawal design with additional components (State & Kern, 2012; Tiger et al., 2009). State and Kern (2012) employed an ABCBC withdrawal design and Tiger et al. (2009) employed an ABABC withdrawal design. An alternating treatment design was utilized in one study (5.6%; Bouck et al., 2014) and a changing criterion was utilized in one study (5.6%; Ganz & Sigafoos, 2005).

Targeted behavior. The total percentage target behaviors coded exceeds 100% as four of the 19 studies evaluated the effects of self-monitoring on more than one behavior (Morrison et al., 2001; Stahmer & Schriebman, 1992; Soares et al., 2009; State & Kern, 2009). The impact of self-monitoring on decreasing disruptive behaviors was evaluated in six of the included studies (31.6%; Crutchfield, et al., 2015; Koegel & Koegel, 1990; Mancina et al., 2000; Morrison et al., 2001; Stahmer & Schriebman, 1992; State & Kern, 2012). For example, one study (Crutchfield, et al., 2015) evaluated the effects of the I-Connect SM intervention on disruptive behavior in the form of stereotypy of two adolescent aged participants with ASD. An ABAB reversal design with an embedded multiple-baseline across participants was used to evaluate the percentage of intervals with stereotypic behavior. Both participants were instructed to respond to the prompt "Do you have quiet hands and mouth?" on their self-monitoring device. The prompt was set at 30-s intervals for both participants. Both participants demonstrated decreases in levels of disruptive behavior upon the introduction of the self-monitoring device and returned to baseline levels during reversal phases. In Morrison, Kamps, Garcia, and Parker's (2001) study, a multiple-baseline design across participants was used to evaluate the use of self-monitoring procedures to increase initiations and social interaction skills across four adolescents with ASD. Although the primary target behavior that the individuals were taught to monitor was social interaction (i.e., sharing, commenting, requesting) the researchers also evaluated the functional relation between increases in social interaction and decreases in inappropriate behaviors. Inappropriate behaviors included disruptive behaviors (e.g., hitting, grabbing, crying, making noise), as well as stereotypic behaviors (e.g., perseverative talking, irrelevant topics, repetitive body movements). The self-monitoring procedures involved the participants self-recording each time they made a request, commented, and shared with the peer. The results demonstrated that self-monitoring one's social skills not only increased the number of skills used but also decreased occurrence of inappropriate behaviors. Mancina, Tankersley, Kamps, Kravits, and Parrett (2000) also successfully evaluated the use of self-monitoring to address disruptive behaviors. The researchers introduced a self-management treatment package that included self-monitoring procedures to decrease disruptive stereotypic behaviors (e.g., vocalizations, facial movements, and body movements) with one adolescent with ASD. A multiple-baseline across settings was utilized. The participant was taught to use a paper-and-pencil self-monitoring procedure with a Timex digital-watch set at 10-s intervals and a self-recording sheet was used to monitor disruptive behaviors. Results showed that the self-monitoring intervention was highly effective in decreasing disruptive stereotypic behaviors across all settings.

Seven studies **(**36.8%; Agran et al., 2005; Bouck et al., 2014; Ganz & Sigafoos, 2005; Rock, 2005; Rock & Thead, 2007; Rouse et al., 2014; Soares et al., 2009) evaluated the effects of self-monitoring on increasing task completion. For example, Ganz and Sigafoos (2005) utilized a changing criterion design to evaluate the effects of self-monitoring on work task completion of two adults, one with ASD, enrolled in a self-contained vocational public school. The participant with ASD was given a container containing tokens with the number of tokens corresponding with the number of tasks that were required to be completed during that work session. The participant was also given a laminated sheet of paper that included line drawings indicating "do work" and a picture of the chosen reinforcement. Self-monitoring training consisted of teaching the participant to place a token on the laminated sheet after he completed a step in the task. Once the participant earned the agreed upon number of tokens, she was given access to reinforcement. Results demonstrated a functional relationship between implementation of self-monitoring and an increase in the number of tasks completed by both participants.

A total of six studies targeted engagement (31.6%; Cihak et al., 2010; Clemons, et al., 2016; Coyle & Cole, 2004; Legge et al., 2010; Rock, 2005; Rock & Thead, 2007). For example, Rock (2005) implemented a multiple baseline design study with an embedded withdrawal design to evaluate the functional relationship between paper and pencil self-monitoring intervention and decreases in academic disengagement for nine participants (age range 7-13), only one of which had an ASD diagnosis (11-years old). The participants were trained to monitor engaged academic behaviors by comparing it to a photograph, which depicted on-task behavior at the sound of a timer set at 5-min intervals. The students were then instructed to mark a check on their self-monitoring “think sheet” if they were engaged at the moment the cue occurred. The results demonstrated a significant decrease in disengaged and problem behaviors upon the introduction of the self-monitoring intervention. Although the study (Rock, 2005) only included one student with ASD, it provided strong evidence that supports the use of self-monitoring to increase engagement in the classroom. Cihak, Wright, and Ayres (2010) also provided evidence supporting the use of self-monitoring to increase engagement in the classroom. The researchers utilized a multiple-probe across-settings design with an embedded ABAB to evaluate the effects of self-monitoring and static-model prompts to increase academic on-task behaviors of three adolescents with ASD. A handheld-computer was used to display photos of each participant’s self-modeling on-task behaviors every 30 s. When the self-model picture was displayed, participants were instructed to self-monitor whether or not they were on-task by circling “yes” or “no” on an index card. Results demonstrated an increase of on-task behaviors and decrease in frequency of teacher prompts across all settings for all participants upon the introduction of the self-monitoring procedure. Similarly, Coyle and Cole (2004) used an ABACA design to evaluate a self-monitoring and self-modeling treatment package to increase on-task behaviors of three participants with ASD. One participant was adolescent-aged (i.e., 11 years), and the remaining two participants were elementary-aged (i.e., 9 years). The treatment package employed both videotaped self-modeling and self-monitoring procedures. The participant was instructed to self-record when the timer went off whether or not the he was "working" or "not working" on a sheet that depicted pictures of both behaviors. The results demonstrated an increase in off-task behaviors upon the implementation of the self-modeling and self-monitoring procedures.

The target behavior of social skills was addressed in four studies (21.1%; Hughes et al., 2002; Morrison et al., 2001; Stahmer & Schriebman, 1992; State & Kern, 2012). For example, Stahmer and Schriebman (1992) utilized a multiple-baseline across participants to evaluate the effects of self-monitoring on appropriate play behaviors for three participants with ASD (ages 7, 12, 13), two of whom met participant inclusion criteria. Appropriate play was defined as using objects or toys in the manner in which they were intended. This was chosen as the target behavior because the research suggests that individuals with ASD often exhibit difficulties with spontaneous functional play as compared to typically developing peers (Lewis & Boucher, 1988). Such difficulties can impede on an individual with ASD's ability to interact appropriately with a peer. Additionally, the researchers chose this target behavior in order to evaluate the reciprocal relationship between increases in appropriate play behaviors and decreases of levels of self-stimulatory behaviors. The participants were taught to check a box on a self-monitoring sheet if they demonstrated appropriate play behaviors during that interval (e.g., 30 s) when a wrist-watch timer went off. Results demonstrated increases in appropriate play behaviors upon the introductions of the self-monitoring intervention and maintained these behaviors during fading and maintenance phases.

Two studies evaluated the impact of self-monitoring for decreasing self-injurious behavior (SIB) (10.5%; Soares et al., 2009; Tiger et al., 2009). Tiger and colleagues first evaluated the effectiveness of differential reinforcement of other behavior (DRO) to decrease SIB in the form of skin picking for one participant with ASD and then evaluated the effects of DRO with self-monitoring on the same behavior. The participant was taught to set a timer to 10 min and reset the timer if an SIB occurred. If the participant did not exhibit any SIB's during the 10 min, he was instructed to record his behavior by placing a ticket in an envelope when the timer went off. Results demonstrated significant reductions in SIB upon the introduction of the DRO intervention and were maintained when self-monitoring was introduced.

Self-monitoring procedure. Across all 19 included studies, the most commonly used self-monitoring procedure was paper and pencil plus a technological cue (n=12, 63.2%; Bouck et al., 2014; Cihak et al., 2010; Coyle & Cole, 2004; Koegel & Koegel, 1990; Legge et al., 2010; Mancina et al., 2000; Rock, 2005; Rock & Thead, 2007; Rouse et al., 2014; Stahmer & Schriebman, 1992; State & Kern, 2012; Tiger et al., 2009). Examples of cueing devices included a kitchen timer (i.e., Coyle & Cole, 2004; Koegel & Koegel, 1990), digital countdown timer (i.e., Tiger et al., 2009) wristwatch timer (i.e., Stahmer & Schriebman, 1992; State &Kern, 2012), Timex watch (i.e., Mancina et al., 2000), MotivAider® (i.e., Legge et al., 2010), and a handheld computer (i.e., Cihak et al., 2010). For example, Cihak et al. (2010) utilized a technological cue in their paper-pencil self-monitoring procedures. A handheld-computer was used to display a self-model picture of the participant every 30 s. The picture prompted the participants to self-monitor whether or not they were on-task. They were instructed to circle the "yes" or "no" option on an index card. Mancina et al. (2000) utilized a Timex digital watch to cue the participant every 10 s to self-monitor whether or not the participant was exhibiting disruptive behaviors. Legge et al. (2010) used a vibrating pager device, MotivAider®, on the on-task behaviors of three adolescent participants with ASD. The researchers taught the participants to self-record on a self-monitoring sheet whether they were on-task each time the MotivAider® vibrated. The MotivAider® was set to prompt the participant every 2 min to self-monitor. The results demonstrated an increase in levels of on-task behaviors across all three participants upon the introduction of the self-monitoring intervention using the MotivAider®. While these studies utilized some form of technology to prompt the participants to self-monitor, the participants still used a paper-pencil format to record their behavior with improvements in behaviors in all 12 studies.

Six studies utilized paper and pencil self-monitoring (31.6%; Agran et al., 2005; Bouck et al., 2014; Ganz & Sigafoos, 2005; Hughes, et al., 2002; Morrison et al., 2001; Rouse et al., 2014) to effectively improve behaviors. Agran et al. (2005) employed a multiple-baseline across participants to evaluate the effects of self-monitoring on task completion and following directions of six adolescent participants, one with an ASD diagnosis. Participants were trained to put a "+" or a "-" on their self-monitoring sheet based on whether they followed the directions that corresponded with the steps on the task analysis sheet. The participant with ASD demonstrated significant improvements in rule following behaviors upon the introduction of the self-monitoring intervention.

One study (Bouck et al., 2014) utilized traditional paper and pencil self-monitoring (low-tech) and a technology based self-monitoring intervention utilizing an iPad (high-tech) in order to evaluate which type of self-monitoring was more effective. The researchers employed an alternating-treatments design to compare high-tech and low-tech self-monitoring options to increase task independence across three students diagnosed with ASD. The study provided a task analysis and the participants were instructed to either check off completion with a traditional paper and pencil self-monitoring sheet (low-tech) or a self-monitoring checklist located on an iPad (high-tech). This was not an interval prompt self-monitoring intervention but rather a checklist self-monitoring procedure that consisted of listing of behaviors (to be increased or decreased) that the student reviewed, checking off those behaviors actually displayed during the monitoring period (Webber, Scheuermann, McCall, & Coleman, 1993). All three participants were more independent while using the iPad and completed tasks in less time than while using the paper-pencil form. The results support the notion that utilizing handheld mobile technologies is an effective means for implementing self-monitoring procedures. Self-monitoring promotes more efficient data collection for both teachers and participants, allows for unobtrusive prompting, and promotes higher levels of engagement (Clemons et al., 2016).

Three studies utilized self-monitoring with both cueing and recording capabilities and via computer based self-monitoring (15.8%, Clemons et al., 2016; Crutchfield et al., 2015; Soares et al., 2009). Soares and colleagues (2009) implemented an ABA design to evaluate the effectiveness of computer aided self-monitoring to increase academic task completion and decrease SIB for one adolescent male with ASD. The computer provided the individual with a static prompt (i.e., continuously available prompt) that allowed for recording of self-monitoring data. The participant was instructed to 'cut and paste' an image of a reinforcing cartoon character (i.e., Mickey Mouse) upon the completion of each activity. Although this self-monitoring intervention did not use a fixed-time interval cue, the checklist itself served as a prompt for the individual to complete the assigned task. A functional relation was revealed between the self-monitoring intervention and increases in task completion and reductions of SIB.

The other two studies utilized the I-Connect SM intervention (Clemons et al., 2016; Crutchfield et al., 2015), an application that provides interval prompt capabilities and also allows the individual to record target behaviors (Wills & Mason, 2014). Crutchfield et al. (2015) evaluated the functional relation between the implementation of the I-Connect SM intervention and the decrease in stereotypic behaviors with two adolescent-aged participants with ASD. Clemons et al. (2015) also evaluated the effects of the I-Connect SM intervention to increase engagement for three adolescents, including one participant with ASD. The participant with ASD was prompted by the device to answer the questions, "Am I on-task?" with a "yes" or "no" response option. The prompts were set at 30-s intervals for all participants. All three participants demonstrated an increase in classroom engagement with the use of the I-Connect SM intervention and a decrease in engagement during return to baseline phases. One limitation of this study was that task completion was not measured. This component would have added to the literature supporting the use of self-monitoring to increase task completion and potentially demonstrate a functional relation between an increase in levels of engagement and an increase in the number of tasks completed.

Social validity and maintenance data. A total of seven of the 19 studies evaluated the social validity of the self-monitoring intervention (36.8%; Agran et al., 2005; Bouck et al., 2014; Cihak et al., 2010; Clemons, et al., 2016; Crutchfield, et al., 2015; Hughes, et al., 2002; Rock & Thead, 2007). Of those seven studies, four evaluated the social validity from the perspective of both the teacher and student (Bouck et al., 2014; Cihak et al., 2010; Clemons, et al., 2016; Crutchfield, et al., 2015), two of the studies evaluated social validity from the perspective of the teacher only (Agran et al., 2005; Hughes, et al., 2002) and one evaluated social validity from the perspective of the student only (Rock & Thead, 2007). The studies that did collect social validity reported high-levels of satisfaction for the participants and/or teachers. For example, the teachers in the Cihak et al. (2010) study indicated that the intervention was an acceptable intervention for the student's problem behavior, found the intervention appropriate, would suggest the intervention to other teachers, and the intervention was beneficial to the student. Additionally, the participants in the Cihak and colleagues (2010) study reported that the intervention was efficient, helped participants change in important ways, allowed for a quick improvement in skills, made a difference in grades, and that the participant would tell others about the intervention.

In regards to maintenance, 11 of the 19 studies evaluated maintenance of intervention effects (57.9%; Agran et al., 2005; Bouck et al., 2014; Clemons, et al., 2016; Coyle & Cole, 2004; Hughes, et al., 2002; Koegel & Koegel, 1990; Legge et al., 2010; Morrison et al., 2001; Rock & Thead, 2007;Rouse et al., 2014; Stahmer & Schriebman, 1992), whereas, eight studies did not (44.4%; Cihak et al., 2010; Crutchfield, et al., 2015; Ganz & Sigafoos, 2005; Mancina et al., 2000; Rock, 2005; Soares et al., 2009; State & Kern, 2012; Tiger et al., 2009). The studies with maintenance data showed that behaviors of interest maintained acceptable levels.

Discussion

This review of the literature identified only 19 peer-reviewed studies that examined the effects of self-monitoring on target behaviors for adolescents with ASD. The review aimed to summarize the adolescent self-monitoring literature based on (a) participant characteristics, (b) setting characteristics, (c) study characteristics (i.e., experimental design), (d) targeted behaviors, (e) types of self-monitoring strategies used, and (f) whether social validity and maintenance data were collected for each included study. Overall, the results suggest that although the use of self-monitoring interventions for individuals with ASD was widely supported, there are gaps in the research base evaluating the impact of self-monitoring on target skills for adolescents with ASD.

Key Findings and Limitations

Previous research has indicated the lack of studies supporting effective interventions for adolescents with ASD (Hilliner et al., 2007), however, results of this review indicate that there is a growing body of literature supporting the use of self-monitoring for adolescents with ASD. Only eleven percent (*n* = 50) of studies were excluded throughout literature review screening process (remaining studies excluded due to setting, diagnosis, etc.) because the participants did not meet the adolescent age criterion (preschool or elementary aged). Of the 55 participants included in the current review of the literature, over half of the participants met the age criterion (*n* = 31). The increase in the number of adolescents with ASD research demonstrates the progress that is being made toward validating interventions, especially self-monitoring, for this age group. Research should continue to focus on interventions supporting adolescents with ASD identifying concerns faced by adolescents and the research should investigate interventions that promote independence along with greater adult outcomes.

In regards to participant diagnosis, five studies included participants with a comorbid diagnosis (Crutchfield, et al., 2015; Ganz & Sigafoos, 2005; Hughes et al., 2002, Mancina et al., 2000; Rock & Thead, 2007). This provides some evidence self-monitoring is effective for participants with varying disability categories including co-morbid diagnoses, such as ID, ADHD, and Downs Syndrome. It was unclear whether participants in other studies actually had other diagnoses due to lack of participant information provided. Furthermore, while all studies that met inclusion criteria for this review included adolescents with an ASD diagnosis, the severity of the ASD symptoms was often unclear. Only four studies (Bouck et al., 2014; Cihak et al., 2010; Ganz & Sigafoos, 2004; Morrison et al., 2001) provided information regarding participant severity. It is difficult to evaluate intervention effects across participants with ASD without the appropriate participant information as different levels of functioning may result in different intervention effects (McDonald & Machaliek, 2013). ASD severity information can also help service providers select interventions best fitted to the level of functioning for an individual. Researchers should provide additional assessments or measures on diagnosis and severity to draw comparisons across participants and studies. Future research on self-monitoring intervention for participants with ASD with and without comorbid diagnoses would be beneficial for the purposes of better understanding the effects of the intervention on such individuals.

In terms of setting characteristics, the majority of studies took place in general education classrooms. These results support previously conducted self-monitoring reviews and meta-analyses (Davis et al., 2015). Few of the studies evaluated the impact of self-monitoring for adolescents with ASD in an alternative program for individuals with ASD. Such alternative programs place students in a structured academic setting sometimes for a limited period with the goal of transitioning the individual back to their regular school once the problem behavior is under instructional control (Tobin & Sprague, 2000). These programs also serve as an alternative to residential placement resulting from expulsions from school systems (U.S. Department of Education, 1994). Alternative programs are important because challenging problem behaviors that are potentially harmful or disruptive can prevent students with severe disabilities, including ASD, from succeeding in inclusive educational and community settings (Lohrmann & Bambara, 2006). However, there are often difficulties with transitioning individuals from one environment to another due to differences in level of staff support, student reliance on staff, staff training, level of reinforcement, and structure of programming (Levy & Perry, 2008). Implementing self-monitoring in alternative settings would be beneficial because the intervention promotes independence in meeting academic and behavioral goals (King-Sears, 2008). In addition, such improvements in independent functioning could help promote successful transition back to public settings. Self-monitoring could also provide home districts with an intervention that requires less individual support thus greatly reducing the effort required by service providers to implement treatments. Self-monitoring interventions require little effort or training on the part of the service providers (Tiger et al., 2009), and therefore, would require minimal training for the service providers assigned to the individual upon transition. Research specifically addressing self-monitoring interventions for individuals with ASD in alternative settings, with a particular focus on supporting the transition back to their home school, is warranted. Furthermore, research on the generalization and maintenance of the effects of self-monitoring upon the transition from an alternative program to the individual's home district should be evaluated as well.

Results of this review indicate self-monitoring is an efficacious intervention for improving a variety of target skills for adolescents with ASD. However, the results of the review of the literature demonstrate that although the research base covers a broad image of targeted skills, when evaluating the number of studies addressing each target behavior, the research is rather limited. For example, only six studies specifically addressed engagement. Likewise, only two studies addressed SIB. This is an issue because the small number of studies for specific behaviors does not provide enough evidence to inform practitioners in regards to choosing self-monitoring. Furthermore, continued research on self-monitoring interventions and disruptive classroom behaviors is needed. Disruptive behaviors are considered to be one of the most difficult behaviors for teachers, behavioral implementers, and other staff employed in special education settings to address (Gerdtz, 2000), and providing evidence supporting the use of self-monitoring to decrease such challenging behaviors would help assist service providers with selecting appropriate interventions. Additionally, more research on self-monitoring interventions that address engagement behaviors is needed, particularly given that high levels of student disengagement yields decreases in academic performance and increases in occurrences of problem behavior (Rock, 2005). Although this review provides some preliminary support of self-monitoring as an effective intervention to increase task completion for adolescents with ASD, there continues to be some gaps in the knowledge base. There were only seven studies included in this review that focused on task completion, and of those studies just four addressed functional living skills. The research on self-monitoring to increase academic task completion is also scarce. Given that academic task completion has been shown to be inversely related to off-task behaviors (Sutherland & Wehby, 2004), there needs to be continued research on interventions that increase academic task completion behaviors.

It is also important to note the WWC single-case design (SCD) panel recommends a specific set of criteria in order for an intervention to be considered an EBP: (1) there are a minimum of five SCD studies examining the intervention, (2) the intervention is conducted by three research teams with no overlapping authorship, and (3) the combined number of cases (participants) totals at least 20 (Kratochwill et al., 2016). Given these standards, the results of this review indicate a need for more research on the effects of self-monitoring on specific target behaviors for adolescents with ASD.

In regards to the self-monitoring procedures implemented, this review demonstrates there are a variety of ways to implement self-monitoring. Although numerous researchers are beginning to explore the efficacy of high-tech self-monitoring interventions (Bouck, et al., 2014;

Crutchfield, et al., 2015; Wills & Mason, 2014), paper and pencil recording format was employed the most frequently. While the majority of studies utilized paper and pencil self-monitoring with a technological cue to help the process of reminding the individual to self-monitor (efficiency), the individuals were still required to use a paper and pencil format to self-monitor. Paper and pencil self-monitoring recording formats have several limitations, including increased potential for inconsistent implementation (Rosenbloom et al., 2016) and social stigmatization (Crutchfield et al., 2015). This procedure also does not account for potential fine motor difficulties individuals with ASD when using a pencil (Bouck, et al., 2014; Dawson & Watling, 2000). Only three studies included in this review evaluated self-monitoring interventions that allow for both cueing and recording data capabilities, two of which utilized the I-Connect SM intervention. Given that the advantages of technology can increase the individual's independence and engagement due to ease of use and visual display opportunities (Bouck, et al., 2014), more research on this type of self-monitoring would be beneficial for the purposes of evaluating the role technology plays in increasing efficiency, decreasing stigmatization, and increasing independence for individuals with ASD.

This review ultimately provided evidence that there is simply not enough research supporting the use of technology enabled self-monitoring interventions that provide both cueing and recording capabilities for adolescents with autism in school settings. Studies comparing paper and pencil interventions with technology-enabled self-monitoring, that allows for both cueing and recording target behaviors, are needed to determine if there are differential effects based on the type of self-monitoring. Further, more research exploring the utility of technology-based self-monitoring are needed to determine if technology enabled self-monitoring is an EBP for adolescents with ASD across settings and target skills.

Additionally, this review highlights a lack of social validation. These results are consistent with other findings regarding lack of evidence of the measurement of social validation for EBPs for individuals with ASD (Callahan et al., 2016; Kennedy, 1992). Assessing social validity for self-monitoring interventions for adolescents with ASD is important because it will help determine the acceptability of procedures, outcomes, and goals from those directly affected by the intervention (Aladjeff-Abergel et al., 2015). Social validity measures are meant to help predict rejection of an intervention upon dissemination (Baer, Wolf, & Risley, 1987). An intervention that aims to produce significant changes in behavior can only be successful if it is positively accepted by those responsible for implementing the intervention and those directly affected by the intervention (Hume et al., 2009). Baer, Wolf, and Risley (1987) expressed that "social validity is not just sufficient for effectiveness, but is also necessary to effectiveness" (p. 323). Therefore, it is recommended that greater emphasis be placed on collecting social validity measures when conducting intervention research. In particular, self-monitoring studies need to adopt these procedures in order to ensure that service providers will accept the intervention procedures upon dissemination. Furthermore, a major goal in self-monitoring is for the participant to implement the self-monitoring procedures independently; therefore, self-monitoring social validity data is crucial.

In summary, self-monitoring is a promising intervention for adolescents with ASD yet more research is needed to fully understand its utility with this population. Additionally, continued emphasis on demonstrating direct evidence of measurement of social validation for self-monitoring interventions is warranted. Studies that evaluate the impact of self-monitoring in alternative education settings and across a variety of target behaviors (engagement, disruptive behaviors, task completion, social skills, and SIBs) are needed as well. Additional research utilizing technology enabled self-monitoring interventions that support both cueing and recording data capabilities would potentially add to the self-monitoring literature. If technology is utilized it could potentially lead to successful integration into home, school, or transitions from high school and increase the potential for independent skill development. Finally, only two studies provided evidence suggesting the I-Connect SM intervention is an effective intervention for adolescents with ASD. In order to be considered an EBP for adolescents with ASD continued research on the use of the I-Connect SM intervention must be conducted.

Purpose and Research Questions

The current study aims to address the gaps in the literature addressed above and seeks to further evaluate the functional relationship between I-Connect SM intervention and increases in on-task behaviors for four adolescents with ASD. The effects of the intervention on the disruptive behaviors of two of the four adolescents were evaluated as well. Task completion was also measured for the purposes of this study.

The following questions will be addressed:

Is there functional relation between the I-Connect SM intervention and the individuals' on-task behaviors?

Is there functional relation between the I-Connect SM intervention and the individuals' disruptive behaviors?

Is there functional relation between the I-Connect SM intervention and the individuals' percentage of task completion?

Study Methodology

Participants, Setting, and Materials

Participants were recruited from a private day school located in a metropolitan area in the Midwest. Participants were placed in this setting because their severe challenging behavior posed a danger to themselves and/or others and impeded education progress in the regular public school setting. The school was a part of a private organization that provides in-home and school consultation in ABA, early intervention services, and the private day school. Students enrolled in the school had a variety of medical and educational diagnoses (e.g., ASD, Down-Syndrome, emotional behavior disorders) and were receiving intensive behavioral interventions aimed at ameliorating problem behaviors and increasing pro-social skills. A total of 17 students, ranging in age from 5 to 19 years, with a variety of differential diagnoses (e.g., ASD, ADHD, Bipolar Disorder) were enrolled at the school upon the initiation of this study.

Participants. The primary researcher first met with the program director of the education center to discuss the purpose and intervention procedures of the study and obtain permission to access students in the setting. Once permission was granted, the primary researcher met with each of the four lead teachers individually to inform them of the purpose of the study and provide them with the student inclusion criteria which included: (a) a diagnosis of ASD, (b) age 10 years or older, (c) target behaviors including off-task behavior during independent academic tasks, and (d) ability to work independently on a task (e.g., did not require training on how to work independently or require fading of the implementer).

A total of six students were nominated for the study by the program director and staff. Five of the six students met the criteria for participation; however, one of the students transferred back to his home district and could not participate in the study. Institutional Review Board (IRB) approved consents were then sent home to the potential participants' parents. Pseudonyms will be used in place of students' names throughout this document. A total of four adolescent students with ASD consented and participated in the study.

The first participant was a 17-year-old male named Carl. He had a diagnosis of ASD and met the State's Eligibility criteria for special education services. According to his individualized education program (IEP), he was functioning at a first-grade level in reading and math. Prior to enrollment, the Board Certified Behavior Analyst (BCBA) at Carl's high school conducted a functional behavior assessment (FBA). It was determined that property destruction and aggression were escape-maintained behaviors. No other formal assessments were discussed in his IEP. His home school district requested that he be enrolled at the private school to help address his physical aggression (hitting, kicking, and biting) and verbal aggression (screaming) toward others. He was placed into classroom 1 (high-school classroom). At the start of the study, he had been a student at the center for two years. His lead teacher nominated him to participate in this study based on his high-levels of off-task and disruptive behaviors during independent work time. Carl exhibited off-task behaviors in the form of looking away from his task and attending to other classroom stimuli (e.g., staring out the window or at other students). Carl also exhibited disruptive behaviors when he was off-task, such as rocking in his chair, vocal stereotypy (scripting), humming, whistling, and hand flapping. The lead teacher indicated that the function of Carl's off-task behaviors was escape maintained. Upon completion of his work, Carl earned a 10-min electronic break (e.g., computer or iPad) and his lead teacher reported that took him between 30 to 40 min to complete his independent work. Carl was able to follow simple step instructions, and express his wants and needs in one-to-two word utterances.

The second participant was a 10-year-old male named Stan. He had an educational diagnosis of ASD diagnosis and was receiving special education services. There was no evidence of formal assessments in his IEP. According to his IEP, he was functioning at a third-grade level in reading and a first-grade level in math. His home school district requested Stan be enrolled in the school to address his physical aggression (punching, hitting, kicking) toward teachers, verbal aggression (swearing and yelling) toward students and teachers, and non-compliant academic behaviors (property destruction, off-task behaviors). He was placed into classroom 2. At the start of the study, he had been at the school for three years. His lead teacher nominated him to participate in the study due to his frequent off-task behaviors and his difficulty with completing independent work without frequent reminders to stay on-task. He exhibited off-task behaviors during independent work in the form of putting his head down on his desk, looking away from his task, and playing with objects on or in his desk. Stan also exhibited disruptive behaviors in the form of singing, talking to other students who were working, and humming. Although a functional behavior assessment was not conducted, the lead teacher indicated that the function of Stan's off-task behaviors was likely maintained by teacher attention as Stan often received adult attention when off-task and disruptive. Upon completion of his work, Stan earned a 20-min electronic break (e.g., computer or iPad). It was reported that it took him between 20 to 30 min to complete independent work and according to the teacher, it typically required a teacher to sit with him or give repeated assistance for Stan to complete his assignment. Stan could express his wants and needs in full sentences and follow multiple-step instructions.

The third participant was a 13-year-old male named Colin with an ASD diagnosis. According to his IEP, his reading comprehension levels were below average and he struggled with being able to complete multi-step math problems without consistent help. His home school district requested that he be enrolled into the school to address frequent property destruction (e.g., throwing objects) and aggression (e.g., hitting staff and peers). He was enrolled into classroom 2 at the start of the study. Colin had been a student at the center for three years. He was nominated by his classroom's lead teacher to participate in this study due to the frequency of his off-task behaviors and his difficulties with attending and completing his independent work tasks without frequent reminders to stay on-task. He exhibited off-task behavior during independent work in the form of putting his head down on his desk and looking away from the task. His lead teacher reported the he did not exhibit disruptive behaviors when he was off-task. His lead teacher indicated that the function of Colin's off-task behaviors was escape maintained. Upon completion of his work, Colin earned a 20-min electronic break (e.g., computer or iPad). His lead teacher reported that it took him between 20 to 30 min to complete his independent work. The participant could follow multiple step instructions, and express his wants and needs in full-sentences.

The fourth participant was an 11-year-old-male named Jack who had been at the school for six months. He had a diagnosis of ASD. According to his IEP he had a diagnosis of ASD, and was a very social student, but exhibited numerous problem behaviors when academic demands were given. His IEP also indicated he was functioning at a first-grade level in all subjects. His home school district requested he be enrolled at the private school to address his aggressive behaviors. Upon enrollment, he was placed into classroom 3. His lead teacher nominated him to participate in this study based on high-levels of off-task behaviors and, difficulties working independently for long periods of time due to such off-task behaviors, and high-levels of disruptive behaviors. The lead teacher indicated that the function of Jack's off-task behaviors was escape maintained. Upon completion of his work, Jack earned a 20-min break for preferred activities in what the school called the "sensory room" (e.g., trampoline, yoga ball). His lead teacher also reported that it took him between 20 to 30 min to complete his independent work. Jack could follow simple step instructions, and could express his wants and needs in one-to-two word utterances.

Setting. The study was conducted in three (i.e., two elementary-middle school and a high school classroom) of the four classrooms in the school. Students were assigned to a classroom based on their age and behavioral needs. More aggressive or self-injurious students were assigned to a different classroom than those who exhibited less intense or frequent behavior problem behaviors. The school was staffed with four lead teachers, one per classroom. There were a total of 17 implementers who supported lead teachers and who worked directly with students. Each classroom was staffed with one implementer per student (i.e., 1:1 ratio), and there was an average of four implementers per classroom (ranging from 2 to 5). Students each had their own desk within their respective classrooms, and there was a large table used for small group activities.

The private school was administered by a program director that had a Ph.D. and was a Board Certified Behavior Analyst - Doctoral (BCBA-D). The program director was responsible for overall training of staff members, working with each lead teacher to develop behavioral plans and monitor progress, acting as a liaison between the school and different school districts, observing potential students in their district school, and monitoring overall progress of each of the students. The classroom lead teachers worked closely with the school director to ensure classrooms were run with the highest of integrity. Lead teachers were required to have a minimum of a bachelor's degree, obtain the registered behavioral technician (RBT) certification, receive restraint training through the Professional Crisis Management Association (PCM), and to have had prior experience teaching in a classroom with students who exhibit severe problem behaviors. Lead teachers were in charge of training and managing the classroom staff (behavior implementers), supervising classroom staff in implementation of behavior plans for students, monitoring overall behavioral and IEP goal progress (e.g., work with staff and students if goals are not being met), providing progress notes for school districts and parents, and implementing PCM restraint procedures when necessary. They were also involved in working with the students' school districts and parents to ensure that needs were met and progress was being made on behalf of the students. The behavior implementers (under the supervision of the lead teachers) were required to have a high-school diploma, obtain BCAT certification, and to have received PCM training. The implementers were responsible for working 1:1 with the students on their assigned academic and functional tasks, implementing behavior plans, collecting IEP and behavioral data, and implementing PCM procedures when necessary.

Classrooms were set up to resemble a typical special education or general education classroom in order to facilitate generalization of skills acquired at the private day school to the typical school setting, with the exception of having fewer desks. This was also done to help facilitate smooth transitions from the private school to the home school district. Lead teachers were in charge of running their respective classrooms in the same format as general or special education teachers. While implementers were typically assigned to the same classrooms on a daily basis, they were systematically rotated across students to ensure each student worked with a different implementer every day. The goal of this rotation was to promote generalization of skills across providers. Pseudonyms will be used in place of the lead teacher's names.

The lead teacher for classroom 1 was Mrs. Charles. She had been employed by the organization since 2012 and worked at the school for 10 months. She had experience implementing ABA procedures in school and home settings. At the time the study was being conducted, she was working on her masters and obtaining her BCBA. Her classroom was staffed with five implementers (i.e., one per student enrolled in the classroom) at the time the study was underway. The students in her classroom were high-school aged and exhibited moderate-to-severe problem behaviors. Carl, participant 1, was a student in Mrs. Charles' classroom.

Mrs. Morgan was the lead teacher in classroom 2 and had been working at the school for two years. Mrs. Morgan had a bachelor's degree in early childhood education and a master's degree in psychology. At the time the study was being conducted she was pursuing requirements to become a BCBA. Her classroom was staffed with four implementers and students in her classroom were both elementary and middle school aged. Students were typically assigned to her classroom if they exhibited low-rates of severe problem behavior or were in the process of being transitioned back to their home districts. Stan and Colin, participants 2 and 3, were students in Mrs. Morgan's classroom.

Classroom 3's lead teacher, Mrs. Erik, had been working with the organization for five years, with the school for two years, and had been recently promoted to lead teacher. Mrs. Erik's education included a bachelor's degree in applied behavior analysis and a master's degree in special education. She was pursuing requirements to become a BCBA at the time of this study. Her classroom was staffed with five implementers. The students in her classroom were both elementary and middle school aged and exhibited moderate-to-severe problem behavior. If a younger student entered the school with severe problem behavior, they were typically placed in her classroom first and then transitioned to classroom 2. Jack, participant 4, was a student in this classroom.

The primary researcher observed the interactions between the participants and staff in each classroom prior to data collection. Indirect observation and anectocal evidence determined there was variability in the number of prompts given to the students while they were working. This was typically dependent on which implementer was working with the student. In other words, some implementers would give frequent prompts and others were more hands-off. There was also variability and inconsistency in the type of prompts given. For example, throughout a work session an implementer may start the session by saying either "time to start working" or "get to work", and when the student became off task the prompts to redirect would be presented in a variety of ways: "you know how to do this", "time to get back to work", "do you need help?", or "keep working". The proximity of the student to implementer also varied. During some work sessions, the implementer would sit right next to the student and at other times they would either be assisting another student or entering data. These observations were consistent across classroom 1 and 2. It was observed that in classroom 3 implementers were always sitting near the student when they were working.

The school reinforcement systems already in place for each participant were continued throughout all baseline and intervention conditions. For example, all four participants were given a choice break (e.g., electronic break, sensory room, walk outside) upon completing their work. Additionally, Jack earned tokens for not exhibiting aggression during a 15-min interval (DRO). Four tokens resulted in him earning a preferred item (e.g., specialty drink).

Materials. The I-Connect SM intervention was used to help the participants manage their off-task behaviors (see Appendix B). This web-based application was developed by the researchers at Juniper Gardens Children's Project at the University of Kansas (Wills & Mason, 2014) and was designed to be a delivery agent for technology based self-monitoring prompting and recording. The application has a variety of customizable prompt options, including: (a) wording (e.g., “Are you on-task”, “Are you being safe?”, “Are you quiet?”), (b) prompt interval length (e.g., 30 s, 1 min, 2 min), and (c) type of notification (i.e., flash, vibrate, ring tone). The application was installed on an Android device. The device had Wi-Fi capabilities and was tested in each classroom prior to implementation to ensure that the application would work. A prompt saying “Are you on-task” with a yes/no option as a response was programmed onto the device prior to training. Intervals were set at 30-s intervals for all four participants. This decision was based on previous research utilizing the device (e.g., Crutchfield et al., 2015, Rosenbloom et al., 2016, Wills & Mason, 2014) that demonstrated that 30 s was an appropriate interval length to use initially. Participants were asked during their training session if they would prefer a flashing screen or noise notification option. All four participants chose the noise notification option.

Experimental Design and Measurement

An ABAB single-subject withdrawal design (Cooper et al., 2007) was used for the purposes of this study. This design was selected for its ability to demonstrate a functional relation between an environmental manipulation and a behavior (Cooper et al., 2007). In order to ensure experimental control, and in accordance with the standards established by the What Works Clearinghouse (WWC, 2009), a minimum of four phases (conditions) were implemented, with no fewer than five data points per phase, and evidence of effect at three different points in time (i.e., changes in data trends within each condition change).

Measurement. Observation sessions were recorded using an iPad video recording and scored at the research facility. A paper-pencil format was used to score each video (see Appendix C). Each data collection session had to be a minimum of 8 min 30 s and a maximum of 10 min. A minimum time requirement was in place to help ensure that a data session could be scored in case any disrupting variables (e.g., fire alarm, severe problem behavior resulting in removal from the classroom) occurred prior to the 10-min mark. A timer was used and started at the beginning of each session. Permanent products of the participants' task were collected at the end of each session.

Dependent measures. The primary dependent variable in this study was the percentage of intervals in which on-task behaviors occurred in a 10-min observation period. On-task behaviors were defined as the percentage of observed intervals in which participants were actively engaged with instructional content in the form of reading, writing, and/or actively completing an assigned task (e.g., typing on computer, taking notes, completing worksheet) (Wills & Mason, 2015). The participant was marked off-task if the student was not actively participating in academic relevant behaviors, staring away from task, playing a game, and/or exhibiting pre-defined off-task behaviors a minimum of three seconds. Ten s momentary time sampling recording was used to determine the occurrence or non-occurrence of the target behavior and measure percentage of intervals in which off-task behaviors occurred. Momentary time sampling is a measurement procedure in which a response is scored if it occurs exactly at a predetermined moment (Harrop & Daniels, 1986). The observer circled "+" if the participant was on-task and "–" if the participant was off-task at the end of the 10-s interval. An interval timer application was used as a timing device. The percentage of intervals that on-task behavior occurred was calculated by dividing the number of intervals in which the on-task behavior occurred by the total number of intervals X 100. The observation recording form included a grid with columns labeled by minutes (i.e., 1–10) and rows labeled by seconds (i.e., 10, 20…60) resulting in a total of 60 recording boxes.

The second dependent variable was the percentage of intervals in which disruptive behaviors occurred. Disruptive behavior was defined as the participant engaging in behaviors that were not in line with behavioral expectations of the classroom and assigned tasks could potentially disrupt others in the environment (Wills & Mason, 2015). Disruptive behaviors were separated into two topographies; verbal disruptive (BV) and physical/motor disruptive (BD). The decision to separate these behaviors was based on indirect observation and discussions with the lead teachers that indicated that these disruptive behaviors often occurred independently of each other. In other words, a BV such as vocal stereotypy could occur in the presence or absence of a BD, such as hand flapping. A BV was defined as making noises (e.g., humming, singing, scripting) or mouthing non-academic stereotypic words that inhibits the student from staying on-task or is distracting to the classroom environment. BDs were defined as physical or motor displays of inappropriate behavior (e.g., tapping object, rocking in chair, hand flapping). Partial interval recording was used to measure the occurrence or non-occurrence of disruptive behaviors during any part of the 10-s intervals. Partial interval recording is defined as scoring occurrence if a response occurs during any part of the interval (Harrop & McDaniels, 1986). The percentage of intervals of BVs and/or BDs was calculated by dividing the number of intervals in which the behavior occurred by the total number of intervals X 100. Because Colin was reported by his lead teacher to have infrequent disruptive behavior, baseline data were collected for this student to confirm this teacher report and collection of this dependent variable was discontinued based on these data. Thus, disruptive behaviors were observed for three of the four participants.

The third dependent variable was percentage of task completion. Task completion was defined as a participant completing the required number of items in an assignment given by his or her teacher. It was measured by the number of items completed during the observation session divided by total number of items X 100. This dependent variable was measured on a completed or not completed basis, and accuracy of responses was not measured. The primary researcher met with the lead teacher prior to each data collection session and discussed what the assignment was for the participant and how many items the student needed to complete in order to finish the task. For example, the lead teacher would inform the researcher at the beginning of the session that Stan was instructed to type five sentences on a novel topic. At the end of the session the researcher would record how many sentences Stan typed.

Data collection. Data were collected during each participant's regularly scheduled independent work time. Observations were conducted in 10-min data collection sessions, 4-5 times a week. Data collection sessions started after the implementer provided instructions about the task and instructed the student to start working. One to two data collection sessions occurred per day depending on the participant's academic schedule (e.g., independent work was scheduled twice on Mondays, but only once on Tuesdays).

Interobserver agreement. A second observer was trained to collect data for the purposes of interobserver agreements (IOA). The second observer was trained by the primary observer on operational definitions and procedures for data collection. The researchers were trained to a 90% interobserver agreement rate on each behavior prior to collecting data for this study. A second observer independently scored data on 30% of sessions to assess reliability. An interval-by-interval IOA procedure was used to assess reliability. IOA was calculated by dividing the total number of items in agreement by the total number of items X 100 for each behavior separately (i.e., on-task, BVs, BDs). An item-by-item IOA procedure was used to assess reliability for task completion. Task completion IOA was calculated by using dividing the total number of items in agreement by the total number of items X 100. Throughout the study the second observer watched video recordings of the data collection sessions to conduct IOA. The mean IOA for on-task behavior across all participants was 94% (range 83%-100%). The mean IOA for BVs and BDs across all participants was 93%, (range 80%-100%) and 97%, (range 83%-100%). The mean IOA for task completion was 99.7% (range 98%-100%).

Treatment fidelity. Treatment implementation fidelity was assessed for 100% of intervention sessions using an 11-item checklist (see Appendix D). The items assessed included: (1) Student was instructed by teacher to begin task, (2) The lead teacher or assigned implementer was not sitting with student during session, (3) Classroom staff did not interrupt student during this independent work time, (4) Session did not have to end due to problem behavior, (6) Teacher prompted student at 5-min mark if student was off-task for the first 5 min, (7) Student was given device at the beginning of the session, (8) Student was instructed to press start on the device, (9) Student used the device for 90% of intervals (27/30), (10) Device was working properly throughout the entire session, (11) If the student completed the assignment before the 10-min data collection session was completed, the lead teacher or implementer instructed the student to begin the next task, and reminded him to stay on-task. The rater responded with "yes", "no", or "NA" for each item at the end of each session. Treatment fidelity was calculated by dividing the total number of "yes" responses by the total number of items x100. Reliability of treatment fidelity was collected for 20% of sessions per each phase. Reliability of treatment fidelity was calculated by dividing the total number of items in agreement by the total number of items X 100. Fidelity of implementation across all sessions was 100%. Reliability of fidelity of implementation was assessed for 30% of sessions. Reliability of fidelity of implementation was 100%.

Social validity. An eight-item participant satisfaction survey (see Appendix E) adapted from Rosenbloom et al. (2015) with ‘yes’ and ‘no’ response options was given to all four participants. The survey was divided into two sections; the first section assessed the participant’s opinion on the impact of the I-Connect SM intervention on beginning assigments, on-task behavior, ability to complete work faster, and productivity. The second section assessed the participant’s overall impression of the intervention and included items for each of the following; (1) ease of use; (2) intrusiveness, (3) satisfaction with the device, and (4) student’s desire to continue using the intervention. The participant satisfaction survey also included three open-ended questions assessing the participant’s favorite part of the I-Connect SM intervention, if there was anything the participant did not like about the intervention, and if the participant would change anything about the intervention.

A ten-item teacher satisfaction survey was given to the three lead teachers (Appendix E). The survey was divided into two sections. The first section assessed the teacher’s observations regarding the impact of the I-Connect SM intervention on the participant’s behavior and included items for each of the following: (1) getting started with assignments; (2) on-task behavior; (3) work completion, (4) classroom disruption, and (5) productivity. The second section assessed the teacher’s overall impression of the intervention and included items for each of the following: (1) ease of use; (2) intrusiveness of the intervention; (3) overall satisfaction with the intervention; (4) interest to continue using the intervention; and (5) any inconsistencies noted when the application was in use. The teachers were asked to rate each of the items using a 5-point Likert scale with 1 indicating “significantly worse” to 5 indicating “significantly better.” Additionally, the survey asked to provide any additional comments regarding the participants’ behavior change and/or satisfaction with the intervention.

Experimental Conditions

Baseline. Baseline data were collected during each participant's regularly scheduled independent work time. Carl was instructed to complete his English language arts (ELA) task of filling out a job application/voter registration form and addressing an envelope. Stan was instructed to type on the computer a pre-determined number of sentences about a novel picture chosen by his teacher (e.g., roller coaster, pizza, classroom). Colin was instructed to take notes on a current events topic worksheet and then write a predetermined number of sentences summarizing what he read. Jack was instructed to complete handwriting worksheets, which consisted of copying a pre-determined number of sentences written by the teacher and completing a pre-determined number of tracing worksheets. All tasks were the same across all phases. The classroom staff (behavioral implementers or lead teacher) was instructed to sit or stand away from the participants' desks and was allowed to engage with them if the student was appropriately raising their hand to ask a question. Additionally, the researcher instructed each participants assigned implementer to verbally prompt them to "stay on task" a second time at the end of the first 5-min of the session only if the participant had been off-task for the whole 5 min. Participants were not provided with an I-Connect SM device during the baseline.

I-Connect self-monitoring (SM) Training. Training on the use of the I-Connect SM intervention began after baseline data demonstrated a stable response pattern, with little variability for each participant. The participants were trained on how to use the device following the steps located the *I-Connect SM Training Fidelity* sheet (See Appendix F). The training was conducted by the primary researcher in the participant's classroom at a table positioned in the corner of the classroom. The participants were required to watch a 20-min self-monitoring module. The self-monitoring module was one of 17 social skills modules created by researchers at Juniper Gardens Children's Project, as part of a development project funded by the National Institute on Disability, Independent Living, and Rehabilitation Research (#90DP0058). The modules consisted of a pre/post-test, slides with narration, video examples, and comprehensive quizzes. The modules provided a broad overview of self-monitoring, how to utilize self-monitoring procedures, and examples of different behavioral goals for which self-monitoring could be a useful intervention. Each participant was required to take a pre-test prior to watching the module. The purpose of the pre-test was to assess the individual's knowledge of self-monitoring. Once the pre-test was completed, the participant watched the module. The self-monitoring module consisted of narrated slides providing information about self-monitoring, video examples, and comprehension checks. The participants were required to correctly answer each comprehension check before they could proceed to the next slide. Upon completing the modules, the participants were required to take the post-test. All post-test questions were identical to the pre-test. The participants needed to receive an 80% or higher o move onto to the second part of the training that focused on SM device training. All participants met the criterion and the average percentage correct for the post-test was 85% (range 80%-95%).

Prior to training, the self-monitoring device was configured to 30 s prompt intervals, and a prompt that displayed "Are you on task?" with a yes/no response option. The training fidelity procedures (see Appendix C) followed a behavioral skills training (BST) approach, which employs instruction, modeling, rehearsal, and feedback (Miltenberger, 2012). During instruction, the researcher provided a definition of self-monitoring and a rationale for using self-monitoring and how it can increase on-task behavior (e.g., increase productivity, learn more). During modeling, the research demonstrated both on-task and off-task behavior three times each. It was repeatedly emphasized that the modeled on-task behaviors were the expected classroom behavior and off-task behaviors were not. Next, the participant was given an opportunity to rehearse the desired behavior. The researcher pretended to either exhibit on-task or off-task behaviors and the participant had to correctly answer which one was being displayed. The participant had the option of verbally answering or using notecards with the words 'on-task' and 'off-task' written on them. The participant needed to respond correctly for five of the six (83%) scenarios in order to meet criterion and move on to the next phase. If the participant was not able to meet this criterion, then the researcher would model the procedures again and repeat the training steps. Feedback was delivered following rehearsal. The researcher provided praise for correct responding and feedback, in the form of instruction, for incorrect responding.

Once participants successfully demonstrated criterion performance for on-task behavior using the above-described training procedures, the researcher trained the participant to use the I-Connect SM device. The BST procedures were also utilized for device training purposes. The researcher provided instruction and a rationale for using the device. Next, the researcher modeled how to respond to the device (e.g., respond to notification prompt by choosing yes or no) and use the device during a task. Next, the participant rehearsed with the device for five intervals (i.e., five notification prompts) and the researcher provided praise for correct responding and feedback for incorrect responding. Participants needed to respond correctly to four of the five prompts (80%) to meet criterion. If the participant did not meet criterion, the researcher repeated the training steps. Once criterion was met, the participant used the device during an independent work task. The participant needed to respond to 80% of the prompts displayed during one 10-min work session to meet criterion for completing training, and proceed to the intervention phase. The average training time across all participants was 25 min (range 20-35 min).

Intervention. Once the participant met the training criteria, the intervention phase was introduced and conducted for a minimum of five sessions across all participants. The I-Connect SM application was set at 30-s intervals with a prompt asking "Are you on task?" for all four participants. At the beginning of each data collection session during independent work tasks, the researcher placed the device on the desk next to the participant. The classroom staff were given the same instructions as in baseline: (a) sit/stand away from the participant, (b) engage if appropriately raising their hand to ask a question, and (c) verbally prompt them to "stay on task" a second time at the end of the first 5-min of the session only if the participant had been off-task for the whole 5-min. School reinforcements procedures remained in place, and no added reinforcement was provided for responding to the I-Connect SM intervention or engaging in target behavior. If the participant did not respond to two consecutive intervals they were prompted by the researcher to "answer the question." If a data collection session was completed (i.e., 10 min), but the participant was still working on an assignment, he continued using the device until his work was completed. In addition, the implementer assigned to the student was instructed to allow the participant to continue using the device and refrain from prompting or reinforcing the participant until the task was completed.

Withdrawal. The withdrawal phases were implemented following a minimum of five intervention data points demonstrating a stable pattern of responding evident through visual analysis of the data. This phase was identical to the baseline phase. Following five withdrawal data points for three participants (seven for Colin) and a stable pattern of responding, the I-Connect SM intervention was reintroduced.

Return to Intervention. The intervention was reintroduced following the collection of a minimum of five data points demonstrating stability during the withdrawal condition and return to baseline levels. The participants were retrained on how to use the device following steps one through four under the training I-Connect SM device section located in the I-Connect SM Training Fidelity sheet (See Appendix F). Set-up procedures and implementation were identical to the first intervention phase. The second intervention condition lasted five to six sessions across participants.

Maintenance. Two weeks following the completion of the second intervention phase, maintenance data was collected to determine the effectiveness of the intervention over a period of time (Kazdin, 1982). Three maintenance data points was collected for this phase. Data were collected once a week for three consecutive weeks.

Data Analysis

Visual analysis of graphical displays of data was utilized to determine if there was a functional relation between implementation of the I-Connect SM and changes in the identified dependent variables (Cooper et al., 2016). Data were displayed graphically to facilitate visual inspection and determine if there is a functional relation between the I-Connect SM intervention and increases in on-task behavior and decreases in disruptive behavior. Graphical display of data allowed for the evaluation of within- and between-phase data. Within-phase analysis included evaluating level, trend, and variability. Between-phase analysis included evaluating changes in level, trend, and variability as well as data overlap and immediacy of change in behavior between phases.

Results

The results examined the functional relation between the use of self-monitoring with the I-Connect SM intervention and a(n) (a) increase in on-task behavior, (b increase in task-completion, and (c) decrease or change in levels of disruptive behaviors. The social validity results of the intervention as reported by the participants and their teachers are presented as well.

On-Task Behavior

Carl. The percentage of intervals in which on-task behaviors occurred per observation session across all phases is graphically displayed in Figure 1. During baseline, Carl was on-task an average of 12% (range 5%-35%) of intervals. Upon the introduction of the I-Connect SM, tCarl's levels of on-task behavior immediately increased (*M* = 81%, range 72%-87%) as evident by the clear intercept gap and stability of data. Withdrawal of the intervention resulted in an immediate return to baseline levels of on-task behavior (*M* = 12%, range 5%-28%) with some variability. The reintroduction of the intervention resulted in an immediate return to intervention levels of on-task behavior (*M* = 85%, range 83%-93%). Visual analysis of maintenance data indicates that intervention effects maintained after a period of time (*M* =9 3%, range 86%-97%).

Stan . The percentage of intervals in which on-task behaviors occurred per observation session across all phases is graphically displayed in Figure 1. The data indicate that Stan was on-task an average of 15% (range 3%-23%) of intervals during baseline. Visual analysis indicates a decreasing trend of on-task behaviors throughout baseline. The introduction of the intervention resulted in an immediate increase, as evident by the clear intercept gap, in levels of on-task behavior (*M*= 89%, range 78%-100%) with little variability. The withdrawal of the intervention resulted in a decrease in levels of on-task behavior (*M*= 51%, range 43%-67%). Although the participant did not return to baseline levels, visual analysis indicates that on-task behavior was well below intervention data. Upon reintroduction of the intervention, Stan's levels of on-task behavior increased (*M*= 86%, range 77%-94%) back to intervention levels. During maintenance, Stan's percentage of intervals in which on-task behaviors occurred remained at intervention levels (*M*=90%, 87%-93%).

Colin (Participant 3). The percentage of intervals of on-task behaviors occurred per observation session across all phases is graphically displayed in Fig 2. Visual analysis of baseline data indicates low-rates of on-task behavior (*M*=33%, range 20%-61%) with some variability. The introduction of the I-Connect SM intervention resulted in an immediate increase in levels of on-task behavior (*M*= 90%, range 87%-93%) as evident by a clear intercept gap. Additionally, visual analysis indicates that levels of on-task behavior became more stable during intervention as compared to the instability of baseline. Removal of the intervention resulted in a decrease in levels of on-task behavior (*M*=52%, range 33%-71%) with variability returning. The average percentage did not decrease to baseline levels during this phase, but it is visually apparent that percentage of on-task behavior remained below intervention levels. Visual analysis of the reintroduction of the intervention indicates an immediate increase in on-task behaviors (*M*= 92%, range 83%-98%) as evident by the clear intercept gap. The percentage of intervals in which on-task behaviors occurred remained at intervention levels during maintenance (*M*=92%, range 87%-95%).

Jack (Participant 4). The percentage of intervals of on-task behaviors occurred per observation session across all phases is graphically displayed in Fig 2. Jack was on-task an average of 24% (range 2%-43%) during baseline. Visual analysis of baseline data indicates variability of data. The introduction of the I-Connect SM resulted in an immediate increase in levels of on-task behavior (*M*=83%, range 76%-89%) with a steady increasing trend and no variability. Withdrawal of the intervention resulted in an immediate return to baseline levels of on-task behavior (*M*=28%, range 12%-50%) with some variability. Visual analysis of the reintroduction of the intervention indicates an immediate increase in on-task behavior (*M*=84%, range 70%-92%) with some variability as compared to the first introduction of the intervention.

Disruptive Behavior

Carl. The percentage of intervals of Carl's disruptive verbals (BVs) and behavior disruptives (BDs) are visually displayed in Fig 3.

BV. During baseline, the participant demonstrated an average of 42% of intervals in which BVs occurred (range 20%-60%). Visual analysis of baseline data indicates some variability of the data. The introduction of the I-Connect SM intervention resulted in a decrease (*M*=18%, range 8%-28%) in levels of BVs with visual analysis indicating some variability. Withdrawal of the intervention resulted in an increase in levels of BVs (*M*=58%, range 25%-73%) with variability as evident by one data point returning to intervention levels. The re-introduction of the intervention resulted in an immediate decrease in levels of BVs (*M*=12%, range 5%-14%) with no variability or increasing trend. Visual analysis of maintenance data indicates that the participant's percentage of BVs remained low and at intervention levels (*M*=12%, range 10-15%).

BD. Visual analysis of baseline data indicates a high percentage of BDs with some variability with an increasing trend on the last three data points (*M*=56%, range 30%-87%). The introduction of the I-Connect SM intervention resulted in an immediate decrease in levels of BDs (*M*=7%, range 5%-17%) with stability evident by a clear intercept gap and no variability. Visual analysis of the removal of the I-Connect SM indicates variability of the data but an overall increase in percentage of BDs (*M*=67%, range 25%-95%) as compared to intervention. The second introduction of the intervention resulted in an immediate decrease in levels of BDs (*M*= 6% range 5%-12%) with no variability or evidence of increasing trend. In maintenance, the percentage of intervals in which BDs occurred remained low (*M*=9%, range 5%-12%) with evidence of stability.

Stan. The percentage of intervals of Stan's behavior verbals (BVs) and behavior disruptives (BDs) are visually displayed in Fig 4.

BV. Visual analysis of baseline data indicates low percentages of BVs with the exception of one data point (*M*=9%, range 0%-23%). Visual analysis of intervention data indicates low levels of BVs with stability (*M*=4%, range 0%-7%). The withdrawal of the intervention did not result in an increase in BVs (*M*=5%, range 3%-7%). The reintroduction of the intervention resulted continued low-levels of BVs as compared to withdrawal (*M*=2%, range 0%-5%) with no variability. Visual analysis of maintenance data indicates that the participant's percentage of BVs remained low (*M*=2%, 0%-5%).

BD. During baseline, the participant exhibited low levels of BDs (*M*=6%, range 0%-15%) with little variability and an increasing trend at the last data point. The introduction of the intervention resulted in low-levels of BDs (*M*=0%, range 0%-2%) with stability. Visual analysis of the removal of the intervention indicates that low-levels of BDs (*M*=1%, range 0%-3%) remained at intervention levels. The second introduction of the I-Connect SM intervention resulted in continued low-levels of BVs (*M*=1%, range 0%-2%). During maintenance, percentage of BDs remained low (*M*=1%, range 0%-2%) with stability.

Colin. As previously reported, baseline data was collected for Colin's disruptive behavior to confirm the teacher reports. Baseline data indicated low-levels of BVs (*M*=1%, range 0%-1%) and BDs (*M*=1%, range 0%-3%), therefore, collection of this dependent variable was discontinued.

Jack. The percentage of intervals of Jack's behavior verbals (BVs) and behavior disruptives (BDs) are visually displayed in Fig 5.

BV. Visual analysis of baseline data for the participant indicated high-levels of BVs (*M*=47%, range 15%-72%) with some variability but evidence of an increasing trend in the last three data points. Upon the introduction of I-Connect SM, the participant's percentage of intervals in which BVs occurred immediately decreased (*M*=21%, range 5%-29%). Visual analysis indicates variability of intervention data as evident by one baseline data point overlapping with intervention data. The removal of the intervention resulted in an increase in the percentage of intervals in which BVs occurred (*M*=47%, range 20%-68%). Again, visual analysis indicates variability in the data evident by the overlap of two data points with intervention data. Visual analysis of the reintroduction of the intervention indicates some variability in the data, but the average percentage of intervals in which BVs occurred decreased to intervention levels (*M*=24%, 4%-38%). During maintenance, percentage of BVs remained at intervention levels (*M*=16%, range 7%-17%).

BD. During baseline, visual analysis indicated high-levels of percentage of intervals in which BDs occurred (*M*=62%, range 23%-100%) with variability. The introduction of I-Connect SM resulted in an immediate and stabilizing decrease in levels of BDs (*M*=6%, range 0%-12%) as evident by the clear intercept gap and no evidence of variability. Although visual analysis of withdrawal phase indicated the data were variable and evidence of a descending trend, Jack demonstrated an average of 23% (range 14%-61%). Reintroduction of the intervention resulted in a decrease in levels of BDs (*M*=3%, range 2%-6%) with a stable pattern of responding and level pattern of responding. Visual analysis of maintenance data indicates that Jack's BDs remained low (*M*=5%, range 2%-6%).

Task Completion

Carl. Figure 6 visually displays Carl's task completion results. Baseline data indicates low-levels of task completion with an average of 9% (range 0%-28%) of items completed. The average percent of items completed during the intervention phase increased to 100% (range 100%-100%) demonstrating an increase in task-completion. Removal of I-Connect SM resulted in a significant decrease in percentage of items completed (*M*=13%, range 0%-25%). The reintroduction of the intervention resulted in an immediate increase in percentage of items completed (*M*=100%, range 100%-100%). In maintenance, the participant completed an average of 100% (range 100%-100%) of items completed demonstrating maintenance of intervention effects.

Stan. Figure 6 visually displays Stan's task completion results. Baseline results indicated low-levels of task completion (*M*=4%, range 0%-20%). The introduction of the intervention resulted in an increase in an increase in the percentage of items completed (*M*=100%, range 28%-40%). During the withdrawal phase, the percentage of items completed decreased to 34% (range 28%-40%) indicating low-levels of task completion. Upon the reintroduction to the intervention resulted in an increase in percentage of items completed (*M*=94%, range 80%-100%). In maintenance, the participant completed an average of 100% of items (range 100%-100%) demonstrating maintenance of effects over time.

Colin. Colin's task completion results are visually displayed in Fig 7. The average percentage of items completed during baseline phase was 29% (range 25%-100%) indicating low-levels of task completion. The introduction if the I-Connect SM intervention resulted in an increase in percentage of items completed (*M*=100%, range 100%-100%). Removal of the intervention resulted in a decrease in task completion (*M*=62%, range 50%-100%). The reintroduction of the intervention resulted in an increase in task completion (M=93%, range 63%-100%). Intervention effects remained positive during maintenance phase (*M*=100%, range 100%-100%).

Jack. Figure 7 visually displays Jack's task completion results. During baseline, results indicated low-levels of task completion with an average of 19% (range 0%-50%). Upon the introduction of the intervention, task completion significantly increased to an average of 100% (100%-100%) of items completed. The removal of the I-Connect intervention resulted in a significant decrease in task completion behaviors (*M*=30%, range 13%-50%). Upon the reintroduction of the intervention, the percentage of items completed increased to intervention levels (*M*=100%, range 100%-100%). During maintenance, Jack completed an average of 100% of items (range 100%-100%) demonstrating maintenance of effects.

Social Validity

All four participants completed the researcher-developed participant satisfaction survey form upon the completion of the study (see Appendix E). Participant social validity forms had a "yes" or "no" response option for each of the eight items. Carl's (Participant 1) social validity score was 5/8. The participant's ratings indicated that the device helped him stay on-task and get more work completed at a faster pace faster (responded 'yes' to these items). Carl also reported that he was satisfied with the device and would continue to use the intervention (responded 'yes' to these items). Carl responded "no" for the following items; "When I was using the I-Connect device I found that getting started on assignments was easier", "Overall impression of intervention/device was that it was easy to use", and "Device was not intrusive". Stan's (Participant 2) social validity score was 7/8. He reported high levels of satisfaction for all items except "When I was using the I-Connect device I found that getting started with assignments was easier". He also expressed that his favorite part of using the application was that it made "staying on-task more fun". Colin (Participant 3) reported high levels of satisfaction with the intervention (7/8). He reported that he did not think that the intervention allowed him to get more work done, but the results of his task completion indicated otherwise. He described the intervention as "awesome", and expressed that he would not change anything about the intervention. Jack's (Participant 4) social validity score was 7/8 indicating high-levels of satisfaction. He responded "no" for the item "Was the device easy to use". Overall, the four participants reported high levels of satisfaction with the I-Connect SM intervention.

The four lead teachers completed the researcher-developed teacher satisfaction survey upon the completion of the study (see Appendix F). Mrs. Morgan completed two satisfaction surveys, one for her experience with each participant in her classroom. Mrs. Charles' social validity score for the 10 satisfaction survey items was 46/50 (M=4, range 4-5) indicating high levels of satisfaction with the intervention. Her ratings indicated that when I-Connect SM application, the participant's (Carl) behavior was "significantly better" (rated a 5) in regards to getting started on assignments and productivity. She also reported that the participant improved in regards to on-task behavior, completing work, and classroom disruptions (rated a 4 indicating "better"). Her ratings also indicated that the intervention was easy to implement, not intrusive, that she was highly satisfied with the intervention, and would like to continue to use the intervention (all rated a 5 indicating "strongly agree"). Mrs. Mary responses yielded an average rating of 5 (48/50, range 4-5) for Stan and 4 (44/50, range 3-5) for Colin. For Stan, her ratings indicated that the intervention improved the participant's on-task behavior, ability to get started on assignments, work completion, and productivity (all rating 5 indicating "significantly better"). She rated that the student's classroom disruption was "better" (rated a 4), but also indicated that he did not exhibit high-levels of disruptive behaviors prior to the intervention. Mrs. Morgan reported she was satisfied with the intervention and would like to continue to use it with Stan. She also reported “the student seemed to enjoy working with the device and worked quicker/focused”. Mrs. Morgan’s ratings for Colin indicated when the intervention resulted in improvements in the participant’s ability to stay on-task (rated a 5 indicating “significantly better”), complete work (rated a 4), and productivity (rated a 4). She did not see improvements in getting started with assignments or classroom disruption (both rated a 3 indicating “same”). However, Colin did not exhibit disruptive behaviors in the classroom. Overall, Mrs. Morgan reported high-levels of satisfaction with overall impressions of the intervention (all items rated a 5 indicating “strongly agree”). She expressed that the intervention improved the participant’s ability to stay on-task, but he did not demonstrate improvements in the accuracy of his work. Mrs. Erik reported extremely high-levels of satisfaction with an overall score of 50/50 (M=5, range 5-5). Her ratings indicated that the intervention improved the participant’s ability to get started with assignments, stay on-task, complete work, decreased classroom disruption, and improved productivity (all were rated a 5 which indicated “significantly better”). She also gave all items for overall impressions of intervention a 5 (“strongly agree”) indicating high-levels of satisfaction with the intervention. Overall, both participant’s and lead teacher’s satisfaction survey results indicate high-levels of satisfaction with behavioral improvements as a result of the intervention and overall impressions of the I-Connect SM intervention.

Discussion

The purpose of this study was to examine the effects of the I-Connect SM intervention on the on-task, disruptive, and task-completion behavior for four adolescents with ASD. The experimental control and strong internal validity of the study as established by repeated demonstrations of change for each student at different points in time, systematic introduction and withdrawal of the intervention, and evidence of a clear pattern of results, with a minimum of five data points per phase (Kratochwill et al. 2010), demonstrates strong experimental control, providing a high level of confidence in the interpretation of the results. All four participants demonstrated clear improvements in both on-task and task-completion behaviors with both introductions of the I-Connect SM intervention. The intervention resulted in clear decreases in disruptive behaviors for one participant whereas the other participant demonstrated more variable results. This study also evaluated participant and teacher social validity of the intervention. Participants and teachers reported high-levels of satisfaction with the intervention and improvements in classroom behaviors. Given these results, the use of the I-Connect intervention shows potential for successful implementation with adolescents with ASD.

The results of the I-Connect SM intervention supports prior literature evaluating the use of self-monitoring for adolescents with ASD (e.g., Agran et al., 2005; Cihak, et al., 2010; Clemons et al., 2016) and extends the literature base in three ways. First, the functional relation between the I-Connect SM intervention and task-completion behaviors was evaluated with positive findings. The effects of the intervention on this targeted behavior had not yet been evaluated. Second, the I-Connect SM intervention did not introduce planned reinforcement. Although several studies have not introduced planned reinforcement as part of the self-monitoring intervention (Crutchfield et al., 2016, Wills & Mason, 2015), there is some variability in the literature regarding embedding reinforcement procedures into the self-monitoring intervention (Fantuzzo & Polite, 1990; Mooney, Ryan, Uhing, Reid, & Epstein, 2005) with some studies showing effects with self-monitoring without planned reinforcement and some combining the intervention with a reinforcement schedule. Although four participants earned a break contingent on completing their independent work, this reinforcement procedure was in place prior to the study and remained in place during baseline and intervention phases. While reinforcement data were not collected for the purposes of this study, one potential explanation as to why self-monitoring without planned reinforcement resulted in improvements in targeted behaviors is that the individuals came into contact with the reinforcement system already in place (e.g., breaks) more quickly. The participants exhibited escape maintained off-task behaviors and earning a break more quickly may have helped maintain their self-monitoring behaviors. Stan’s lead teacher originally indicated that off-task and disruptive behaviors were maintained by attention yet because teacher and implementer attention was controlled for (e.g., no prompting across all phases) and no extinction burst or diminishing trends occurred, it is likely that this assumption or original indication was inaccurate. For Stan, like the other participants, perhaps earning reinforcement more quickly helped maintain his on-task behavior. This study provides additional evidence that self-monitoring interventions can result in improvements in behaviors without embedding planned reinforcement procedures. Third, the I-Connect SM intervention was implemented in a novel alternative-program setting.

Additionally, the results of this study demonstrate a promising intervention for adolescents with ASD due to the intervention’s ease of use and increased opportunity for the user to increase on-task behavior without prompting from outside agent. Current EBP for individuals with ASD often requires the support of an outside agent, which increases prompt and adult dependency thus impacting independent functioning (Ganz et al., 2007; Hume et al., 2009). Few steps were necessary in order to ensure implementation fidelity of the intervention. An outside agent was only required for the purposes of training the individual how to use the intervention and giving an instruction to start the timer. The intervention ultimately allowed the participants to not only self-monitor their own behavior, but complete their work without continuous support from an outside agent.

Although the intervention resulted in improved on-task and task-completion behavior for all participants, there was a difference in disruptive behaviors results for Carl and Jack. Carl's data demonstrated a clear functional relation between increases in on-task behavior and decreases in disruptive behavior; in other words, he infrequently displayed disruptive behaviors while on-task. Conversely, the measure of disruptive behavior for Jack was variable and did not demonstrate clear improvements across phases, and he displayed disruptive behavior while both on-and off-task. A potential explanation for these results is that Carl's on-task and disruptive behaviors were mutually exclusive in the sense that one rarely occurred in the presence of the other, but all responses were maintained by the same contingencies, making them functionally equivalent (Critchfield, 1989). Alternatively, Jack's on-task and disruptive behaviors were not mutually exclusive and could occur concurrently indicating that such behaviors were not of the same response class. Perhaps in order to decrease disruptive behaviors for Jack the prompt needed to explicitly address disruptive behavior. These results provide some insight in the relationship between concurrent behaviors and how they can vary depending on the individual and affect self-monitoring results. In other words, for some individuals, on-task and disruptive behaviors can occur independently of each other, whereas, for others, there is a clear negative relationship (as one decreases, the other increases) between the two behaviors. Future research on such behaviors and how self-monitoring interventions can improve both behaviors either simultaneously or independently is warranted.

The I-Connect SM intervention resulted in an increase in task completion behaviors across all four participants. An interesting observation was that as task completion increased, the number of items assigned to the participants increased as well, especially for Stan, Colin, and Jack. The results demonstrate the strength of the intervention in showing a clear relationship between on-task behaviors and task completion. As on-task behaviors improved they participants were able to complete more tasks.

Limitations and Future Research

There are several limitations of the current study that should caution the interpretation of study results and conclusions being drawn. First, the interval length was set at 30 s for all participants and was not varied within the study, therefore, it unclear what effects longer intervals would have on the target behaviors. Additionally, assessments for interval lengths were not conducted prior to baseline, therefore it is unclear as to whether or not participants needed shorter or longer interval prompts. Future research on the relationship between increasing interval frequency and targeted behaviors would be beneficial for the purposes of evaluating fading procedures and interval length thresholds. Second, accuracy of response to the I-Connect SM application prompt was not evaluated for the purposes of this study. Third, generalization data in terms of setting and skills was not evaluated purposes of this study. Future research using the I-Connect SM intervention across multiple-settings would help assess the use of the intervention to help individuals with ASD generalize their self-monitoring skills. Fourth, the instructional activities did not vary during data collection across all phases. Although this was set up in order to control for internal validity, future research on the effects of the I-Connect SM intervention across multiple tasks would help assess the generalizability of the intervention.

In addition to addressing the limitations of this study, continued research on the I-Connect SM intervention with adolescents with ASD is warranted. Studies that focus on utilizing the intervention with adolescents would provide additional evidence regarding the efficacy of the intervention for this population. Evaluation of the use of the I-Connect SM intervention in non-school based settings (e.g., community, work, volunteer) could also be beneficial. Additionally future studies evaluating the mechanism of behavior change of self-monitoring would be beneficial for the the field. Many behavior analysts have argued that self-monitoring is either a reactive chain (Kanfer, 1975) or that self-monitoring responses serve primarily to cue to environmental events that control response frequency (Bandura, 1976; Rachlin, 1974). This has been a much debated topic in the field of behavior analysis (Badura, 1976), and extending the literature comparing potential mechanisms of change would provide additional evidence supporting or negating either perspective. Finally, it remains unclear whether or not technology based self-monitoring procedures or paper and pencil procedures yield different results at the level of student outcomes and social validity. Technology currently plays a significant role in schools attempting to maximize intervention resources (Clemons et al., 2016) and research on the role technology plays in comparison to more traditional methods would help service providers make better intervention selection decisions. Overall, this study demonstrates effectiveness of the I-Connect SM intervention on improving on-task, disruptive, and task completion behaviors for adolescents with ASD.

Figures

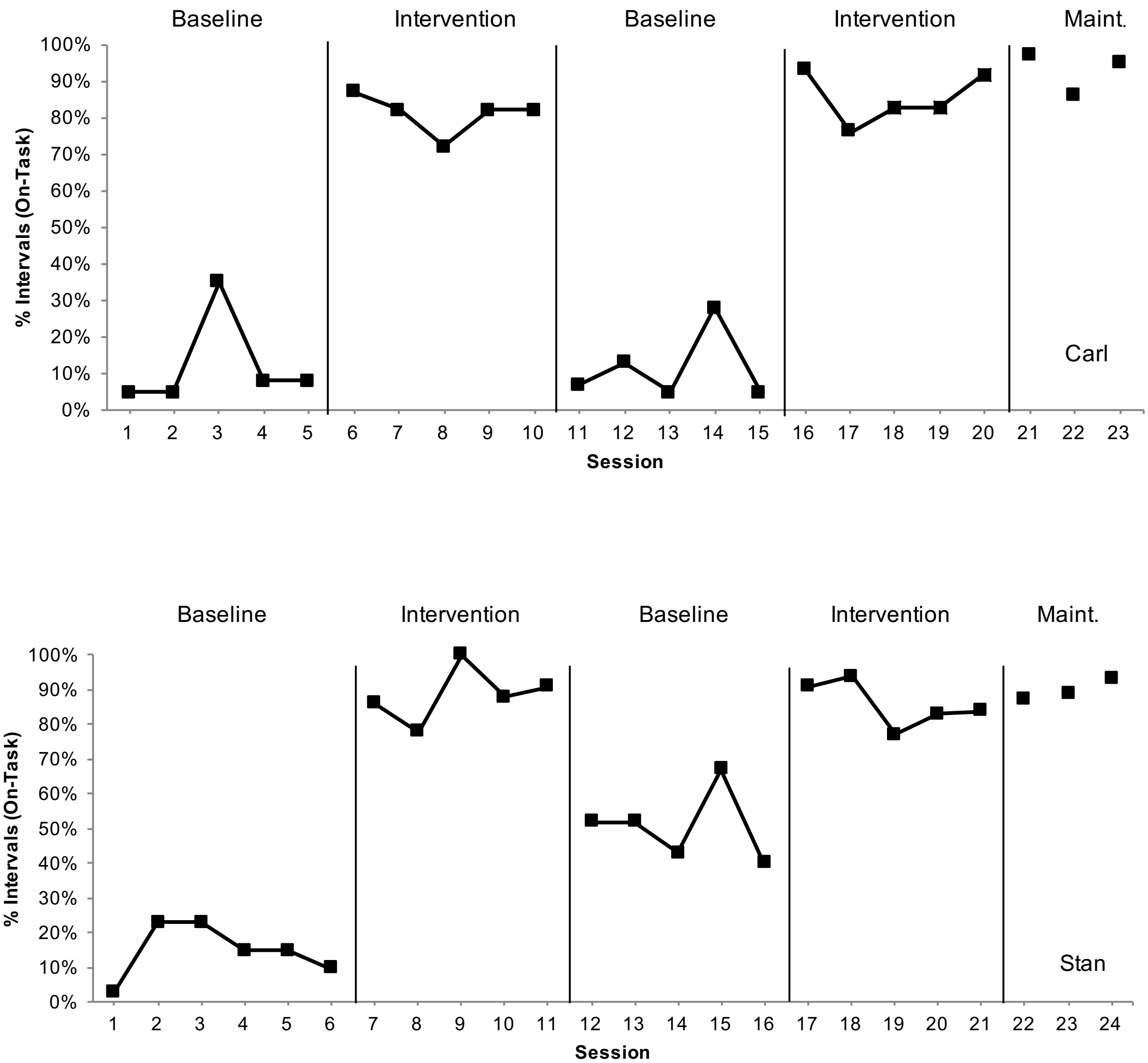


Figure 1. Percentage of intervals of on-task behavior (y-axis) for each data collection session (x-axis) for Carl (top) and Stan (bottom). Maintenance phase is represented as "maint".

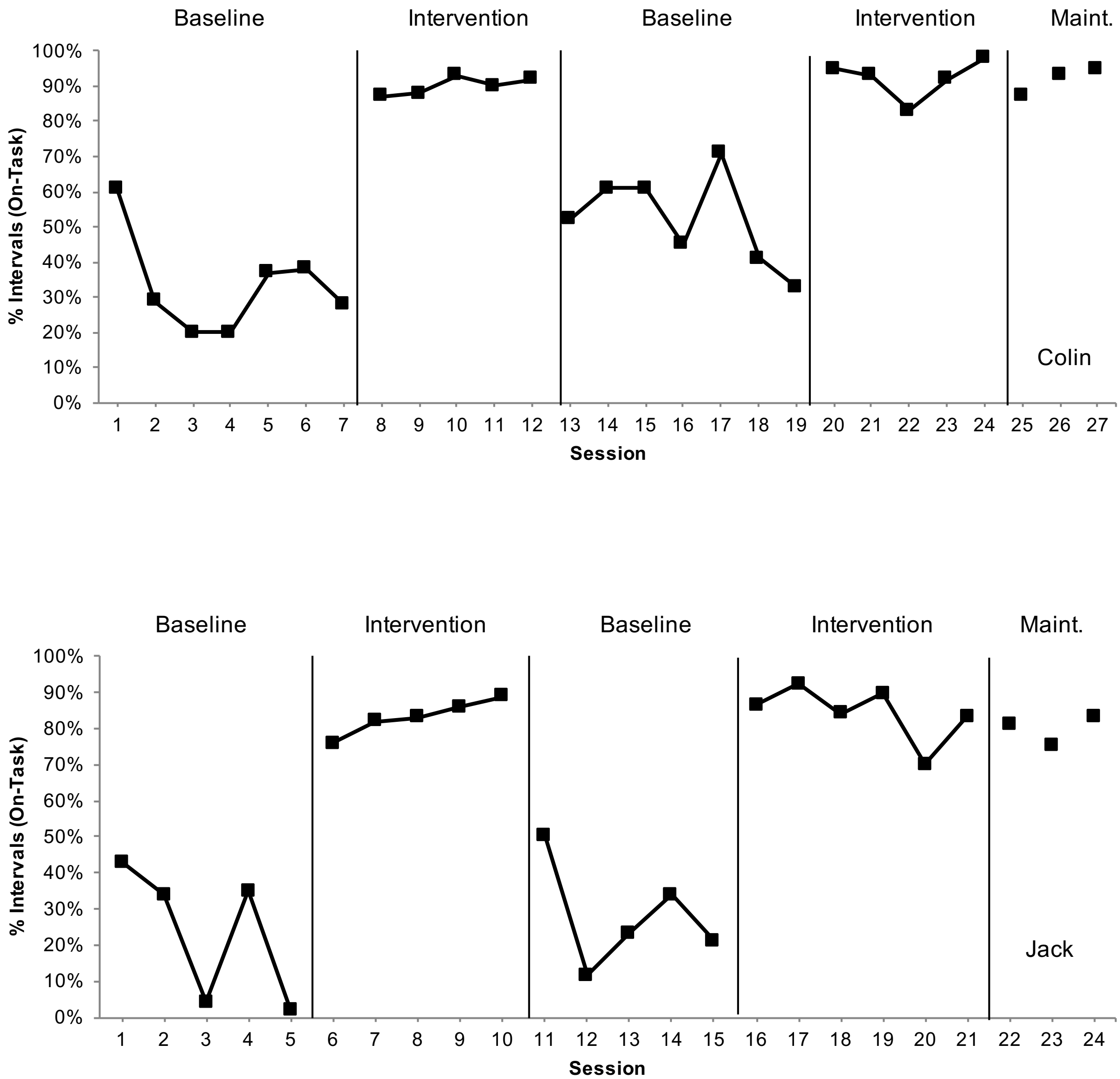


Figure 2. Percentage of intervals of on-task behavior (y-axis) for each data collection session (x-axis) for Colin (top) and Jack (bottom). Maintenance phase is represented as "maint".

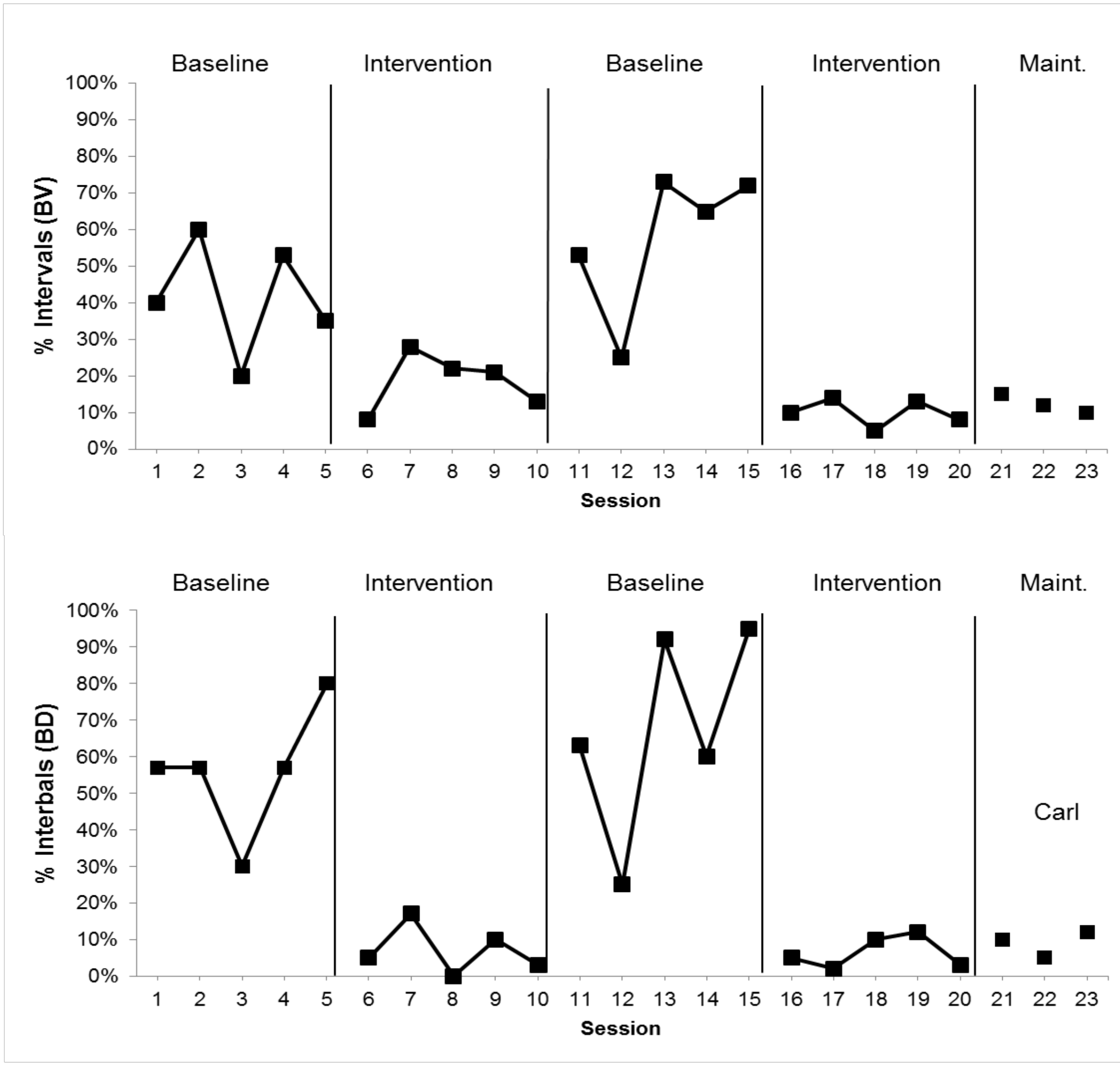


Figure 3. Percentage of intervals (y-axis) of BVs (top) and BDs (bottom) across all data collection sessions (x-axis) for Carl. Maintenance phase is represented as “maint”.

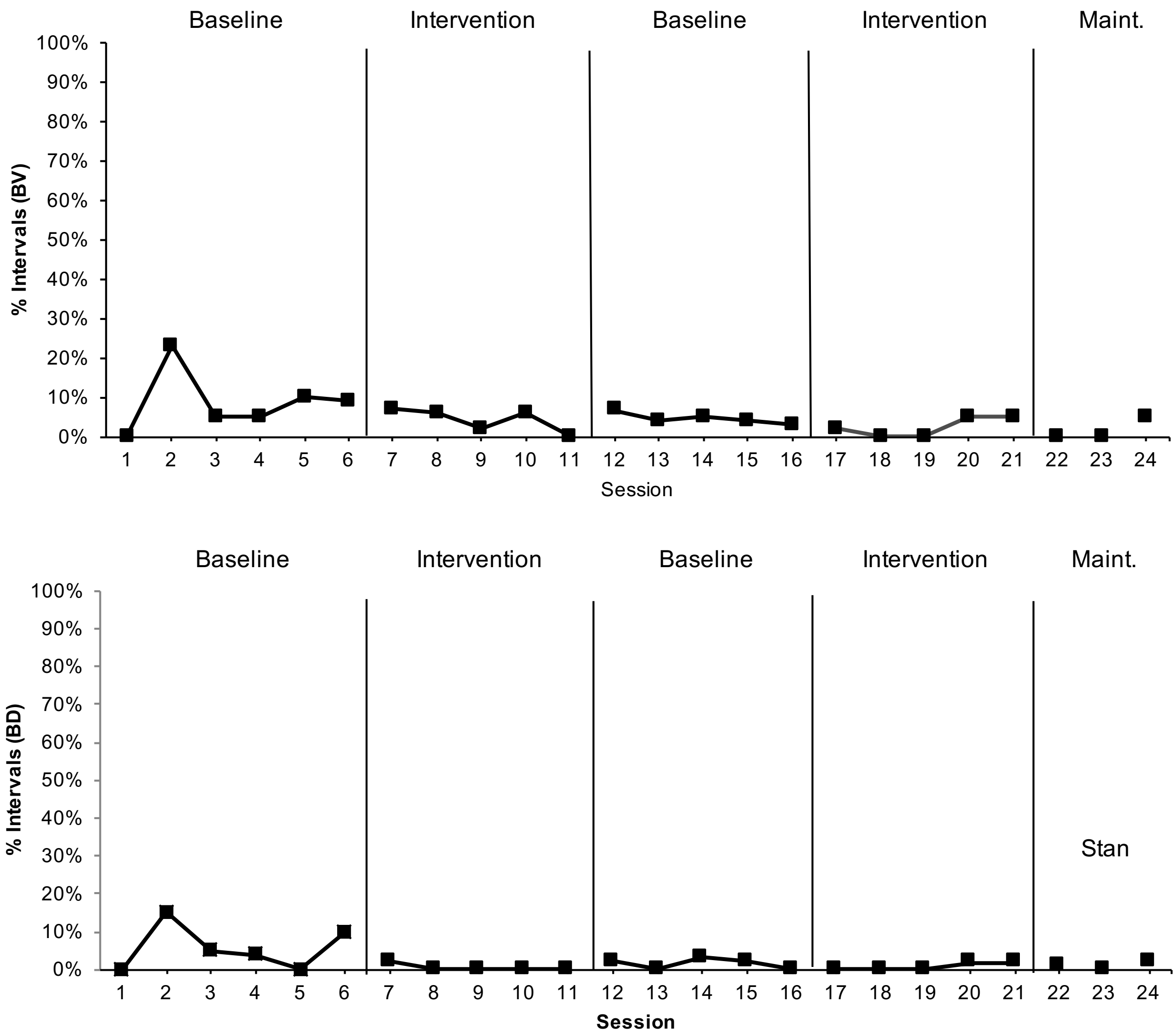


Figure 4. Percentage of intervals (y-axis) of BVs (top) and BDs (bottom) across all data collection sessions (x-axis) for Stan. Maintenance phase is represented as “maint”.

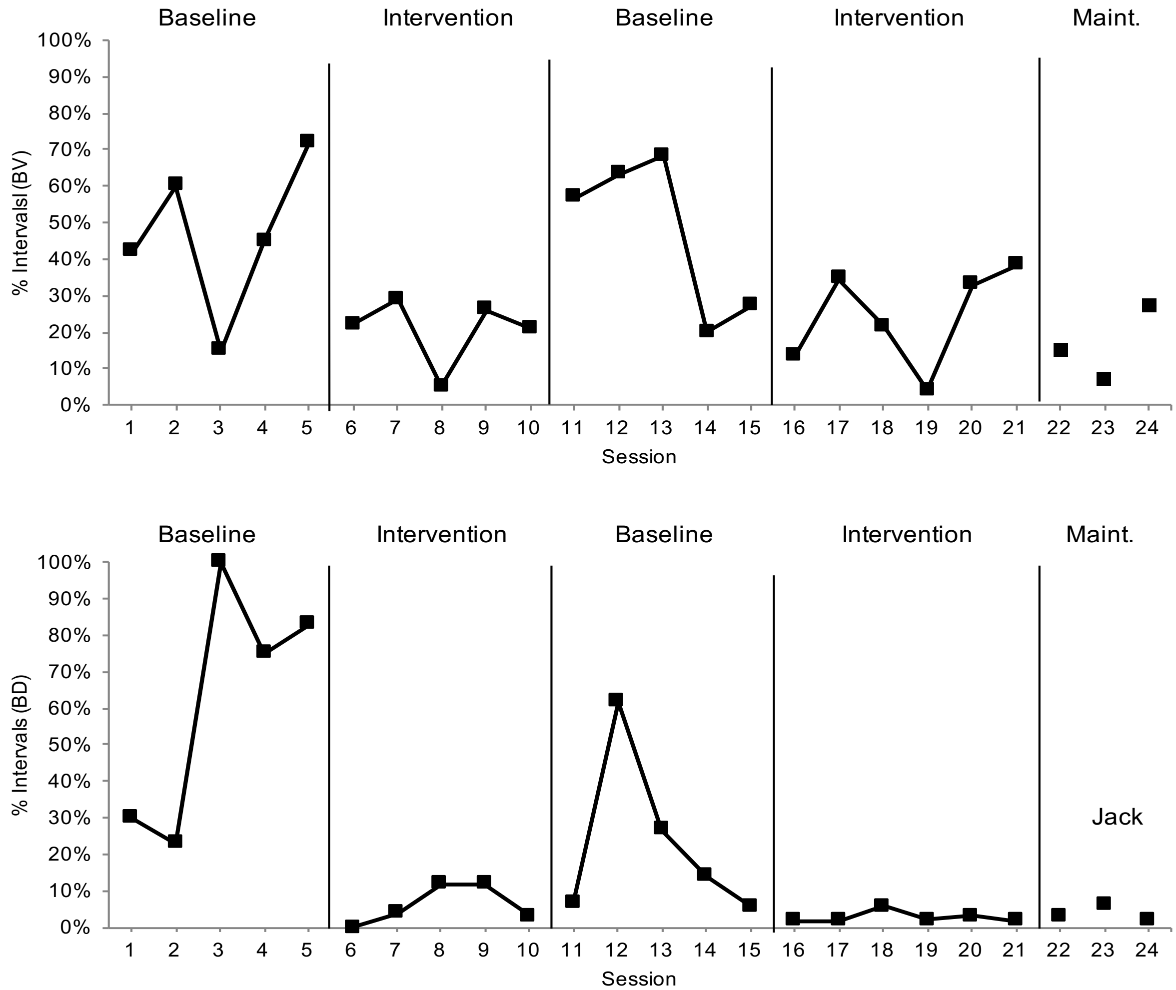


Figure 6. Percentage of intervals (y-axis) of BVs (top) and BDs (bottom) across all data collection sessions (x-axis) for Jack. Maintenance phase is represented as “maint”.

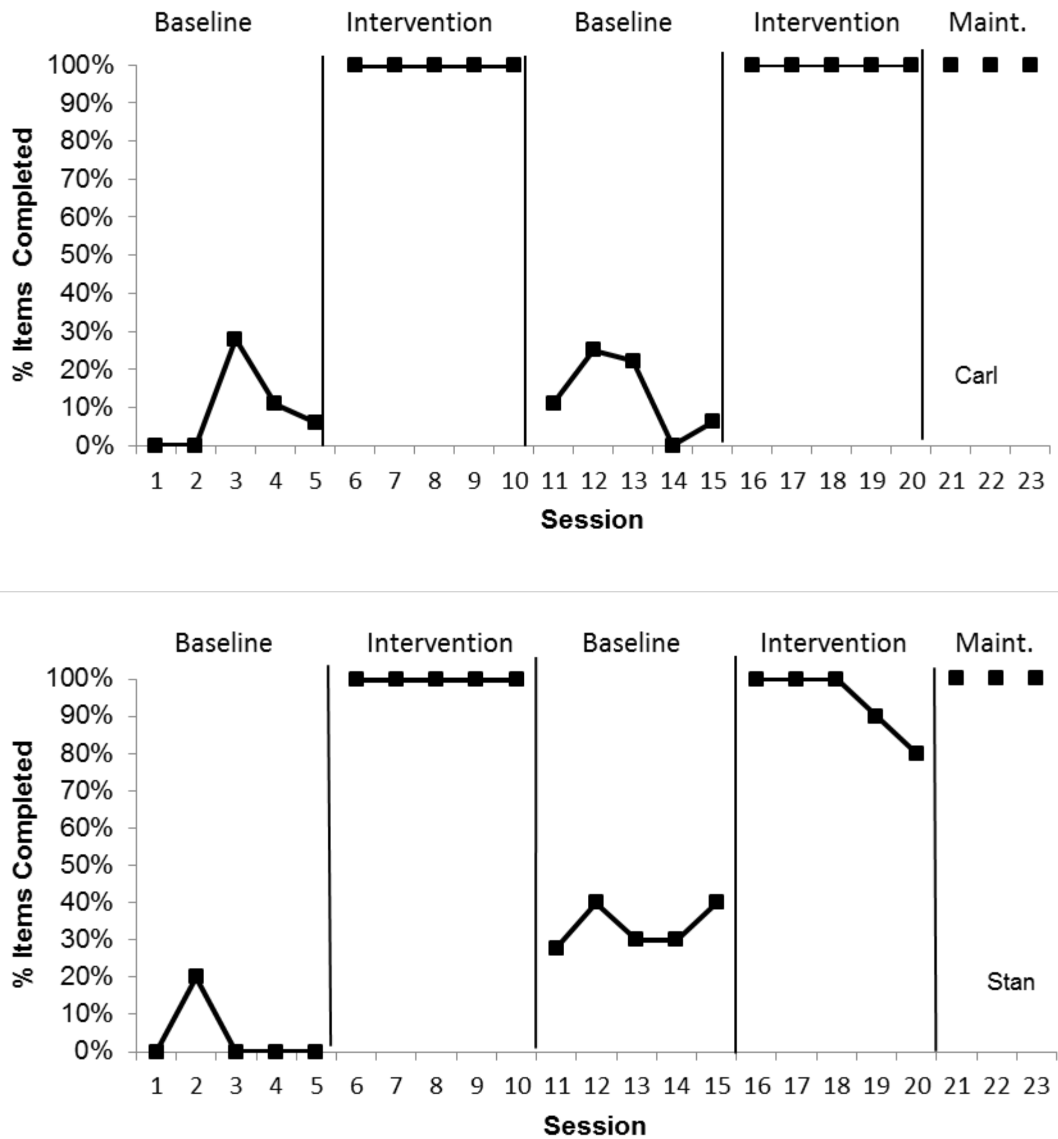


Figure 7. Task completion for Carl (top) and Stan (bottom). The y-axis represents the percentage of items completed and the x-axis represents the data collection session. Maintenance phase is represented as "maint".

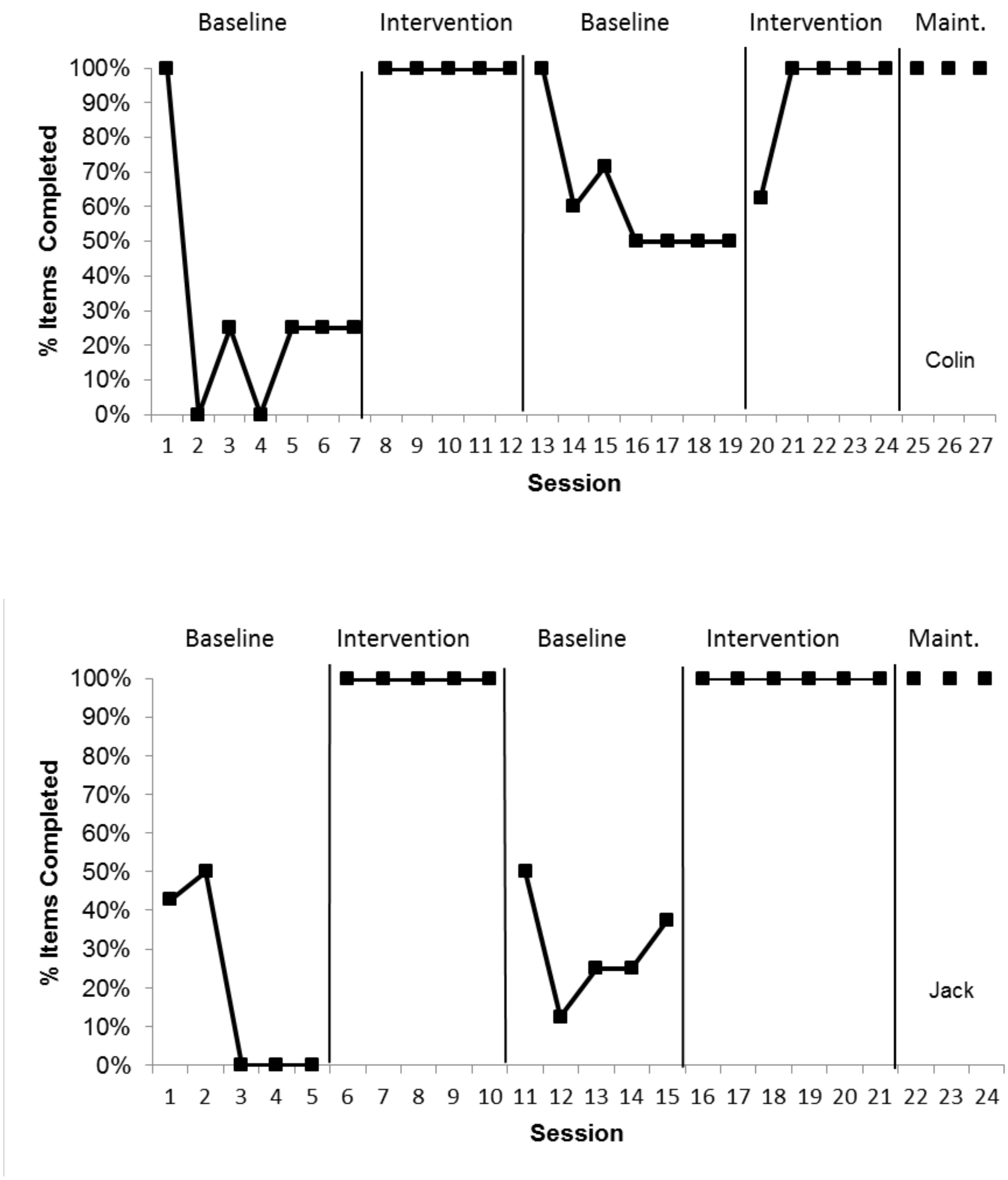


Figure 8. Task completion for Colin (top) and Jack (bottom). The y-axis represents the percentage of items completed and the x-axis represents the data collection session. Maintenance phase is represented as “maint”.

Tables

Table 1

Literature Review Results

Author	# Particip. ASD	Age/ Gender	Dx	Setting	Target Skills	Design	Type of SM	Maint.
Agran, Sinclair, Alper, Cavin, & Wehmeyer, (2005)	1	15 Male	ASD	Gen Ed. classroom	Task completion	MBD across participants	Paper and pencil	Yes
Bouck, Savage, Meyer, Taber-Dougherty, Hunley (2014)	2	13, 15 1 Male 1 Female	ASD	SPED classroom	Task Completion	Alternating Treatment Design (ATD)	Paper and pencil	Yes
Cihak, Wright, & Ayres (2010)	3	11, 11, 13 Male	ASD	Gen Ed. classroom	Engagement	MPB across participants	Paper and pencil plus Cue	No
Clemons, Mason, Garrison-Kane, & Wills (2016)	3	17, 17, 15 Male	ASD	Gen Ed. classroom	Engagement	ABAB	Tech. based self-monitorin g (I-Connect SM)	Yes
Coyle & Cole (2004)	3	11, 9 ,9 Male	ASD	SPED classroom	Engagement	ABA and ABACA	Paper and pencil plus Cue	Yes
Crutchfield, Mason, Chambers, Wills, & Mason (2015)	1	14 Male	ASD, ADHD	SPED classroom	Disruptive Behavior (Stereotypy)	MBD with embedded ABAB	Tech. based self-monitorin g (I-Connect SM)	No
Ganz & Sigafoos (2005)	1	20 Male	ASD	Alt. Setting	Task Completion	Changing Criterion	Paper and pencil	No
Hughes, Copeland, Argran, Wehmeyer, & Rodi (2002)	1	20 Male	ASD, ID	Gen Ed. classroom	Social Skills	MBD across Participants	Paper and pencil	Yes
Koegel & Koegel (1990)	3	14, 11, 13 Male	ASD	Alt. Setting	Disruptive Behavior (Stereotypy)	MBD across participants	Paper and pencil plus cue	Yes
Legge, DeBar, &	2	13, 11 Male	ASD	SPED classroom	Engagement	MBD across	Paper and pencil	Yes

Alber-Morgan (2010)						Participants	plus cue	
Mancina, Tankersley, Kamps, Kravits, & Parrett (2000)	1	12 Female	ASD, ID	SPED classroom	Disruptive Behavior	MBD across settings	Paper and pencil plus cue	No
Morrison, Kamps, Garcia, & Parker (2001)	4	11,10,13, 11 3 Males 1 Female	ASD	Gen Ed. classroom	Social Skills, Disruptive Behavior	MBD across Participants	Paper and pencil	Yes
Rock (2005)	1	11 Male	ASD	Gen Ed. classroom	Engagement, Task Completion	MBD across participants	Paper and pencil plus cue	Yes
Rock & Thead (2007)	1	14 Female	ASD, ID	Gen Ed classroom	Engagement, Task Completion	ABAB	Paper and Pencil plus cue	Yes
Rouse, Everhart-Sherwood, & Alber-Morgan (2014)	1	12 Male	ASD	SPED classroom	Task Completion	MPD across behaviors	Paper and pencil	Yes
Stahmer & Schreibman (1992)	2	13,12 Female	ASD	Alt. Setting	Social skills (play), Disruptive Behavior	MBD across participants	Paper and pencil plus cue	Yes
Soares, Vannest, & Harrison (2009)	1	13 Male	ASD	Alt. Setting	Task Completion, SIB	ABAB	Tech. based self-monitorin g	No
State & Kern (2012)	1	14 Male	ASD	Gen Ed. classroom	Social Skills, Disruptive Behavior	ABCBC	Paper and pencil plus cue	Yes
Tiger, Fischer, & Bouxsein (2009)	1	19 Male	ASD	Alt. Setting	SIB	ABABC	Paper and pencil plus cue	Yes

References

Alberto, P. A., & Troutman, A. C. (2013). *Applied behavior analysis for teachers.* Boston: Then tables, figures, and appendices in that order.Pearson.

Agran, M., Sinclair, T., Alper, S., Cavin, M., & Wehmeyer, M. (2005). Using self-monitoring to increase following-directions of students with moderate to severe disabilities in general education. *Education and Training in Developmental Disabilities, 40*(1), 3-13.

Aljadeff-Abergel, E., Schenk, Y., Walmsley, C., Peterson, S. M., Frieder, J. E., & Acker, N. (2015). The effectiveness of self-management interventions for children with autism: A literature review. *Research in Autism Spectrum Disorders, 18*, 34-50. doi:10.1016/j.rasd.2015.07.001

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5th Ed.). Arlington, VA: American Psychiatric Publishing.

Baer, D.M., Wolf, M.M., & Risley, T. (1987). Some still-current dimensions of applied behavior analysis. *Journal of Applied Behavior Analysis, 20*(4), 313- 327. doi:10.1901/jaba.1987.20-313

Bandura, A. (1976). Self-reinforcement: Theoretical and methodological considerations. *Behaviorism, 4,*135-155.

Binder, C. (1993). Behavioral fluency: Evolution of a new paradigm. *Educational Technology, 19*(2), 163-197.

Bjorklund, D. F. (2012). *Children's thinking: Cognitive development and individual differences.* Belmont, CA: Wadsworth/Cengage Learning.

Bouck, E.C., Savage, M., Meyer, N.K., Taber-Doughty, T., & Hunley, M. (2014). High-tech or low-tech? Comparing self-monitoring systems to increase task independence for students with autism. *Focus on Autism and Other Developmental Disorders, 29*(3), 156-167. doi:10.1177/1088357614528797

Briesch, A. M., & Chafouleas, S. M. (2009). Review and analysis of literature on self-management interventions to promote appropriate classroom behaviors (1988-2008). *School Psychology Quarterly, 24,* 106–118.

Browder, D. M., Wood, L., Thompson, J., & Ribuffo, C. (2014). *Evidence-based practices for students with severe disabilities* (Document No. IC-3). Retrieved from the University of Florida, Collaboration for Effective Educator, Development, Accountability, and Reform Center website: http://ceedar.educatoin.ufl.edu/tools/innovation-configurations/

Buschbacher, P. W., & Fox, L. (2003). Understanding and intervening with the challenging behavior of young children with autism spectrum disorder. *Language, Speech, and Hearing Services in Schools, 34*, 217–227. doi:10.1044/0161-1461(2003/018)

Callahan, K., & Rademacher, J. A. (1999). Using self-management strategies to increase the on-task behavior of a student with autism. *Journal of Positive Behavior Interventions*, *1,* 117–122.

Callahan, K., Hughes, H. L., Mehta, S., Toussaint, K. A., Nichols, S. M., Ma, P. S., . . . Wang, H. (2016). Social validity of evidence-based practices and emerging interventions in autism. *Focus on Autism and Other Developmental Disabilities*, 1-10. doi:10.1177/1088357616632446

Carr, M., Moore, D., & Anderson, A. (2014). Self-management interventions on students with autism: A meta-analysis of single-subject research. *Exceptional Children, 81*(1), 28-44. doi: 10.1177/0014402914532235

Centers for Disease Control and Prevention. (2014). Prevalence of autism spectrum disorders among children aged 8 years. *MMWR Surveillance Summaries, 63*, 1–21.

Cihak, D. F., Wright, R., & Ayres, K. M. (2010). Use of self-modeling static-picture prompts via a handheld computer to facilitate self-monitoring in the general education classroom. *Education and Training in Developmental Disabilities, 45,* 136–149.

Clemons, L.L., Mason, B.A., Garrison-Kane, L., & Wills, H.P. (2016). Self-monitoring for high school students with disabilities: a cross-categorical investigation of I-connect. *Empirical Research, 18*(3), 145-155. doi:10.1177/1098300715596134

Conroy, M.A., Asmus, J.M., & Sellers, J.A. (2005). The use of an antecedent-based intervention to decrease stereotypic behavior in a general education classroom. *Focus on Autism and Other Developmental Disabilities, 20*(4), 223-230. doi: 10.1177/10883576050200040401

Cooper, J.O., Heron, T.E., & Heward, W.L. (2007). *Applied behavior analysis* (2nd Ed.). Upper Saddle River, NJ: Pearson.

Coyle, C., & Cole, P. (2004). A videotaped self-modeling and self-monitoring treatment program to decrease off-task behavior in children with autism. *Journal of Intellectual & Developmental Disability, 29*, 3–15.

Critchfield, T.S. (1989). Self-recording mutually exclusive multiple responses. *Behavior Modification*, *13*(3), 361-375.

Crosland, K., & Dunlap, G. (2012). Effective strategies for the inclusion of children with autism in general education classrooms. *Behavior Modification, 36*(3), 251-269. doi:10.1177/0145445512442682

Crutchfield, S. A., Mason, R. A., Chambers, A., Wills, H. P., & Mason, B. A. (2015). Use of a self-monitoring application to reduce stereotypic behavior in adolescents with autism: A preliminary investigation of I-Connect. *Journal of Autism and Developmental Disorders, 45*(5), 1146–1155. doi:10.1007/s10803-014-2272-x

Daly, P.M., & Ranalli, P. (2003). Using countoons to teach self-monitoring skills. *Teaching Exceptional Children, 35*(5), 30-35. doi:10.1177/004005990303500504

Davis, J. L., Mason, B. A., Davis, H. S., Mason, R. A., & Crutchfield, S. A. (2016). Self-monitoring interventions for students with autism: A meta-analysis of school-based research. *Journal of Autism and Developmental Disabilities, 3*(3), 196-218. doi:10.1007/s40489-016-0076-y

Dawson, G., & Watling, R. (2000). Interventions to facilitate auditory, visual, and motor integration in autism: A review of the evidence. *Journal of Autism and Developmental Disorders, 30*, 415–421.

Dunlap, G., & Johnson, J. (1985). Increasing the independent responding of autistic children with unpredictable supervision. *Journal of Applied Behavior Analysis, 18*(3), 227-236. doi:10.1901/jaba.1985.18-227

Fantuzzom J.W., & Polite, K. (1990). School-based, behavioral self-management: A review and analysis. *School Psychology Quarterly, 5*(3),180-198. http://dx.doi.org/10.1037/h0090612

Finn, L., Ramasamy, R., Dukes, C., & Scott, J. (2015). Using watchminder to increase on-task behavior in students with autism spectrum disorders. *Journal of autism and Developmental Disorders, 45,* 1408-1418. doi: 10.1007/s10803-014-2300-x

Ganz, J. B., & Sigafoos, J. (2005). Self-monitoring: Are young adults with MR and autism able to utilize cognitive strategies independently? *Education and Training in Developmental Disabilities, 40*(1), 24–33.

Gertz, J. (2000). Evaluating Behavioral Treatment of Disruptive Classroom Behaviors of an Adolescent with Autism. *Research on Social Work Practice*, 10(1), 98-110. doi:10.1177/15527581-00010001-09

Giangreco, M. F., & Broer, S. M. (2007). School-based screening to determine overreliance on paraprofessionals. *Focus on Autism and Other Developmental Disabilities, 22*(3), 149-158. doi:10.1177/10883576070220030201

Gresham, F.M. (2004). Current status and future directions of school-based behavioral interventions. *School Psychology Review, 33*(3), 326-343.

Gulchak, D.J. (2008). Using a mobile handheld computer to teach a student with an emotional and behavioral disorder to self-monitor attention. *Education and Treatment of Children, 31*(4), 567-581. doi: 10.1353/etc.0.0028

Hallahan, D. P., & Kauffman, J. M. (2000). *Exceptional learners: Introduction to special education* (8th ed.). Boston: Allyn and Bacon.

Heflin, L.J., & Alaimo, D.F. (2007) *Students with ASD spectrum disorders: Effective instructional practices.* Upper Saddle River, New Jersey: Pearson Education Inc.

Hillier, A., Fish, T., Cloppert, P., & Beversdorf, D.Q. (2016). Outcomes of a social and vocational skills support group for adolescents and young adults on the autism spectrum. *Focus on Autism and Other Developmental Disabilities, 22*(2), 107-115. doi:10.1177/10883576070220020201

Hoff, K. E., & DuPaul, G. J. (1998). Reducing disruptive behavior in general education classrooms: The use of self-management strategies. *School Psychology Review, 27,* 290-303.

Horner R., Carr E., Halle J., McGee G., Odom S., Wolery M. (2004). The use of single-subject design research to identify evidence-based practice in special education. *Exceptional Children, 71*, 165–179. doi: 10.1177/001440290507100203

Hughes, C., Copeland, S. R., Agran, M., Wehmeyer, M., L., Rodi, M. S., & Presley, J. A. et al., (2002). Using self-monitoring to improve performance in general education high school classes. *Education and Training in Mental Retardation Developmental Disabilities, 37*, 262–272.

Hume, K., Boyd, B.A., Hamm, J.V., & Kucharczyk, S. (2014). Supporting independence in adolescents on the autism spectrum. *Remedial and Special Education, 35*(2), 102-113. doi: 10.1177/0741932513514617

Hume, K., Loftin, R., & Lantz, J. (2009). Increasing independence in autism spectrum disorders: A review of three focused interventions. *Journal of ASD and Developmental Disorders*, *39*, 1329–1338. doi: 10.1007/s10803-009-0751-2

Iovanne, R., Dunlap, G., Huber, H., & Kincaid, D. (2003). Effective educational practices for students identified as having autism spectrum disorders. *Focus on Autism and Other Developmental Disabilities, 18* (3), 150-165.

Kanfer, F.H. (1975). Self-amangement methods. In F.H. Kanfer & A.P. Goldstein (Eds.), *Helping people change.* New York: Pergamon, 1975.

Kazdin, A. E. (1977). Assessing the clinical or applied significance of behavior change through social validation. *Behavior Modification*, *1*(4), 427–452. doi: 10.1177/014544557714001

Kazdin, A. E. (1982). *Single-case research designs: Methods for clinical and applied settings.* New York, NY: Oxford University Press.

King-Sears M. E. (2008). Using teacher and researcher data to evaluate the effects of self-management in an inclusive classroom. *Preventing School Failure, 52*(4), 25–36

Koegel, R. L., & Koegel, L. K. (1990). Extended reductions in stereotypic behavior of students with autism through a self-management treatment package. *Journal of Applied Behavior Analysis, 23*(1), 119–127. http://doi.org/10.1901/jaba.1990.23-119

Koegel, L., Matos-Fredeen, R., Lang, R., & Koegel, R. (2011). Interventions for children with autism spectrum disorders in inclusive school settings. *Cognitive and Behavioral Practice, 18*(3), 421-588. https://doi.org/10.1016/j.cbpra.2010.11.003

Koegel, L. K., Park, M. N., & Koegel, R. L. (2014). Using self-management to improve the reciprocal social conversation of children with autism spectrum disorder. *Journal of Autism and Developmental Disorders, 44*(5), 1055–1063. doi:10.1007/s10803-013-1956-y

Lee, S., Simpson, R.L., & Shogren, K.A. (2007). Effects and implications of self-management for students with autism: A meta-analysis. *Focus on Autism and Other Developmental Disabilities*, *22*, 2-13. doi:10.1177/10883576070220010101

Legge, D. B., DeBar, R. M., & Alber-Morgan, S. R. (2010). The effects of self-monitoring with MotivAider [R] on the on-task behavior of fifth and sixth graders with ASD and other disabilities. *Journal of Behavior Assessment and Intervention in Children*, *1*(1), 43–52. doi:10.1007/s10803-014-2300-x

Lerman, D. C., Vorndran, C., Addison, L., & Kuhn, S. A. (2004). A rapid assessment of skills in young children with autism. *Journal of Applied Behavior Analysis*, *37*(1), 11–26. http://doi.org/10.1901/jaba.2004.37-11

Levy, A., & Perry, A. (2008). Transition of children with autism from intensive behavioral intervention programs into the school system. *Journal on Developmental Disabilities, 14*(1), 1-10.

Lewis, V., & Boucher, J. (1988). Spontaneous, instructed and elicited play in relatively able autistic children. *British Journal of Developmental Psychology, 6,* 325-339. doi: 10.1111/j.2044-835X.1988.tb01105.x

Lohrmann, S., & Bambara, L.M. (2006). Elementary education teachers' beliefs about essential supports needed to successfully include students with developmental disabilities who engage in challenging behaviors. *Research and Practice for Persons with Severe Disabilities, 31*, 157-173.

Machalicek, W. O'Reilly, M.F., Beretvas, N., Sigafoos, J., & Lancioni, G.E. (2007). A review of interventions to reduce challenging behavior in school settings for students with autism spectrum disorders. *Research in Autism Spectrum Disorders, 1*(3), 229-246. https://doi.org/10.1016/j.rasd.2006.10.005

Mancina, C., Tankersley, M., Kamps, D., Kravits, T., & Parrett, J. (2000). Brief reports brief report: reduction of inappropriate vocalizations for a child with ASD using a self-management treatment program*. Journal of Autism and developmental disorders*, *30*(6), 599-606.

McCloskey, G., Perkins, L.A., & Van Diviner, B. (2008). *Assessments and Intervention for Executive Function Difficulties*. New York, New York: Taylor & Francis Group.

McDonald, T., & Machalicek, W. (2013). A systematic review of intervention research including adolescents with autism spectrum disorders: 1980-2011. *Research in Autism Spectrum Disorders, 7*(11), 1439-1460.

Morrison, L., Kamps, D., Garcia, J., & Parker, D. (2001). Peer mediation and monitoring strategies to improve initiations and social skills for students with autism. *Journal of Positive Behavior Interventions, 3*, 237–250. doi:10.1177/109830070100300405

Myles, B. S., & Simpson, R. L. (2002). Asperger syndrome: An overview of characteristics. *Focus on Autism and Other Developmental Disabilities*, *17*, 132–137. doi:10.1177/10883576020170030201

National Autism Center. (2015). *National Standards Report*. Retrieved from http://www.nationalautismcenter.org/national-standards-project/results-reports/

Nelson, J. R., Smith, D. J., Young, R. K., & Dodd, J. M. (1991). A review of self-management outcome research conducted with students who exhibit behavioral disorders. *Behavioral Disorders, 16*, 169-179.

Odom, S. L., Cox, A. W., & Brock, M. E. (2013). Implementation science, professional development, and autism spectrum disorders. *Exceptional Children, 79*, 233-251. doi:10.1177/001440291307900207

Odom, S.L., Collet-Klingenberg, L., Rogers, S.J., & Hatton, D. (2010). Evidence-based practices in intervention and youth with autism spectrum disorders. *Preventing School Failure, 54*(4), 275-282. doi:10.1080/10459881003785506

Palermo, T M., Valenzuela, D., & Stork, P. P. (2003). A randomized trial of electronic versus paper pain diaries in children: Impact on compliance, accuracy, and acceptability. *Pain, 107*, 213-219. doi: 10.1016/j.pain.2003.10.005

Parker, D., & Kamps, D. (2011). Effects of task analysis and self-monitoring for children with autism in multiple social settings. *Focus on Autism and Other Developmental Disabilities, 26*(3), 131-142. doi:10.1177/1088357610376945

Peterson, L.D., Young, K.R., Salzberg, C.L., West, R.P., & Hill, M. (2006). Using self-management procedures to improve classroom social skills in multiple general education settings. *Education and Treatment of Children, 29*(1), 1-21.

Pierce, K., & Schriebman, L. (1997). Using peer trainers to promote social behavior in ASD: Are they effective at enhancing multiple social modalities? *Focus on Autism and Other Developmental Disabilities, 12*, 207–218. doi:10.1177/108835769701200403

Rachlin, H. (1974). Self-control. *Behaviorism, 2,* 94-104.

Reynolds, S., Urruela, M., & Devine, D. P. (2013). Effects of environmental enrichment on repetitive behaviors in the BTBR T+tf/J mouse model of ASD. *Autism Research*, *6*(5), 337–343. doi: 10.1002/aur.1298

Rock, M. L. (2005). Use of strategic self-monitoring to enhance academic engagement, productivity, and accuracy of students with and without disabilities. *Journal of Positive Behavioral Interventions, 7*, 3–17.

Rock, M.L., & Thead, B.K. (2007). The effects of fading a strategic self-monitoring intervention on students' academic engagement, accuracy, and productivity. *Journal of Behavioral Education, 16*(4), 389-412. Retrieved from http://www.jstor.org/stable/41824418

Rosenbloom, R. N., Mason, R. A., Wills, H. P., & Mason, B. A. (2016). Technology delivered self-monitoring application to promote successful inclusion of an elementary student with autism. *Assistive Technology. 28* (1) 9-16.

Rouse, C.A., Everhart-Sherwood, J.M., & Alber-Morgan, S.R. (2014). Effects of self-monitoring and recruiting teacher attention on pre-vocational skills. *Education and Training in Autism and Developmental Disabilities, 49*(2), 313–327.

Rutherford, R. B., Quinn, M. M., & Mathur, S. R. (1996). *Effective strategies for teaching appropriate behaviors to children with emotional/behavioral disorders.* Reston, VA: Council for Children with Behavioral Disorders.

Simpson, R. L., & Myles, B. S. (1998). Aggression among children and youth who have Asperger's syndrome: A different population requiring different strategies. *Preventing School Failure*, *42*, 149–153.

Smith, T. (2001). Discrete trial training in the treatment of autism. *Focus on Autism and Other Developmental Disabilities, 16*(2), 86-92. doi:10.1177/108835760101600204

Smith, B.W., & Sugai, G. (2016). A self-management functional assessment-based behavior support plan for a middle school student with EBD. J*ournal of Positive Behavior Interventions*, *2*(4), 208 – 217. doi:10.1177/109830070000200405

Soares, D.A., Vannest, K.J., and Harrison, J. (2009). Computer aided self-monitoring to increase academic production and reduce self-injurious behavior in a child with autism. *Behavioral Interventions, 24*, 171-183. doi:10.1002/bin.283

Southall, C.M., & Gast, D.L. (2011). Self-management procedures: A comparison across the autism spectrum. *Education and Training in Autism and Developmental Disabilities, 46*(2), 155-171.

Stage, S. A., & Quiroz, D. R. (1997). A meta-analysis of interventions to decrease disruptive classroom behavior in public education settings. *School Psychology Review, 26,* 333–368.

Stahmer, A. C., & Schreibman, L. (1992). Teaching children with autism appropriate play in unsupervised environments using a self-management treatment package. *Journal of Applied Behavior Analysis*, *25*(2), 447–459. http://doi.org/10.1901/jaba.1992.25-447

State, T.M., & Kern, L. (2012). A comparison of video feedback and in vivo self-monitoring on the social interactions of an adolescent with asperger syndrome. *Journal of Behavioral Education, 21*, 18-33. doi: 10.1007/s10864-011-9133-x

Strain, P.S., Wilson, K., Dunlap, G. (2011). Prevent-teach-reinforce: addressing problem behaviors of students with autism in general education classrooms. *Behavioral Disorders, 36*(3), 160-171.

Sutherland, K., & Wehby, J.H. (2001). The effect of self-evaluation on teaching behavior in classrooms for students with emotional and behavioral disorders. *Journal of Special Education, 35*(3), 161-171. doi:10.1177/002246690103500306

The National Professional Development Center on Autism Spectrum Disorders. (2014). *Evidence-based practices*. Retrieved from http://ASDpdc.fpg.unc.edu/

Tiger, J.H., Fischer, W.W., & Bouxsein, K.J. (2009). Therapist- and self-monitored DRO contingencies as a treatment for the self-injurious skin picking of a young man with asperger syndrome. *Journal of Applied Behavior Analysis, 42*(2), 315-319.

Tobin, T., & Sprague, J. (2000). Alternative education strategies: Reducing violence in school and the community. *Journal of Emotional and Behavioral Disorders*, *8*(3), 177-186. doi:10.1177/106342660000800305

U.S. Department of Education. National Center for Education Statistics. (1994). *Curricular differentiation in public high schools*. (Report No. NCES 95-360). Washington, D.C.

Vaughn, S., Bos, C. S., & Schumm, J. S. (2000). *Teaching exceptional, diverse, and at-risk students in the general education classroom* (2nd ed.). Boston: Allyn and Bacon.

What Works Clearinghouse. (2016). *Procedures and standards handbook (version 2.0).* Retrieved August 10, 2016, from http://ies.ed.gov/ncee/wwc/references/idocviewer/doc.aspx?docid=19&tocid=1

Wills, H. P., & Mason, B. A. (2014). Implementation of a self-monitoring application to improve on-task behavior: A high school pilot study. *Journal of Behavioral Education, 23*(4), 421–434. doi:10.1007/s10864-014-9204-x

Wilkinson, L.A. (2008). Self-management for children with high-functioning autism spectrum disorders. *Intervention in School and Clinic, 43*(3), 150-157. doi:10.1177/1053451207311613

Webber, J., Scheuermann, B., McCall, C., & Coleman, M. (1993). Research on self-monitoring as a behavior management technique in special education classrooms: A descriptive review. *Remedial & Special Education, 14*(2), 38-56.

Wehmeyer, M. L., Hughes, C., Agran, M., Garner, N., & Yeager, D. (2003). Student directed learning strategies to promote the progress of students with intellectual disability in inclusive classrooms. *International Journal of Inclusive Education, 7*(4), 415–428. doi:10.1080/1360311032000110963

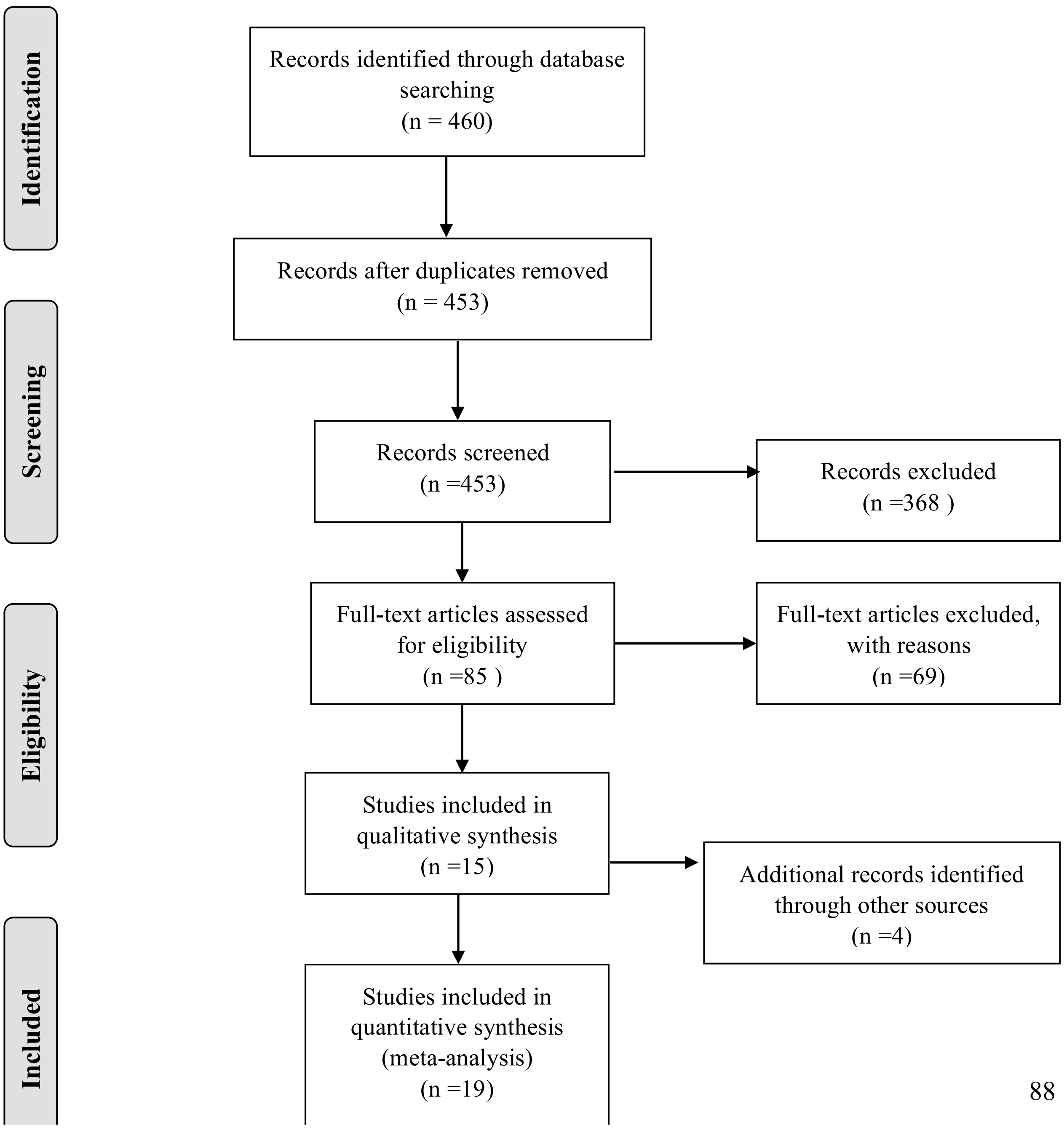
Wehmeyer, M. L., & Palmer, S. B. (2003). Adult outcomes for students with cognitive disabilities three years after high school: The impact of self-determination. *Education and Training in Developmental Disabilities, 38*, 131–144.

Wolf, M. M. (1978). Social validity: The case for subjective measurement or how applied behavior analysis is finding its heart. *Journal of Applied Behavior Analysis,* 11, 203–214. doi:10.1901/jaba.1978.11-203

Zirpoli, T. J. (2012). *Behavior management: Positive applications for teachers.* Upper Saddle River, N.J.: Pearson.

Appendices

Appendix A. Literature Review Flow Diagram



Appendix B. I –Connect SM Application Screen Shot

Appendix C. Data Collection Sheet

Participant Initials	Date	Time/Duration	Observer	Classroom

Data Point									Reliability	Reliability Observer	Reliability On-task %
BL/I/R/I/M	1	2	3	4	5	6	7	8	Yes ☐ No ☐		

	10 S	20 S	30 S	40 S	50 S	60 S
Min 1	+ - BV BD	+ - BV BD	+ - BV BD	+ - BV BD	+ - BV BD	+ - BV BD
Min 2	+ - BV BD	+ - BV BD	+ - BV BD	+ - BV BD	+ - BV BD	+ - BV BD
Min 3	+ - BV BD	+ - BV BD	+ - BV BD	+ - BV BD	+ - BV BD	+ - BV BD
Min 4	+ - BV BD	+ - BV BD	+ - BV BD	+ - BV BD	+ - BV BD	+ - BV BD
Min 5	+ - BV BD	+ - BV BD	+ - BV BD	+ - BV BD	+ - BV BD	+ - BV BD
Min 6	+ - BV BD	+ - BV BD	+ - BV BD	+ - BV BD	+ - BV BD	+ - BV BD
Min 7	+ - BV BD	+ - BV BD	+ - BV BD	+ - BV BD	+ - BV BD	+ - BV BD
Min 8	+ - BV BD	+ - BV BD	+ - BV BD	+ - BV BD	+ - BV BD	+ - BV BD
Min 9	+ - BV BD	+ - BV BD	+ - BV BD	+ - BV BD	+ - BV BD	+ - BV BD
Min 10	+ - BV BD	+ - BV BD	+ - BV BD	+ - BV BD	+ - BV BD	+ - BV BD

KEY:

TIME SAMPLING:

"+"= On-task: actively engaged with instructional content in the form of reading, writing, and/or actively completing an assigned task

"-" = Off-task: not actively participating in academic relevant behaviors, staring off, playing a game, and/or exhibiting pre-defined off-task behaviors a minimum of three second

PARTIAL INTERVAL:

BV=Behavior Verbal: Vocal stereotypy, classroom disruption (i.e., emits noise above appropriate classroom level), mouthing non-academic words humming

BD: Behavior Disruptive: Snapping fingers, clapping loudly, banging on table, rocking chair.

Percentage of Intervals On-Task	Percentage of Intervals BV	Percentage of Intervals BD

Notes/Task:

Appendix D. Fidelity Sheet

I-Connect Plus Self-Monitoring Rosenbloom Dissertation
Procedural Fidelity Checklist

Participant Initials	**Date**		**Time/Duration**	**Observer**	**Classroom**
Condition/Data Pt.	**Reliability**		**Reliability Observer**	**Reliability %**	
	Yes	No			

I-Connect SM Session Procedures			
1. Student was instructed by teacher to begin task	☐Yes	☐ No	
2. Teacher was not sitting with student during session	☐Yes	☐ No	
3. Classroom staff did not interrupt student during this independent work time. * If no, what was the frequency of the interruptions:	☐Yes	☐ No	
4. Session did not have to end due to problem behavior	☐Yes	☐ No	
5. Teacher prompted student at 5 minute mark if student was off-task for the first 5 minutes	☐Yes	☐ No	☐ NA
6. Student was given device at the beginning of the session	☐Yes	☐ No	☐ NA
7. Student was instructed to press start on the device	☐Yes	☐ No	☐ NA
8. Student used the device for 90% (27/30) of intervals	☐Yes	☐ No	☐ NA
9. Device was working properly throughout the entire session	☐Yes	☐ No	☐ NA
10. If student missed an interval prompt, the researcher prompted the student to respond during the next interval	☐Yes	☐ No	☐ NA
11. If the student completed the assignment before the 10 minute data collection session was completed, the teacher instructed the student to begin the next task and reminded them to stay on-task	☐Yes	☐ No	☐ NA

***Subtract N/A when computing your totals**

Notes:

Total Score: _______________

Total Score Possible: _________

Percent Fidelity: ___________

Reliability of Fidelity: ______

Appendix E. Participant and Teacher Social Validity

Participant ID:______________ Date:______________

Participant Satisfaction Survey

Please assess this student's academic or learning behaviors in your classroom when they are using the I-Connect application.

	When I was using the I-CONNECT device I found that…"		
1.	Getting started with assignments was easier	**YES**	**NO**
2.	I was able to stay on-task	**YES**	**NO**
3.	I was able to complete my work faster	**YES**	**NO**
4.	I was able to get more work done	**YES**	**NO**

	Overall impression of intervention/device		
1.	Easy to use	**YES**	**NO**
2.	Was not intrusive (define intrusive for participant if needed)	**YES**	**NO**
3.	Satisfied with the device	**YES**	**NO**
4.	Would like to continue to use the intervention	**YES**	**NO**

What was your favorite part of using the device?

Was there anything you did not like about the device? If so, what…

Would you change anything about the device?

Appendix E. Participant and Teacher Social Validity (Continued)

Student:_____________ Teacher/Implementer:______________

Teacher Satisfaction Survey

Please assess this student's academic or learning behaviors in your classroom when they are using the I-Connect application.

	"When my student used the I-Connect application I observed the following results…"					
1.	Getting started with assignments	1 **Significantly Worse**	2 **Worse**	3 **Same**	4 **Better**	5 **Significantly Better**
2.	On-task behavior	1 **Significantly Worse**	2 **Worse**	3 **Same**	4 **Better**	5 **Significantly Better**
3.	Completing Work	1 **Significantly Worse**	2 **Worse**	3 **Same**	4 **Better**	5 **Significantly Better**
4.	Classroom disruption	1 **Significantly Worse**	2 **Worse**	3 **Same**	4 **Better**	5 **Significantly Better**
5.	Productivity	1 **Significantly Worse**	2 **Worse**	3 **Same**	4 **Better**	5 **Significantly Better**

	Overall impression of intervention/device					
1.	Easy to implement	1 **Strongly Disagree**	2 **Disagree**	3 **Neither**	4 **Agree**	5 **Strongly Agree**
2.	Not intrusive	1 **Strongly Disagree**	2 **Disagree**	3 **Neither**	4 **Agree**	5 **Strongly Agree**
3.	Satisfied with the intervention	1 **Strongly Disagree**	2 **Disagree**	3 **Neither**	4 **Agree**	5 **Strongly Agree**
4.	Would like to continue to use the intervention	1 **Strongly Disagree**	2 **Disagree**	3 **Neither**	4 **Agree**	5 **Strongly Agree**
5.	Did not notice any inconsistencies when in use	1 **Strongly Disagree**	2 **Disagree**	3 **Neither**	4 **Agree**	5 **Strongly Agree**

Additional comments regarding student's behavior change and/or satisfaction with intervention/device:

Appendix F. Training Fidelity

Participant Initials	Date	Time/Duration	Trainer

I-Connect SM Training Procedures		
Instruction		
1. Provide definition of self-monitoring and on-task behavior	☐Yes	☐ No
2. Provide rationale for using SM and increasing on-task behavior (e.g., get more work done, learn more, etc.)	☐Yes	☐ No
Modeling Engagement Behaviors		
1. Show participant what on-task and off-task behaviors look. Model this behavior three times each. Make sure you are clear that we are aiming to increase *on-task* behaviors. ☐ ☐ ☐ On-task ☐ ☐ ☐ Off-task	☐Yes	☐ No
Rehearsal/Role Play + Feedback		
1. Role play with the participant. Pretend to either role-play on-task or off-task behaviors and have the participant tell you which is being portrayed. Participant must get 4/6 correct before moving on. *If participant does not meet criteria, then go back to Modeling- Step 1 and then set up the role play scenario again) ☐ ☐ ☐ ☐ ☐ ☐ extra: ☐ ☐ ☐ ☐ ☐ ☐/ ☐ ☐ ☐ ☐ ☐ ☐	☐Yes	☐ No
2. Provide feedback and positive praise for correct responding to the responses during role play	☐Yes	☐ No
Training I-Connect Device		
1. Show participant how to use the device (e.g., click start, select notification prompt)	☐Yes	☐ No
2. Model for participant how to use the device during task *Demonstrate appropriate on-task behaviors	☐Yes	☐ No
3. Allow participant to rehearse with the device for 5 intervals and provide praise for correct responding and feedback for incorrect responding to the device ☐ ☐ ☐ ☐ ☐	☐Yes	☐ No
4. Participant practices using the device during an independent work task. The participant must respond to 80% of the prompts displayed during a 10-minute work session in-order to meet criteria for a phase change (i.e., training → intervention). *If the participant does not meet criteria then go re-do *Training-Steps 1-4* until criteria is met	☐Yes	☐ No

Notes:

Percent Fidelity: _______