

Evaluating an eHealth Case Management System in an Intensive Behavioural Intervention

Program

by

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A Thesis submitted to the Faculty of Graduate Studies of

The University of Manitoba

In partial fulfillment of the requirements of the degree of

MASTER OF ARTS

Department of Psychology

University of Manitoba

Winnipeg

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### Abstract

EIBI is a treatment program designed to increase adaptive behaviour and decrease maladaptive behaviours for children with ASD. The current standard of data collection used by EIBI programs is paper-and-pencil. Participants were three Autism Consultants and one Autism Senior Tutor currently employed in a large, community-based EIBI program. Differences between accuracy of collecting DTT and challenging behaviour data using paper-and-pencil and an eHealth tool (TNAC®) were examined. Questions regarding the social validity of both methods of data collection were also examined. There were no substantial differences between collecting DTT and challenging behaviour data using paper-and-pencil or TNAC®. However, respondents indicated in the social validity questionnaires that, overall, paper-and-pencil was the preferred method to collect data across all categories. These findings suggest that using an eHealth tool for data collection could provide benefits to an EIBI program if the social validity components are addressed.

*Keywords:* eHealth, EIBI, data collection, accuracy, social validity

## **Evaluating an eHealth Case Management System in an Intensive Behavioural Intervention**

A rise in prevalence of children diagnosed with Autism Spectrum Disorder (ASD) has increased the demand for early intensive behavioural intervention (EIBI). EIBI is the only empirically validated treatment for ASD. While there are several core features of EIBI that contribute to the overall success of the treatment, there are also challenges with delivering this treatment. For individuals accessing EIBI through a publicly funded community-based service provider, challenges related to treatment fidelity, time requirements, and communication can occur. These challenges can potentially be addressed using an eHealth tool for client management. In the following sections I will discuss the prevalence and diagnostic criteria for ASD, the core features of a successful EIBI program, challenges associated with treatment delivery, and how eHealth solutions could resolve these challenges. I will then describe an experimental evaluation of an eHealth case management system in the context of a community-based EIBI program.

Autism Spectrum Disorder (ASD) is a neurodevelopmental disorder that creates marked impairments in several areas including language acquisition and social interactions, as well as difficulties engaging in typical daily behaviours (Carter & Scherer, 2013). Individuals with ASD are characterized by poor or deficient interpersonal interactions, rigid and repetitive behaviours, and limited interests overall (Anagnostou et al., 2014). Prior to the release of the fifth edition of the *Diagnostic and Statistical Manual of Mental Disorders*, Autistic Disorder, Pervasive Developmental Disorder Not Otherwise Specified, Rett's Disorder, Asperger's Disorder, and Childhood Disintegrative Disorder were all categorized under the greater umbrella of Pervasive Developmental Disorders (Gensler, 2012). All the disorders are now classified under the single

term, “Autism Spectrum Disorders,” in an attempt to help clarify ASD diagnosis, eliminate ambiguous symptomology, and inform clinical decision making on the extent of provisions and services required for the individual diagnosed (Gensler, 2012). The exact cause of ASD has not yet been identified. However, recent studies suggest that a combination of genetics, phenotypic expression, and other environmental factors contribute to the overall influence/causation of ASD (Anagnostou et al, 2014; Carter & Scherer, 2013; Freitag & Konrad, 2014).

### **Prevalence and Diagnosis**

The Centres for Disease Control and Prevention (CDC) estimates the prevalence of ASD at 1 in every 88 children (Anagnostou et al., 2014; Manning-Courtney et al., 2013). In addition, it is estimated that approximately 67,000 individuals are currently diagnosed with ASD in Canada (Anagnostou et al., 2014). Prevalence is increasing, for reasons not yet known (Manning-Courtney et al., 2013; Ouelette-Kuntz et al., 2013). The prevalence of ASD has a significant impact on society, on the families of individuals diagnosed with ASD, and on the individuals themselves.

Parents or caregivers are typically the first people to identify typical characteristics of ASD, and have done so often before twenty four months of the child’s life (Anagnostou et al., 2014; Martinez-Pedraza & Carter, 2009; Ouelette-Kuntz et al., 2009; Matson, Wilkins, & Gonzalez, 2008). Features such as minimal or decreased eye contact, absence of joint-attention, limited or non-existent engagement in social or imaginative play, and poor receptive and expressive language are often reported (Manning-Courtney et al., 2013). Associations concerned with the health of children, such as The American Academy of Pediatrics, encourage parents and caregivers to take their children to a pediatrician for screening earlier than 18 months of age and no later than two years of age (Anagnostou et al., 2014; Manning-Courtney et al., 2013;

Martinez-Pedraza & Carter, 2009; Matson et al., 2008). Although several research studies have concluded that ASD can be diagnosed reliably by the age of two, it is often diagnosed between ages three and four, with the average diagnosis occurring at four years of age (Anagnostou et al., 2014; Matson et al., 2008; Ouellette-Kuntz et al., 2009). Accuracy of the diagnosis increases significantly if the child is diagnosed at four years of age or later (Martinez-Pedraza & Carter, 2009).

### **Early Intensive Behavioural Intervention (EIBI)**

EIBI is a treatment for ASD designed to improve and increase adaptive behaviours (interpersonal communication, socialization, requesting, etc.), decrease undesirable and maladaptive behaviours (self-injurious behaviours, rigid and repetitive behaviours, bizarre vocalizations, self-stimulatory behaviours, etc.), increase academic skills, and promote independent daily functioning (e.g., routine, personal hygiene, feeding and dressing skills, etc.). Established by Ivaar Lovaas in 1987, EIBI utilizes methods, principles, and applications from applied behaviour analysis to create a comprehensive, controlled, and systematic treatment package for individuals with ASD (Foxy, 2008; Reichow, Barton, Boyd & Hume, 2012). EIBI is considered the gold standard and preferred method of treatment for individuals with ASD. It is a treatment supported by a well-established, large body of scientific literature (Eldevik, Hastings, Jahr, & Hughes, 2012; LeBlanc & Gillis, 2012; Luiselli, 2008; Matson & Jang, 2014; Peters-Scheffer, Didden, Korzilius, & Sturmey, 2011; Reichow et al., 2012; Virues-Ortega, 2010).

### **Characteristics of EIBI**

A complementary characteristic to treatment intensity is the instructor-to-child treatment ratio. A 1:1 instructor to child ratio is ideal for EIBI service delivery in order to promote skill acquisition and develop a positive rapport with the child. Delivering EIBI at a 1:1 ratio in the

initial stages of treatment allows for greater acquisition of skills that are prerequisites for group instruction, observational learning, and instruction in natural settings (Foxx, 2008; LeBlanc & Gillis, 2012; Virues-Ortega, 2010).

Another characteristic of efficacious and successful EIBI service delivery is the use of discrete-trials teaching (DTT). DTT is a procedure used commonly within a comprehensive curriculum that combines methods of operant conditioning such as positive reinforcement, shaping, prompting, and errorless teaching to teach targeted skills to children with ASD (Downs & Downs, 2013; Love et al., 2009). In detail, DTT involves the instructor directly delivering an antecedent to the child, waiting for the child to respond to the instruction, and then providing a consequence to the child based on whether the child responded correctly or incorrectly to the instruction. This would be considered one trial. As an example, an instructor might place a picture of a book and a cup in front of the child and deliver the instruction, “show me the book”. Together, the presentation of the stimuli with the instruction, serves as the antecedent. If the child correctly selects the book, the response is followed by praise and positive reinforcement. However, if the child incorrectly selects the cup, the instructor would re-present the trial with the exact antecedent, prompt the child (perhaps with a gestures or physically moving their hand) to select the book, and follow the response with neutral praise.

Ongoing collection and assessment of data is essential for efficacious and successful EIBI delivery (Tarbox, Wilke, Findel-Pyles, Bergstrom, & Granpeesheh, 2010). Kazdin (2011) describes on-going collection and measurement of data as the continuous observation prior to, during, and after the intervention is implemented, with the intention of allowing the investigator to assess the pattern and consistency of the individual’s behaviour over time. Ultimately, the

purpose is to inform clinical decisions regarding the treatment package that is to be delivered to the child.

Parental involvement is another important feature of effective EIBI (Foxx, 2008; Hayward, Gale, & Eikseth, 2009; Leblanc & Gillis, 2012; Peters-Scheffer et al., 2011). Parents play a significant role in the generalization of the skills their child has acquired during EIBI service delivery. It is common that once a child has mastered skills with a tutor first, a parent will be asked to test for generalization the specific skill by presenting occasions for it in the natural environment. If the child successfully performs the skill with the parent, the parent is also responsible for the maintenance of that skill. This involves the parents ensuring that they have the child perform the skill on a frequent or intermittent basis. Having children engage in certain behaviours intermittently supports long-term maintenance of skills, which is essential due to the relatively brief span of EIBI treatment in relation to the child's lifespan. Also, when a child is enrolled in an EIBI program, parents are the primary source of information regarding the child's behaviour outside of sessions, potential reinforcers that can be used during treatment delivery, or other health information that could possibly interact with the child's performance during the 1:1 delivery time (Foxx, 2008).

### **Treatment Delivery Challenges**

When delivered properly, EIBI treatment can provide favourable outcomes for some individuals with ASD, such as an IQ score in average range for the child's age, full integration into mainstream classrooms, and significant decreases and/or elimination of stereotypical behaviour to the point where the child could not be distinguished from the typically functioning children in their cohort (LeBlanc & Gillis, 2012). These outcomes are highly desirable for the



individuals, the individuals' families, and society in general. Unfortunately, there are significant challenges associated with treatment delivery, especially in publicly funded community settings.

EIBI service delivery presents several similar difficulties as all public health service settings (LeBlanc, Gravina, & Carr, 2009). Other challenges are unique to EIBI service delivery. Three general themes have emerged in the recent literature: challenges with treatment fidelity, time requirements, and communication and collaboration (Bryson, Koegel, Koegel, Openden, Smith, Nefdt, 2007; Dymond, Gilson, & Myran, 2007; Eikseth, Klintwall, Jahr, & Karlsson, 2012; Jacobson & Mulick, 2000; LeBlanc et al., 2009; Matson & Jang, 2014; Murphy & Ruble, 2012; Rivard, Terroux, & Mercier, 2014; Stahmer, 2007; Symes, Remington, Brown & Hastings, 2006).

**Treatment fidelity.** It is important to differentiate between EIBI treatment integrity and EIBI treatment fidelity. Treatment integrity in EIBI refers to the ability of the behaviour analyst or consultant to design an individualized, comprehensive treatment package for the child, whereas treatment fidelity refers to the ability of the therapist or tutor to implement that treatment package consistently on a daily basis (Symes et al, 2006). The specific challenges with treatment fidelity mostly relate to lack of supervision, children who present more challenging behaviours than others, poorly educated/trained staff, and providing services in rural areas.

For example, Symes et al., (2006) conducted a study to identify which features of EIBI helped staff to achieve high treatment fidelity in the delivery of services, and which features of EIBI challenged treatment fidelity. Nineteen participants who provided direct 1:1 EIBI service delivery were questioned on topics such as supervision, their personal qualities, the children's personal qualities, session characteristics, and training characteristics. The results of this study

demonstrated that continuous supervision and feedback in many EIBI service delivery programs do not occur with the optimal level of regularity that the treatment demands in order to produce the most desirable results for the child receiving services. Furthermore, tutors preferred to work with children who displayed less challenging, or undesirable behaviours. The researchers concluded that better treatment fidelity would be established if more supervision would be afforded to the EIBI service providers in the community who have children who in engage in more challenging behaviours.

Similarly, Jacobson and Mulick (2000) proposed factors that are strong determinants of high treatment fidelity. These factors were the degree of support provided by the behaviour analyst or supervisor to the staff member responsible for implementing the treatment, the knowledge and proficiency of the supervisor, and the approaches that the supervisors took to provide support to the staff member (e.g., extra training sessions, increased interobserver agreement, and increased feedback).

The reason that strong supervision is necessary for effective EIBI seems to be not only due to the behavioural characteristics of the child, but also due to limited staff training and education; that is, often times the staff members who are charged with delivering 1:1 EIBI have minimal experience or do not have an educational background in ABA (Eikseth et al., 2012). While having an educational background in ABA is not a requirement or a predictor in the therapist's success for delivering 1:1 EIBI services, having minimal time to train or a restricted exposure to a variety of teaching opportunities can create challenges for staff to maintain high treatment fidelity (Stahmer, 2007).

Treatment fidelity may be a particular challenge for rural families receiving EIBI. Murphy and Ruble (2012) utilized parent reports to understand issues and concerns felt by

families in rural compared to urban areas. The results confirmed that it was more difficult to obtain adequately skilled service providers in rural communities as opposed to city communities. Given that high treatment fidelity in community EIBI service delivery is very valuable, facilities that are responsible for delivering EIBI services to children with ASD and their families need to require consistency in all aspects of service delivery regardless of geographical location (Bryson et al., 2007).

**Time requirements.** Many aspects of EIBI service delivery are time-intensive. Time is a vital and limited commodity to a consultant, who in most cases, is charged with the “clinical responsibility for intervention decisions, fidelity of treatment, monitoring of child progress, and satisfaction of parents and others involved in the child’s care and education” (Bryson et al., 2007, p. 143). It takes a consultant an extensive amount of time to construct a comprehensive, individualized treatment plan for each child under her or his care, due to the fact that these plans utilize several different ABA methods, across several different areas of teaching that aim to teach adaptive behaviours and decrease challenging behaviours and maintain previously learned skills.

After treatment plans are implemented, consultants also need to continually assess the data being collected by the tutor in order to determine whether the treatment plan is succeeding, needs modifications, or needs to be re-modeled completely. This also takes a considerable amount of time as each child’s learning needs are unique and progress is not uniform among the children receiving their services.

Current practice for many EIBI service providing facilities is gathering session data that has been recorded with paper and pencil (Tarbox et al., 2010). While it has been the service standard since the introduction of EIBI, paper and pencil data collection can be problematic and labour intensive. In publicly funded EIBI community settings, increased caseloads produce

increased amounts of paperwork. Data sheets cannot be re-used, which means that multiple copies need to be printed repeatedly over the course of the child's treatment (Tarbox et al., 2010). The data gathered from the sessions needs to be accumulated by a supervisor and subsequently converted or transcribed into an electronic database in order for the consultant to examine the child's progress – a task that is labour-intensive and susceptible to human error (Seebregts et al., 2009). Paper records are also vulnerable to being lost or damaged.

Time requirements are a particular issue for a publicly funded EIBI service provider. This is largely due to having services that can be obtained for free by any individual in need. The number of children requiring service is far greater than the number of practitioners able to provide that service (Rivard et al., 2014). Rivard et al. (2014) came to the conclusion that when EIBI is offered as a free service to the public sector, extensive wait-lists and large caseloads are inevitable, especially when dealing with limited staff and funds. This is problematic in relation to time management and consumption for many reasons. Firstly, extensive wait-lists delay a child's access to EIBI. As stated previously, one of the hallmark characteristics of efficacious EIBI is beginning treatment early. Therefore, delaying the introduction of treatment is not favourable. For many programs, there are typically age restrictions or deadlines for accessing EIBI services. Unfortunately, it has been the case that when some families encounter extensive wait-lists, their child does not have the opportunity to receive any services as they have “aged off” of the wait-list; that is, they are now older than the oldest possible age at which the community agency can still provide services. Secondly, once a child is enrolled with a community EIBI service provider, they may still not receive the recommended duration of treatment required to promote best outcomes (Matson & Jang, 2014; Rivard et al., 2014).

**Lack of communication and collaboration.** Printed materials (notes, datasheets, etc.) is the most common communication medium among consultants, families, and other members of a child's service team. It is the responsibility of the consultant to obtain these notes from the environment where the observation occurred in order to incorporate any feedback or suggestions into the child's EIBI programming. However, paper and pencil data is not typically retrieved from the service setting on a daily basis in an EIBI program. This can lead to poor communication and a lack of collaboration between all members of a child's EIBI team, other professionals, and their families – another challenge with treatment delivery by a publicly funded EIBI facility.

Many public health organizations that advocate for EIBI suggest incorporating other professionals' (occupational therapist, speech-language pathologist, physiotherapist, physicians, social workers, etc.) recommendations into a child's treatment package (Jacobson & Mulick, 2000). In an article detailing the needs of children diagnosed with ASD and their families, LeBlanc et. al, (2009) highlighted the fact that “most individuals with an ASD will have multiple providers across multiple settings...” (p. 225). Research by Bryson et al. (2007) examined the core factors that contributed to the acceptance, distribution, and application of a treatment program for children with ASD. They identified that having the child's family and all professionals charged with treating the child collaborating together on a treatment package was desirable – provided that it adhered to current best practice recommendations for that population.

However, some studies have reported poor communication and a lack of collaboration among consultants, other professionals, and families to be a hindrance to successful delivery of EIBI (Dymond et al., 2007). In a study surveying 783 parents of children with ASD on suggestions to advance the current practice for EIBI service delivery, one area identified as in

need of development was “quality, quantity, accessibility, and availability of services” (Dymond et al., 2007, p. 133). Within that category, parents specified that there needs to be an increase in partnership and collaboration between all members of the child’s service team with the parents and across service providers (Dymond et al., 2007). This would mean that the EIBI treatment facility would ensure that correspondence, treatment information, and data collected from the EIBI session would be transparent and easily accessible to the families and other professionals caring for and providing other services to the child (Jacobson & Mulick, 2000). Consistency is a major factor in achieving high fidelity; this does not apply only to consultants and tutors directly responsible for the treatment package but, it also applies to the other professionals and the child’s family. As LeBlanc et. al., (2009) stated, “Consistency across caregivers and service providers...at any given time is critical to ensure the integrity of behaviour treatment and to minimize problem behaviour...The effects of inconsistency across care providers can be potentially detrimental” (p. 231).

### **Addressing the Challenges**

**eHealth and mHealth.** An eHealth solution may help to address the challenges with EIBI treatment delivery in public funded community settings. The term “eHealth” is broadly defined as “the use of technology to function as an active ingredient in treatments such as health behavior interventions” (Wu, Steele, Connelly, Palermo, & Ritterband, 2014). In the context of EIBI specifically, and for the purposes of this proposal, eHealth refers to the use of technology to aid in the recording, collection, and analysis of data required to inform a consultant’s clinical decision making regarding the child’s EIBI treatment.

One form of eHealth in the medical field is mHealth. mHealth, in general, refers to the use of mobile equipment (e.g., smartphones, apps, fitness tracking devices, etc.) in health care

settings to assist “consumers or providers, for monitoring health status or improving health outcomes, including wireless diagnostic and clinical decision support” (Kumar et al., 2013, p. 228). Mobile devices are capable of performing many functions simultaneously, including instant messaging, video recording, and connecting on the intra or internet (Klasnja & Pratt, 2012). Primarily, mHealth has been deployed for disease control, reducing substance abuse, mental illness monitoring, facilitating proper hygiene, physical health monitoring, managing stress, and managing depression, among other uses (Kumar et al, 2013; Klasnja & Pratt, 2012; Luxton, McCann, Bush, Mishkind, & Reger, 2011). However, many problems associated with treatment delivery in these areas are similar to those in the treatment delivery of EIBI. Consequently, many of the eHealth and mHealth solutions used to alleviate treatment challenges in those areas have the potential to generalize to solving treatment challenges experienced in EIBI.

Treatment fidelity challenges relating to lack of supervision, challenging behaviours of children, and rural areas can potentially be addressed by mHealth. Borrelli and Ritterband (2015) note that “there are many benefits of eHealth and mHealth interventions including their availability and accessibility (use anywhere, anytime), cost-effective delivery, scalability, ability to personalize and tailor content, capability to provide real-time strategies to users in their everyday settings, and capacity to calibrate intervention intensity to user’s needs” (p. 1205). In the context of EIBI, tutors servicing children with more severe problem behaviour, or those in rural areas, could use a mobile device like the Apple iPad® to record video of session time or instances of problem behaviour and upload these videos in real-time. This would allow the consultant to be able to examine the videos and provide feedback without spending extra time driving out for visits.

In addition, mHealth apps can upload real-time DTT trial data, which allows for consultants to make decisions regarding treatment delivery immediately, rather than waiting for the data to be collected, entered, and delivered on site. Consultants would also have the advantage of monitoring treatment fidelity by seeing how many trials are delivered to a child within a given period of time. mHealth apps can produce graphs of behaviour data that allow for a user-friendly “visual display to characterize treatment outcome” (Luxton, McCann, Bush, Mishkind, & Reger, 2011, p. 506). This is relevant and valuable for consultants, as single-case research designs that are typically used in EIBI often utilize visual analysis to make conclusions regarding the effectiveness or ineffectiveness of the treatment delivery.

mHealth can also address the service challenges related to intensive time requirements. If a consultant is able to communicate remotely with tutors or parents from the child’s home, this can open up time in the day for the consultant to work on other tasks that require more attention, or to open up time on their caseload to acquire new clients waiting for service. mHealth has the potential to reduce the amount of time required for clinical decision making. For example, if the consultant is able to examine real-time data from a tutor whose child has just mastered a receptive language program, she can upload a new program immediately for the tutor to begin teaching accompanied with a video that models the desired implementation of the program, saving the senior tutor (an employee who assists the consultant and supports the tutors) from having to collect the raw data, bring it to the consultant, print out a new program, and wait for the next visit to have the program brought to the tutor. Furthermore, it may reduce the time required for data transfer during EIBI sessions. Before an EIBI session begins, it is required for the tutor to examine the data from the previous session to understand which skills will be targeted during that session. After an EIBI session, the tutor must transfer any data from that day



into a binder for tracking mastery, and prepare for new data to be collected for the next day.

This translates to several minutes of reviewing separate sheets of paper, gathering a separate binder that holds all the session information, filing away any “full” datasheets, and creating new datasheets to replace them.

**TN Active Care®.** A specific eHealth application that has been designed to decrease challenges with treatment fidelity, time management requirements, and lack of communication and collaboration between professionals and families is TN Active Care® (TNAC®). TNAC® is a mobile cloud-based system that allows consultants, families, and other professionals to create, access, and manage multi-client information regardless of location, on an individualized and continuous basis. TNAC® currently allows real-time recording and collection of EIBI session data, automated graphing of data, and secure uploading of the data to an electronic storage base. Tutors are also able to record real time data.

**Current research.** Literature review articles on eHealth tools have been positive overall (Wu et al., 2014; Kreps & Neuhauser, 2010), but there is little evidence on the ability for eHealth technology to advance the area of EIBI service delivery specifically. Kreps and Neuhauser (2010) reported that an analysis of ten years of eHealth technology in health care found positive results mostly in the areas of “computer-controlled telephone counseling, personally tailored communication, and online support groups for promoting health” (p. 330).

One study that has examined eHealth and mHealth in an EIBI program was conducted by Tarbox et al., (2010). The researchers compared traditional a paper-and-pencil method for collecting DTT data with an mHealth tool called mTrial®. Four pre-school aged children with ASD receiving public, home-based EIBI services and their tutors were the participants in this study. All research observations occurred during typically scheduled session time. Each

participant had three target programs being observed that were currently being taught as a part of the child's treatment. Before the start of the experiment, the tutors were exposed to mTrial®. They all received one hour of hands-on training, verbal explanations, and role playing with a confederate, with the option to extend training if tutors were struggling with the technology. All the tutors had previously been collecting data using paper-and-pencil. In both paper-and-pencil and mTrial® phases, tutors ran DTT with their students as designed. However, prior to the mTrial® phase, the participants' target program information was entered by the tutor. The dependent measures for this study were the duration of time necessary for collection of DTT data for both methods of recording, accuracy of collection for both methods of recording, and the duration of time necessary to graph session data for both methods of recording.

The results of the study showed that overall, mTrial® required more time for data collection but less time for graphing session data, compared to paper-and-pencil. There was no observed difference in the accuracy of the two methods for recording session data. These findings suggest that both methods have their advantages and disadvantages. However, the researchers noted several limitations of their study including the tutors' initial level of expertise in traditional data collection, and the fact that data were only collected on DTT alone. The authors recommended further research in the area to evaluate eHealth tools like mTrial® for recording data on all other aspects of EIBI service delivery, including challenging behaviours. In addition, the authors proposed examining the efficacy of an eHealth tool like mTrial® with recently hired tutors who have little or no exposure using the traditional method or electronic method of recording data.

Although TNAC® shares several similarities to mTrial® and appears promising in the alleviation of the previously mentioned EIBI service delivery challenges, its utility has never

been evaluated in an EIBI setting. Thus, its efficacy, validity, and reliability cannot be confirmed or denied until a scientific evaluation is conducted. Therefore, the purpose of my study is to examine the utility of TNAC® in comparison to traditional paper-and-pencil for collecting data in an EIBI program.

## **Method**

### **Participants**

The participants were three Autism Consultants and one Autism Senior Tutor employed by the St. Amant Autism Program. Each participant had obtained an undergraduate degree, and three had obtained a graduate degree. All participants had collected data using the paper-and-pencil method for at least one year prior to participating in the study. Additionally, all participants had not previously collected data using TNAC®.

**Setting.** The research was conducted at St. Amant while the participants watched videos of the researcher and a confederate role-playing as a child with ASD and an Autism Tutor (respectively).

**Videos.** In the video, the confederate delivered typical EIBI services to the child with ASD in a home-based setting. Each video contained a scripted 30 – 34 DTT trials distributed across five to eight different teaching programs, and zero to three topographies of challenging behaviour (see Appendix A). The percent of scripted “correct DTT trials” and “incorrect DTT trials” was approximately 80% and 20%, respectively, for each video. Thirty-five videos were made, and for each session for each condition, the participant viewed a novel video. No videos were repeated with a participant throughout the study.

### **Materials and Procedure**

**Design.** TNAC® was compared to the traditional method of paper and pencil data collection using an alternating conditions design. Within the same session, all participants used either TNAC® or paper-and-pencil first and the alternate method afterwards. The order of the conditions alternated across sessions and across days. Each observation period that included one rotation of paper and pencil and TNAC® was counted as one repetition of the experimental conditions. For example, if a participant was in the paper-and-pencil experimental condition to start the session and then alternated to TNAC® immediately after, they would start the next session with TNAC®.

Three baseline observations of each dependent variable for paper and pencil data collection were made prior to the implementation of the experimental conditions. The baseline observation period allowed us to examine the participants' level of paper-and-pencil performance without any interference from TNAC®. The experimental phase continued until visual inspection of data indicated clearly the presence or absence of an effect.

**Data collection training.** All participants were fully trained and had already consistently used paper-and-pencil for collecting challenging behaviour data and DTT data prior to the study. Therefore, no additional training on paper-and-pencil data collection was provided. TNAC® was pre-installed onto four Apple iPad 2®'s. All programs and challenging behaviours were pre-programmed onto the iPad by the researcher. The application was used by the participants to collect challenging behaviour data and DTT data. None of the participants were formally trained on collecting data using TNAC® prior to recruitment. Autism Consultants and Autism Senior Tutors who have had previous experience actively taking data for more than five sessions using TNAC® were excluded from recruitment.

A 1-hr instructional session was provided by the researcher to each of the participants. At the training session, the participants received step-by-step verbal and visual instructions on how to properly operate TNAC® for EIBI sessions (see Appendix B, attached separately).

Following the verbal and visual demonstration, a practice session was offered to the participants in which the participants had the opportunity to explore the application and practice data collection while watching a sample video. None of the participants requested a practice session. Subsequently, a question and answer period was offered to the participants where they were allowed to ask any questions pertaining to their training or use of TNAC®. A checklist was used by researcher during the training sessions to ensure that all participants received identical training (see Appendix C). In order to observe any effects and trends with both variables, there were no mastery criteria for transitioning from training to using the TNAC®, and no mastery criteria for transitioning from baseline into experimental conditions for paper-and-pencil.

**Dependent variables. *Discrete trial data.*** For the baseline DTT condition and the experimental DTT condition, the researcher observed the accuracy of discrete trial data being collected by the participants using both paper and pencil and TNAC®. Specifically, the participant was responsible for recording whether each trial was an “independent” (i.e. an independent correct response), a “partial prompt” (i.e. a correct response with a partial prompt), a “full prompt” (i.e. a correct response with a full physical prompt), or an “error.” As the participants were watching a pre-recorded, pre-scripted video created by the researcher, the researcher's data was considered the standard. The researcher and confederate had four years of experience collecting DTT data using paper and pencil as well as conducting EIBI sessions. Percent agreement was calculated by adding up the participants total number of correct

responses, dividing the number of correct response by the numbers of trials in total, and multiplying by 100.

***Challenging Behaviour Data.*** The researcher observed the accuracy of challenging behaviour data in the baseline DTT condition and experimental DTT condition. All challenging behaviours were measured by frequency. Once the challenging behaviour occurred, the participant was responsible for recording the occurrence(s) using paper and pencil on the data sheet designed by the researcher. Frequency data was tracked with a simple tally. Percent agreement was also calculated. In the TNAC® condition, challenging behaviour data was recorded in the tab labelled “challenging behaviour.” When a challenging behaviour occurred, a button with the symbol “+” was tapped to indicate an occurrence.

**Observation procedures.** Each research session took approximately 30 minutes and consisted of observing 30 – 34 DTT trials. Challenging behaviour was observed only as it occurred during the videos.

### **Social Validity**

Three questionnaires using Likert-type scales were administered to the participants, each at a different time over the course of the study. One questionnaire pertained to paper and pencil data, the other two pertained to TNAC®. The first questionnaire was administered prior to the baseline phase of the study surveying the participants about the acceptability and ease of using paper and pencil for data collection (see Appendix D). When the TNAC® training session ended, a questionnaire was administered to the participants regarding the acceptability and perceived ease of an eHealth tool for data collection (see Appendix E). Once the experimental phase of the study had concluded, the participants were administered the second TNAC® questionnaire surveying actual acceptability and ease of an eHealth tool for data collection (see

Appendix F). Measures of central tendency were calculated and reported for all questionnaires. Items measuring *perceived ease of data collection* for all surveys were Questions 1 – 3. The Likert scale items measuring *actual ease of data collection* for surveys 1 and 2 were Questions 4 – 6. Questions 7 -9 for surveys 1 and 2 measured *ease of training*. Two Likert Scale items, Questions 10 – 11, measured *previous data collection experience* in surveys 1 and 2. Finally, for Survey 3, Questions 4 – 7 measured *perceived program/service benefits*, Questions 8 – 10 measured *actual ease of data collection*, Questions 11 – 13 measured *ease of training*, Question 14 measured *preference for future data collection methods*, and Question 15 – 16 measured previous data collection experience.

### **Data Analysis**

Line graphs of each variable were used to plot the data from all phases and conditions of the study. Visual inspection was used to examine stability in the data from each variable to determine whether a participant had completed the experimental phase of the study. If any of the four variables did not show stable data, additional sessions were conducted and data was collected until a clear effect had emerged. After all experimental data had been gathered, percent correct was calculated in both conditions. Measures of central tendency was used to summarize data collected from the social validity components.

## **Results**

### **DTT Data Collection Accuracy**

All participants demonstrated a high degree of accuracy collecting DTT data using paper-and-pencil during the baseline phase (see Figure 1). Mean accuracy across all sessions for all participants was 97% (range = 94% - 100%).

High accuracy was also observed across all participants in both the paper and pencil ( $m = 95\%$ , range = 83% - 100%) and TNAC® ( $m = 94\%$ , range = 75% - 100%) conditions of the experimental phase (see Figure 1). Participant 1 (P1) maintained a stable performance for paper-and-pencil in the three baseline sessions and the first session of paper-and-pencil in the experimental phase. The first session of TNAC® resulted in a slight drop in performance for P1. P1's second session of both conditions showed a significant drop in scores. Following the second session of the paper-and-pencil condition, P1's performance steadily increased back to baseline levels. In the TNAC® condition, following the second session, performance was variable until the fifth session, when performance levels began to increase and stabilize.

Participant 2 (P2) maintained a stable, accurate performance in all sessions of each condition with little variation. 100% accuracy was observed for two out of four sessions of the experimental phase in both conditions.

Participant 3 (P3) maintained a stable, accurate performance in the experimental conditions for both methods. Overall, TNAC® performance was slightly better than paper-and-pencil, with one instance of 100% accuracy observed in the third session. No instances of 100% accuracy were observed in the paper-and-pencil condition.

Participant 4 (P4) also maintained a stable, accurate performance in the experimental conditions. Two instances of 100% accuracy were observed: one instance in paper-and-pencil, and one instance in TNAC®.

### **Challenging Behaviour Data Collection Accuracy**

All participants accurately collected challenging behaviour data using paper and pencil across sessions in the baseline phase,  $m = 100\%$  (see Figure 2). All participants were also accurate in collecting challenging behaviour data in both the paper-and-pencil ( $m = 98\%$ , range =



80% - 100%) and TNAC® (m = 99%, range = 75% - 100%) conditions of the experimental phase (see Figure 2). It is worth noting that the decreases in challenging behaviour data accuracy were influenced by the low number of instances of challenging behaviour occurring within that session (for example, if there were only five instances of challenging behaviour in one session, and one instance was not recorded, that would reduce the accuracy to 80%).

### **Social Validity Data**

The participants completed all three social validity surveys (see Table 1). Overall, in the categories of *perceived ease of data collection*, *actual ease of data collection*, and *ease of training*, all participants scored paper-and-pencil higher than TNAC® across all questionnaires. All participants reported having previous experience collecting data using paper-and-pencil. Some participants reported having previous experience collecting data using TNAC® and using another form of electronic data collection. In the category of *perceived program/service benefits*, the average response among participants was “neutral”. Most participants strongly disagreed that they would prefer to master the use TNAC® over paper-and-pencil for future data collection.

### **Discussion**

The purpose of this study was to compare the accuracy of collecting DTT and challenging behaviour data with paper-and-pencil and with TNAC®. A secondary purpose was to gather social validity data about the two methods of data collection. Overall, the findings of this study showed that participants achieved high accuracy collecting DTT and challenging behaviour data using both methods, which suggests that using an eHealth tool, such as TNAC®, could be a viable alternative to paper-and-pencil data collection without compromising accuracy. The outcomes of the social validity component indicate that the participants found collecting

DTT and challenging behaviour data with paper-and-pencil easier than using TNAC®. These outcomes also indicate that the participants would prefer to continue to use paper-and-pencil to collect data than to master the use of TNAC®.

The outcomes of this research are consistent with the findings from Tarbox et al., (2010). In both the current study and the Tarbox et al. study, high rates of accuracy were observed with paper-and-pencil and eHealth tool DTT data collection. These results suggest that there is minimal to no difference in active DTT data collection using TNAC®. An important difference in the current study is that accuracy of challenging behaviour data collection was also measured. The present results showed minimal to no difference in challenging behaviour data collection accuracy using TNAC®. Another novel contribution extending Tarbox et al.'s previous research was the addition of the social validity component. Overall, the findings suggest that the standard paper-and-pencil data collection method was the most acceptable to the participants.

### **Implications**

The results of this study have several implications regarding the utility of an eHealth tool for an EIBI program. The fact that both methods appear to be equally accurate implies that from eHealth is a reliable alternative for paper-and-pencil data collection and possesses several intrinsic advantages. The reduced environmental impact of an eHealth tool may become important to a publicly funded EIBI program; specifically, there would be less paper and ink use. Similarly, an eHealth tool could potentially reduce the amount of driving required to collect paper data sheets. Furthermore, although this outcome was not directly measured in this study, using an eHealth tool could prove to be beneficial for rural tutors in training. As the participants in this study scored videos of the researcher and the confederate engaging in a teaching session, a Senior Tutor or Consultant could also score videos of the Tutor and the Child in a teaching

session, and then compare the data that had also been collected by the tutor on the same eHealth tool. This could allow the training staff to determine whether additional visits should be arranged to support the tutor in data collection.

P1's data suggest that a transition from paper-and-pencil to eHealth should be gradual, since the presence of both methods of data collection may have interfered with performance. Staff may therefore benefit from scoring videos and practice sessions using the eHealth tool until "mastery", prior to introducing eHealth data collection in real-time sessions with a client.

Most participants found collecting data using paper-and-pencil preferable to collecting data with TNAC®. Although all the features of TNAC® that could potentially influence more support for an eHealth tool were not utilized for this study, the features of TNAC® that would be most frequently used by staff would be the data collection features. Additional comments left on the surveys by three out of the four participants highlighted the difficulty with needing to switch from one DTT data collection tab to another challenging behaviour tab, and expressed their concerns with gathering inaccurate data because of said difficulty. These comments imply that an eHealth application would need to create a data collection feature that supported the practical needs of collecting different types of data for the specific EIBI program; specifically, the eHealth application would need improved user interaction design.

### **Limitations**

I was unable to recruit tutors and clients as originally intended. The study was modified by having senior tutors and consultants scoring videos of confederates rather than videos of an actual tutor and child with ASD, or scoring real-time EIBI session of a tutor and a child with ASD. Although scoring role-playing videos may demonstrate its benefits for rural tutor training or tutor training in general, to demonstrate the real potential utility for an eHealth tool in an EIBI

program, it would be ideal to use the tool in the actual environment while delivering EIBI to a child with ASD, and to collect data on the primary staff (i.e. tutors) responsible for data collection.

A second limitation of the current study was that all of the pre-determined challenging behaviours were collected using frequency measures. If other behaviours were collected simultaneously using different measures such as duration or time-interval for both conditions, it may have decreased the accuracy of data collection for both DTT and challenging behaviour.

Another limitation is relatively small sample size. Although this is a single-case research design, the participant group all shared similar demographic characteristics, and three of the participants were all employed in the same position, which may limit external validity. Therefore, the social validity outcomes may not be representative of the population who would utilize these data collection methods.

Additionally, the social validity responses only reflect the participants experience was a limited set of TNAC® functions. Exposure to additional features of TNAC® may influence social validity results in the future.

### **Future Research**

In order to address the limitations of this study, I propose that future research should continue to examine the utility for an eHealth tool in an EIBI program by having a staff member who is currently providing EIBI to a child with ASD collect DTT and challenging behaviour data with an eHealth tool. Furthermore, research should also explore collecting DTT and challenging behaviour data with children who receive different teaching programs from one another and display different challenging behaviours that use different measures of collection. Moreover, conducting a similar study with additional participants with differing levels of experience

collecting paper-and-pencil data would be valuable. Future research should also explore differences in performance when participants receive different training packages for eHealth training.

It is apparent that the literature on using an eHealth case management system for an EIBI program is still in need of contributions by other researchers. More replications of studies such as this, in addition to other studies examining what features of eHealth tools would be required for successful use by EIBI service delivery staff, would be essential to maximizing the value of eHealth tools in EIBI programs.

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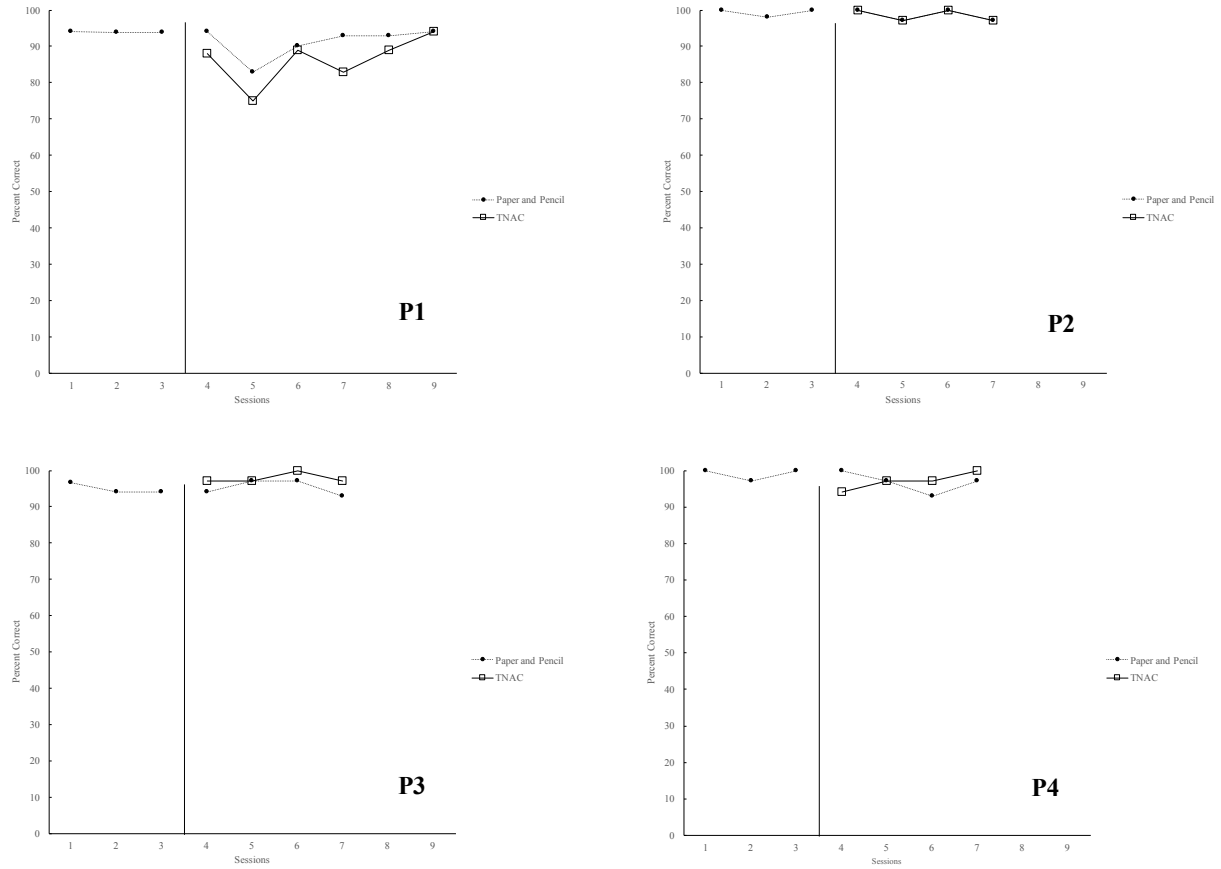


Figure 1. Percent correct on collecting DTT data using paper and pencil and TNAC®.

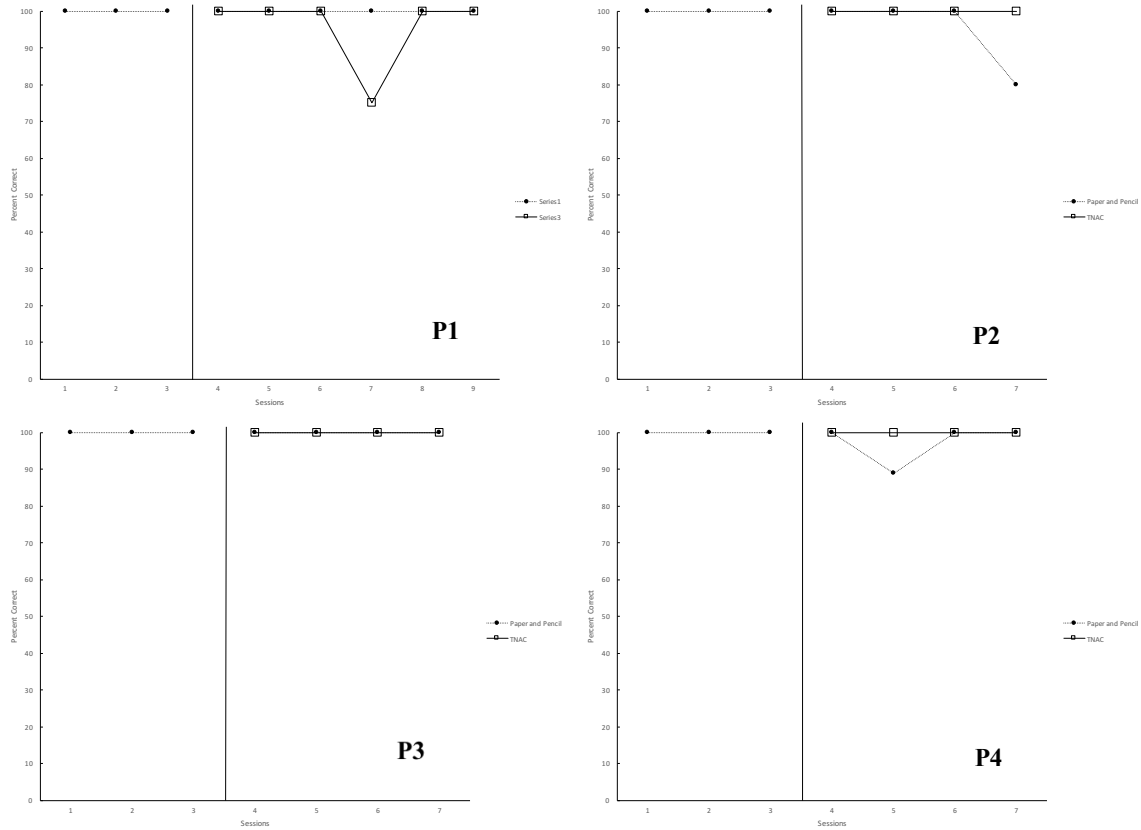


Figure 2. Percent correct on challenging behaviour data collected using paper and pencil and TNAC®.

Table 1.

*Social Validity Questionnaire Scores*

	<b>Survey 1 – Paper and Pencil</b>	<b>Survey 2 – TNAC®</b>	<b>Survey 3 – TNAC®</b>
<b>Perceived Ease of Data Collection</b>	4 (3 – 5)	3 (2 – 4)	3.25 (2 – 4)
<b>Actual Ease of Data Collection</b>	4.5 (4 – 5)	3.4 (2 – 4)	3.3 (2 – 4)
<b>Ease of Training</b>	4.6 (4 – 5)	3.5 (2 – 4)	3.7 (2 – 4)
<b>Previous Data Collection Experience</b>	4 (2 – 5)	1.75 (1 – 4)	1.75 (1 – 4)
<b>Perceived Program/Service Benefits</b>	N/A	N/A	3.2 (2 – 4)
<b>Preference for Future Data Collection</b>	N/A	N/A	1.83 (1 – 5)

*Note.* The mean scores (top number) reflect the average of all participants scores. The range scores (bottom numbers) reflect the average of all participant scores. Likert items were scored between 1 and 5, with 5 = strongly agree, 4 = agree, 3 = neutral, 2 = disagree, and 1 = strongly disagree. *Previous data collection experience* in Survey 1 referred to previous experience collecting EIBI data using any other type of method other than paper-and-pencil. In Survey 2 and 3, *previous data collection experience* referred to previous experience collecting data with another type of electronic method of data collection. In Survey 3, *perceived program/service benefits* referred to belief that using an eHealth tool, such as TNAC®, would benefit their current EIBI program, and *preference for future data collection* referred to whether participants preferred to master the use of TNAC® rather than to continue to use paper-and-pencil.

## Appendix A

## Sample Video Script for “Autism Tutor” Confederate

Video 5 – DTT Script for “Autism Tutor”

- 1) “Show me colouring”
- 2) “Show me sleeping”
- 3) “Show me sneezing”
- 4) “Clap”
- 5) “Blow a kiss”
- 6) “Wave”
- 7) “Match” – square
- 8) “Match” – circle
- 9) “Match” – triangle
- 10) “Show me the spoon”
- 11) “Show me the fork”
- 12) “Show me the bowl”
- 13) “Do this” – touch nose
- 14) “Do this” – touch shoulders
- 15) “Do this” – thumbs up

## BREAK

- 16) “A dog says”
- 17) “A cow says”
- 18) “A pig says”
- 19) “What colour” – blue
- 20) “What colour” – green
- 21) “What colour” – red
- 22) “Show me your ears”
- 23) “Show me your tummy”
- 24) “Show me your nose”
- 25) “Clap”
- 26) “Show me jumping”
- 27) “Wave”
- 28) “Show me sleeping”
- 29) “Blow a kiss”
- 30) “Show me sneezing”

## END VIDEO

## Appendix C

## TNAC® Training Checklist for Researcher Use



## Participant TNAC® Training Checklist

### PARTICIPANT INFORMATION

Participant#: \_\_\_\_\_ Start date: \_\_\_\_\_

### MATERIALS

- Training Manual
- iPad® with TNAC® application

### PRE-TRAINING SET-UP

- Charge and turn on iPad®
- Log on to iPad® using secure password.
- Locate and run TNAC® application

### TRAINING MANUAL WRITTEN COMPONENT REVIEW

- How to login with unique username and password
- How to unlock/lock client profiles
- How to prepare work session
- How to select DTT programs to run
- How to track DTT trials
- How to track challenging behaviours
- How to program novel challenging behaviours
- How to review session data
- How to carry over session data
- How to finalize session data
- How to write communication notes
- How to log out of the application

### VISUAL DEMONSTRATION

- Visually demonstrate "pre-training steps"
- Visually demonstrate "written components"

### ROLE PLAYING

- Researcher role plays with the confederate using TNAC®
- Participant role plays with the confederate using TNAC®
- If needed or requested, constructive feedback will be given to the participant. (Leave box blank if feedback was not requested)
- If requested, the participant can do an additional role play demonstration during the training session. (Leave box blank if additional role play was not requested)

### QUESTION AND ANSWER PERIOD

- If needed or requested, participants can ask the researcher questions regarding TNAC® or any component of training. (Leave box blank if no additional questions were asked).



Appendix D

Social Validity Survey for Pencil and Paper Data Collection



**PAPER AND PENCIL DATA COLLECTION SURVEY**

The following questions are regarding your experience with paper and pencil data collection during your sessions with your client. Please answer the questions honestly, and to the best of your ability. Please place a check mark (✓) in the box that most accurately represents your opinion. All responses will be kept anonymous and confidential.

Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Collecting data using paper and pencil is easy.					
Collecting data using paper and pencil is timely and efficient.					
Collecting data using paper and pencil is most relevant for this type of service (EIBI).					
I am comfortable collecting challenging behaviour data using paper and pencil.					
I am comfortable collecting Discrete Trial Training data (DTT) using paper and pencil.					
I am comfortable collecting other program data using paper and pencil (i.e., maintenance data, requesting data, etc.)					
I have been sufficiently trained on collecting data using paper and pencil.					
I learned to collect data using paper and pencil easily.					
I would feel comfortable training another Autism Tutor on collecting data using paper and pencil.					
Before my position as an Autism Tutor, I had experience collecting data using paper and pencil.					
Before my position as an Autism Tutor, I had experience collecting data using another method.					
<b>Additional Comments:</b>					

Appendix E

Social Validity Survey for eHealth Data Collection Post Training Session



**TNAC® DATA COLLECTION SURVEY**

The following questions are regarding your experience with TNAC® data collection during your sessions with your client. Please answer the questions honestly, and to the best of your ability. Please place a check mark (✓) in the box that most accurately represents your opinion. Please leave your response blank if the item does not apply to you (not applicable). All responses will be kept anonymous and confidential.

Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Collecting data using TNAC® is easy.					
Collecting data using TNAC® is timely and efficient.					
Collecting data using TNAC® is most relevant for this type of service (EIBI).					
I am comfortable collecting challenging behaviour data using TNAC®.					
I am comfortable collecting Discrete Trial Training data (DTT) using TNAC®.					
I am comfortable collecting other program data using TNAC® (i.e., maintenance data, requesting data, etc.)					
I have been sufficiently trained on collecting data using TNAC®.					
I learned to collect data using TNAC® easily.					
I would feel comfortable training another Autism Tutor on collecting data using TNAC®.					
Before my position as an Autism Tutor, I had experience collecting data using TNAC®					
Before my position as an Autism Tutor, I had experience collecting data using another electronic method.					
<b>Additional Comments:</b>					

Appendix F

Social Validity Survey for eHealth Data Collection Post-Experiment



**TNAC® DATA COLLECTION SURVEY**

The following questions are regarding your experience with TNAC® data collection during your sessions with your client. Please answer the questions honestly, and to the best of your ability. Please place a check mark (✓) in the box that most accurately represents your opinion. Please leave your response blank if the item does not apply to you (not applicable). All responses will be kept anonymous and confidential.

Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Collecting data using TNAC® is easy.					
Collecting data using TNAC® is timely and efficient.					
Collecting data using TNAC® is most relevant for this type of service (EIBI).					
Collecting data electronically is the method that will be most valuable in the future.					
Collecting data electronically will keep this EIBI program ahead of the curve.					
Collecting data electronically will benefit the clients					
Collecting data electronically will fulfill the need for conserving program time.					
I am comfortable collecting challenging behaviour data using TNAC®.					
I am comfortable collecting Discrete Trial Training data (DTT) using TNAC®.					
I am comfortable collecting other program data using TNAC® (i.e., maintenance data, requesting data, etc.)					
I have been sufficiently trained on collecting data using TNAC®.					
I learned to collect data using TNAC® easily.					
I would feel comfortable training another Autism Tutor on collecting data using TNAC®.					
I would rather master the use of TNAC® for data collecting than go back to with paper and pencil.					
Before my position as an Autism Tutor, I had experience collecting data using TNAC®					
Before my position as an Autism Tutor, I had experience collecting data using another electronic method.					
<b>Additional Comments:</b>					