

**Behavioral Data Collection for Caregivers: An Evaluation of Mobile-Based vs. Traditional
Methods**

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Abstract

As the world navigates the challenges presented by the COVID-19 pandemic, telehealth services have become an increasingly available in-demand option. Behavior analysis must adopt the latest technology available to support various aspects of service delivery, including providing the highest quality services available via telehealth, behavior. As of the writing of this article, only one previous study has empirically evaluated mobile-based data collection against traditional BRC data collection by caregivers. The current state of telehealth, travel restrictions, and the age of the last research support the need for ongoing empirical investigation into electronic data collection and the conditions with which optimal levels of responding may be evoked. This study seeks to evaluate the use of a mobile-based app data collection system with daily prompts versus traditional pencil-and-paper data collection on the rate of caregiver-collected behavioral data in a telehealth setting utilizing an alternating treatment design with the best treatment final phase.

Keywords: data collection, generalization, parent training, electronic data collection, caregiver training, caregiver data collection, behavior report card, telehealth

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In applied behavior analytic (ABA) research, there is an importance placed on training parents of children with autism and other developmental disabilities to acquire a behavior analytic repertoire such that they may become agents of behavioral change as can be evidenced by the profusion of returns when searching for parent training literature in ProQuest. Given the current global conditions due to the COVID19 virus, caregivers are required to implement behavioral treatment in the absence of a trained professional. Therefore, recurrent data collection and graphing by a visiting therapist is not an option at this time. Although there is much support for the utility of caregivers collecting data, currently, there is a dearth of literature identifying the optimal means for those caregivers to take repeated objective behavioral measures. Since 1987, ABA therapy has been demonstrated to be a highly effective approach to autism spectrum disorder (ASD) treatment (Lovaas, 1987). Given the effectiveness of ABA as an effective treatment, and the limited availability for a trained therapist to enter a home, it is essential to develop a technology of behavior change for caregivers. One often overlooked an important aspect of parent training is programming for generalization of strategies learned in the training environment to the actual setting for implementation.

Programming for skill generalization has also is as an essential area of ABA research; however, little research has been conducted to identify the methods of data collection most likely to generalize to non-training environments. Stokes and Baer (1977) described generalization as "the occurrence of relevant behavior under different non-training conditions (across subjects, settings, behaviors, and time) without the scheduling of other same events in those conditions and had been scheduled in the training conditions (p. 350)" Following their description they

provided a rubric for which to evaluate the presence of generalization promoting components and stress the importance of actively programming for generalization rather than training and hoping for this effect to occur.

Although the 1977 Stokes and Baer article was seminal, there was an absence of the identification of the functional variables responsible for the promotion of generalization within training programs. The rubric was refined in a 1989 article by Stokes & Osnes to stylize Stokes & Baer's components as functional variables rather than procedural aspects as explanations for generalization. This shift in the description of agents of generalization is in line with a statement from B. F. Skinner in which he notes, "generalization is not an activity of the organism; it is simply a term which describes the fact that other stimuli share the control acquired by a stimulus with common properties" (1953, p. 134). This rubric included three categories of generalization promotion: exploiting current functional contingencies, training diversely, and incorporating functional mediators. The author's state incorporating agents of generalization within behavioral programming is essential to behavior analysts as it allows for validation of the effectiveness of the behavior change program.

For a clinician to provide support to an ongoing behavior intervention plan, the behaviors slated for change must be measured. Regarding in-home and clinic-based ABA service delivery settings, Nadler and Roberts (2013) indicate that direct observation and measurement by trained professionals is the most common method of data collection during the evaluation of treatment for challenging behaviors as well as during skill acquisition. During this Coronavirus pandemic, with travel restrictions, this leaves behavioral measurement to the primary caregivers. As Skinner points out, it is difficult to rely solely on verbal reports as a substitute for accurate observation of behavior. This difficulty is because changes in the rate of behavior are difficult to describe.

Skinner (Skinner, 1969 p.116) stated, "any report, no matter how specific, is subject to the verbal contingencies which induce a person to describe behavior," which indicates that without reliable and repeated measures of behavior, evaluating a behavioral intervention will be difficult if not impossible to do objectively.

Objective and frequent measurement and analysis of behavior and behavior data is substratum to ABA (Baer et al., 1968). Although caregiver verbal reports may be useful as an indirect report of behavior to inform ongoing therapeutic interventions by a trained practitioner, when caregivers themselves collect behavioral data while implementing interventions with their children, this practice produces positive outcomes (Singh, 2012). The data that caregivers have been trained to obtain ranges from child skill acquisition and challenging behavior frequencies to taking self-monitoring data on treatment integrity (Nadler, 2012; Singh, 2012).

Given the amount of time a parent of a child with autism may spend with that child, caregivers should be prepared to not only deliver treatment interventions but also actively engage in objective treatment evaluation in the absence of a practitioner. Sundberg et al. (2018) suggest that one way for a parent as a trainer of their child with autism to evaluate the treatment should be the collection of behavioral data directly related to the target behaviors. They stated that because of the extensive time spent with their child, a parent might have upward of 220,000 learning opportunities with their child per year, indicating importance for the caregivers to be equipped to both teach and evaluate their teaching.

Due to the amount of time a caregiver spends with their child, it is beneficial when the methods of ABA taught to caregivers transfer to the non-training environments (Nadler, 2012). This behavioral repertoire would likely become even more crucial to the parent trainer if ongoing

professional assistance is not available. Arming caregivers with this repertoire can assist to strengthening the occurrence of desirable behaviors in both caregiver and child (Singh, 2012) but can also help to reduce those which are undesirable (Frea & Hepburn, 1999) Also, caregivers have been trained to participate in behavior tracking and to then evaluate the data to allow for them to engage in evaluation of treatment efficacy (Berquist & Charlop, 2014). Tracking and evaluating data may facilitate the caregiver's ability to become a more effective agent of behavior change (Singh, 2012) Furthermore, the introduction of a parent data collection component to a parent training program has been shown to increase the number of teaching interactions between caregiver and child. Also, this addition produces concomitant effects on the behavior of the children. Singh (2012, p. 6) states that "allowing parents more control in their children's intervention programs can strengthen trust in the professional and also help parents feel more efficacious with their children," indicating this may, in turn, function as motivation increasing the likelihood of engagement in treatment-related behaviors.

Caregiver data collection during a behavioral intervention is a useful component to allow for ongoing treatment evaluation and planning. Also, training caregivers to collect data produces not only direct but also concomitant behavioral effects. To study this phenomenon, using a non-concurrent multiple baseline design across participants, Singh (2012) studied the effect of adding a data collection component to Pivotal Response Training (PRT) parent education sessions. In this study, the participants, in conjunction with the experimenter, established their children's target goal. In a standard parent training condition, caregivers are not typically required to collect data; instead, they only implement the teaching procedures. Singh's intervention included the introduction of a personalized trial-by-trial datasheet and a progress tracking graph with which the caregivers collected performance data during training sessions. The researcher trained caregivers on

components of the datasheet. She also trained on how data is to be collected and also how to evaluate graphs to track progress visually. As such, the researcher modeled how to identify both correct and incorrect responses as well as to track trial-by-trial data on the child's target behaviors. After this, parents engaged in in-vivo practice with their child and recorded data on the child's responses, either correct or incorrect. During this practice, the therapist provided the participants with feedback on the implementation of the mand procedure and how well data was collected. The researcher took data on trainee performance, and practice continued until a predefined performance criterion was met.

The ability to replicate the results from previous studies is central to Applied Behavior Analysis (Baer et al., 1968). Although these studies include statements that parents collected data, the procedures use to evoke data collection, and to evaluate the quality of parent data were not included. This is a concern for two reasons. First, ABA is technological – researchers are exhorted to include specific information on procedures so that others can readily obtain the same results. Second, situations in which behavior analysts do not hold the reinforcers for a client and still generate a high level of performance are unusual. The discerning consumer of this literature will be skeptical of reports that lack details regarding procedures used and basic principles that explain the results obtained. Without reinforcement, it is unclear to the skeptical reader how high levels of parent data collections were evoked and maintained.

An appropriate system of data collection allows the practitioner to evaluate treatment efficacy on an ongoing basis. With a more in-depth focus on parental data collection to identify the best data recording system, Nadler and Roberts (2013) note that professionals are often limited in providing optimal intervention conditions due to a lack of accurate and objective information relating to child behavior in the absence of a practitioner. As such, the authors conducted a between-

groups random controlled study to contrast two systems of caregiver collected behavioral data. The researchers evaluated the Behavior Record Card (BRC) and the Parent Daily Report (PDR). The PDR is a binary observation system in which the researcher would call the caregiver daily and ask a yes/no question related to the occurrence.

In contrast, the BRC is designed to record each instance of behavior on a notecard when it occurs. It should be noted that though this data collection system does not allow for highly sensitive data analysis, it is sensitive to treatment effects. Nadler and Roberts describe the BRC as a system designed to allow caregivers to "capture the full range of discrete actions a child might display in a given day" (2013, p. 97).

Accuracy is an important measure, but how the behavior being measured is equally as important. The researchers found that the frequency count of the BRC was more accurate, despite the fact the binary measure of the PDR resulted in higher levels of IOA (Nadler & Roberts, 2013). This discrepancy is due to the binary nature of the PDR data, and it should be noted that the BRC provided a more accurate behavior count. The response effort involved in data collection will impact the reliability and frequency of data collection. As such, the author recommended that a BRC which records daily behavioral rate should be used by parents in behavioral observation to provide for continuous treatment evaluation in the natural setting and because it involves the parent directly making behavioral discriminations in real-time, setting the occasion for immediate implementation of prescribed treatment. One critical concern that was not addressed in this current study is the question of whether or not advances in modern technology could improve the outcomes of the caregiver data collection and what stimulus, if any, evoked and maintained responding.

Still on the evaluation of parental data collection modes, using a between-groups design, Nadler (2012) studied the BRC methodology intending to replicate and expand this technique of behavioral reporting. In line with this, the BRC and electronic BRC (eBRC) were empirically evaluated utilizing clinician observations, caregiver survey data, extensive home-based parental coding, and extra video coding evaluation by researchers to validate the data captured through either system. The eBRC is a system that requires parents to log observed misbehaviors via text message rather than tallies on a card. This system capitalizes on the ubiquity of mobile electronic devices and allows for experience sampling by permitting participants to report on events as they are experienced in the natural setting.

Because of the ubiquity of smart-device technology, electronic data collection as a replacement for traditional pencil-paper methods is a promising area of research in recent years (Tarbox et al., 2010). In his 2012 study, Nadler replicated the training and evaluation conditions from the Nadler and Roberts (2013) study with the exception that in the current study, the eBRC replaced the PDR. One result of this study supports the use of BRC as a measure of accuracy for child behavior when used by caregivers; however, when not in the presence of a researcher, the accuracy of recording did drop, though not significantly. The most relevant results of this study are that the eBRC did not produce the same level of accuracy in responding as the standard BRC. The authors suggest several variables may be responsible for this. One such variable is that mobile devices are ubiquitous, which may decrease the saliency of the device. The current model of the eBRC seems to suppress rates of behavior and, therefore, cannot be supported as a replacement for the standard BRC. The author discussed that one difficulty was using the data submission component for the eBRC likely leading to the subpar performance when compared to the BRC. In his 2012 study, Nadler ends with a statement that further investigation into the utility of an

electronic behavior recording system for caregivers is warranted. The author suggests reducing response effort via smartphone applications to collect and submit data, the use of feedback and encouragement for data collection behaviors, and scheduling prompts for caregivers via texts to improve adherence to observation and treatment procedure. These suggestions are in line with some of those provided by Stokes and Ones to promote skill generalization.

Currently, there is a dearth of literature evaluating data collection systems for the collection of behavioral data by caregivers. However, this is common if a not vital component of Applied Behavior Analytic interventions. A recent search on ProQuest revealed only a few studies in past years that have directly evaluated competing systems of caregiver data recording (Nadler, 2012; Nadler & Roberts, 2013). Future research should address the use of up-to-date mobile app technology, the inclusion of immediate social reinforcement via text messages or phone calls from a clinician. Several areas could be evaluated, such as child progress and fidelity of implementation. Which measures are best to take would also be well, for example, taking just self-monitoring data, child data, or both. Another area of research would be the inclusion of prompting to evoke data collection.

The purpose of this study is to evaluate caregiver rates of data collection when using pencil/paper data against a mobile-based treatment package designed to collect and submit the same data. This package will include the use of a mobile-app, inclusion of functional mediators in the form of push messages, a banner that appears across the screen, to act as prompts, and providing immediate putative social reinforcement via SMS text messages or phone calls shortly after data submission. Should this package fail to produce sufficient rates of responding, a focused Acceptance and Commitment training telehealth intervention will be provided by the principal investigator.

Method

Participants

Three caregivers that were unfamiliar with behavioral data collection procedures were selected to participate in this study. Participants were recruited through an ABA provider in Kalamazoo, MI, Twitter, and Facebook. Only one participant, Sarah, completed the study. Two others dropped out of the study due to giving birth and home stress. The only child who participated in this study, the subject of the data recording, was 4-years-old with a diagnosis of ASD and received ABA therapy at a rate of 20 hours per week. Due to the COVID19 pandemic, direct care ABA services were on hold while telehealth ABA services were conducted with the caregiver only.

Exclusion criteria for this study were the absence of an Android or iPhone device with a current operating system, unwillingness to install the eBRC mobile app, or prior experience using electronic behavior data collection.

Setting and Materials

The entire duration of the study took place in the home of the caregiver over video-based telehealth. The participant was required to use her iPhone device on which was installed the eBRC. She was also provided with enough paper data sheets to complete all conditions of the study. Each paper data sheet was 3 in (7.62 cm) X 5 in (12.7 cm).

Telehealth data collection training was conducted on the Zoom video chat platform. Telehealth required a high-speed internet connection, private home-office setting, cellphone, tablet, or laptop with a webcam and headphones with a microphone.

Independent Variables

The two primary independent variables in this study are the use of the eBRC data collection and the traditional BRC data collection methods.

Dependent Variable

The dependent variables in this study are the cumulative total of once-daily data submissions in either condition. The cumulative sum of weekly presentations will be counted by hand, weekly, for the BRC condition, and automatically calculated by a computer daily for the eBRC conditions.

Experimental Design

In this study, an alternating treatment design (ATD) (Barlow & Hayes, 1979) was used to compare the weekly participant number of data submission. The conditions in the design were presented randomly by flipping a U.S. Penny each morning; however, the experimenter did ensure that no condition was contacted for more than three consecutive days through manual corrections. Each session length of the ATD was three hours, beginning at a 3 PM and ending at 6 PM. This time frame was agreed upon as it was the most likely time of the day to observe the targeted behaviors per the participant's verbal report. Conditions were counterbalanced such that during a two-week period; the participant was exposed to each IV an equal number of times.

Procedure

Identification of Behavioral Targets

At the start of the study, the participant was provided with both data recording platforms that she would use for the duration of the study. During the initial meeting, one reduction behavior (inappropriate climbing on furniture) and one acquisition behavior (independent vocal mands) were chosen to monitor as they both related to her child's current ABA goals and programming.

The participant chose two behaviors she would be actively engaging with through teaching procedures. In coordination with the participant's ABA provider, training for this skill, but not data collection, to an 80% fidelity criterion across three post-training probe trials occurred before the implementation of the data collection.

Training

The experimenter trained the participant to collect data using both data collection procedures using both video models and a combination of provided written instructions, various models, and then practice opportunities with performance feedback from the experimenter. The participants received a total of 80 min of training, all of which occurred in one day. Before beginning data collection training, 15 min were spent to finalize and operationally define the chosen target behavior and answer any remaining questions on this topic. The remainder of the time was spent training on data collection. The time was spent such that the traditional data collection condition received 25 min of training prior to reaching the training termination criterion, and thee-BRC received 40 minutes of training prior to reaching termination criteria.

During each session, 5-8 min was spent watching a 3-min video model of the relevant data recording method with embedded written instructions and then answering any questions related to the video; however, only clarifying questions were answered. Following the initial model video for either condition, the participant was then exposed to a 15-min recorded training video with a predetermined number of target behaviors. In either setting, termination criteria were five consecutive correct responses during data collection.

For the BRC condition, the participant was trained on how to record relevant behavior data using a count method by hand using the paper datasheet. In the eBRC condition, first, the app was installed and set up on her phone. Then she was trained to operate the application by

pressing the correct button on the screen after the target behavior occurs then clicking submit when done recording for the day. Once the training was complete, any questions that the participant had were answered.

During either treatment, the recording modality utilized was a frequency count of observed behavior.

Intervention

Traditional BRC Data Collection Condition. In the traditional BRC condition, the participant was given ninety 3 in X 5 in datasheets (Appendix A), two labeled manila folders to organize new and used datasheets and some pencils. The datasheet contained three columns, labeled with the predefined target behaviors, in which the participant tracked the data by writing a tally mark to indicate that an instance of that behavior had occurred.

Data was collected, graphed, and reviewed by the co-investigator with the participant on a weekly basis. During this time, the participants were praised for completing data collection and were able to ask any questions she had. The data sheets were collected from the participant's home on Fridays of each week between 5 PM and 6 PM, by the co-investigator, at a time predetermined with each participant.

e-BRC condition. In the eBRC condition, when tracking behaviors, the participant opened the screen, clicked the corresponding count buttons, and returned to the app either to later submit data or to track further instances of behavior. Following any data submission, the participant was immediately shown an up to date line graph providing a visual analysis with a superimposed trendline following the third data submission for the behaviors being tracked (Appendix E) for the data recorded with the app only. Within 15 min of any data submission,

that participant received a text message from the experimenter with a general praise statement for engaging in data collection and a specific statement related to the behaviors being tracked.

Each day, the participants received one to two notifications on her phone automatically with a reminder to collect data regardless of the treatment condition. If there were a time in which the user did not open the app for longer than 12 hours, she would have received one additional reminder to open the app and take data.

Data Recording Target Skills

Count. During this condition, the caregiver was be asked to record only two behaviors as they occurred daily. She was required to collect data on the behavior identified during the initial training by counting the behaviors when they occur and submitting this data daily.

A data submission with the traditional BRC will be defined as a data sheet scored and dated, placed in the yellow manilla folder labeled "completed data submissions," dated for a day in which that type of recording was to have taken place. These will be tallied by a trained data collector weekly.

Data submission for the eBRC will be defined as a single row of data in the online database, dated for a day in which that type of recording was to have taken place and also which bared the username chosen by the participant.

Response Measurement

Accuracy

Data submissions were collected by a trained data collector to measure the participant's level of responding. Submissions were counted at the end of each week by hand for BRC data collection or daily through automated electronic means for the eBRC and then double-checked by hand. For either data collection system, submission counts were video recorded at the home

of the participant when retrieving data or recorded in the home of the data collector in his home office while counting using the online database. 33% of those videos were then reviewed later by the primary investigator to obtain an accurate measurement. Data was collected with 100% accuracy. The following formula was used:

$$\frac{\text{Number of counted data submissions with agreement}}{\text{Total number of counted data submissions}} \times 100$$

Reliability

33% of these data count videos were scored later a second time by the primary investigator observer to obtain a reliability measure. The reliability of the measure of the data submissions will be calculated by dividing the number of counted data submissions with 100% agreement by the total number of data submissions, then multiplying by 100. Reliability in data collection occurred with 100% agreement. The following formula was to be used:

$$\frac{\text{Number of counted data submissions with agreement}}{\text{Total number of counted data submissions}} \times 100$$

Inter-observer Agreement

At least 33% of all data count videos were reviewed and scored by an independent observer to obtain an inter-observer agreement on the experimenter's data collection. IOA was identified to be at a level of 100% agreement. Inter-observer agreement (IOA) was calculated by dividing the number of trials with 100% inter-observer agreement by the total number of trials and then multiplying them by 100. This is an IOA method which produces a conservative and meaningful index of agreement between observers.

The measure of IOA was calculated by a second observer completing the same operation described above. These data will be reported as dividing the larger of the two agreements by the smaller. The following formula will be used:

$$\frac{\text{smaller number of observed agreements}}{\text{larger number of observed agreements}} \times 100$$

Social Validity

The experimenter validated the social importance of the goals, the social acceptance of the intervention, and the social importance of behavior change. In order to validate the social importance of the goals, prior to beginning the experiment, the experimenter asked the participants questions regarding any data collection that they engaged in and how well they could describe the specific frequency of any given challenging behavior being addressed through ABA. The participant before the beginning of the study collected no behavioral data, reporting that although her child was in ABA, she was "usually too busy to worry about collecting the data." She was unable to describe the previous week of targeted behaviors stating that a lot of things happen and that it was "easy to forget how much behavior happens from day to day."

Validating the acceptance of the intervention occurred through the use of a Likert scale questionnaire administered to the participant at the end of the study. The questionnaire consisted of a 1-5 rating scale based on specific questions regarding data collection with the use of both the eBRC and the BRC. The participant reported having an understanding of the purpose of the study as 4/5. She felt that the methods employed in the study were both acceptable and that she was confident that she had the skills to continue recording data if needed for other behaviors.

Further validation of the importance of this intervention as an active agent of behavior change occurred through the comparison of pre and post-study data-collection behaviors. The participant both pre-study and post-study was provided with a datasheet and writing utensil, a cellphone with the eBRC app installed, 20 brief video clips video of a child engaged in either targeted or neutral behaviors, behavior definitions, and a sheet of graphing paper. During each interaction, she was asked to track and graph the behaviors using whatever method she preferred

while being video recorded without any further information. Following the termination of the study, an experienced data collector who was a Ph.D. level behavior analyst sorted these videos by answering the question of whether or not they felt the parent in the video was an effective data collector. Video clips were sorted correctly for 100% of the video clips.

Results

The total duration of the study took place over 25 days. During each day, there was one opportunity to respond, either using the e-BRC or the traditional BRC data collection. The alternating treatment phase took place across 20 cumulative days, while the final best phase lasted a total of 5 days. The cumulative daily data submission count results of this study are shown in Figure 1. The participant responded at a higher rate during the e-BRC condition than during the BRC condition. These individual rates are discussed below.

Alternating Treatment Phase

BRC. During traditional BRC data collection conditions, the participant submitted a total of four daily reports (40% of available opportunities) for a rate of .4 data submissions per session. This is the equivalent of one data submission every two-and-a-half sessions or a prorated rate of 2.8 per week. There was a range of 1-2 data submissions per week.

e-BRC. During e-BRC conditions, the participant submitted a total of ten daily reports (100% of available opportunities) for a rate of 1 data submission per session. This is the equivalent of one data submission per session or a prorated mean rate of seven data submissions per week.

Final Best Phases

During this phase, the participant was only exposed to the e-BRC data collection condition. This phase lasted a total of five days, during which there were a total of five data

submissions (100% of available opportunities). This equaled a response rate of 1 per session or a prorated mean of 7 data submissions per week.

Discussion

With the growing body of evidence demonstrating the importance and utility of caregivers as trainers and given the state of need for telehealth services with caregivers taking on the role of the primary clinician for their child, there is a need for a method of data collection which permits those caregivers to quickly and efficiently take these data. The results of this study support the efficacy of using mobile-based data behavioral collection systems for parents of children with autism to evoke and maintain high levels of data collection behaviors. More specifically, the results indicate that mobile-based data collection systems may be a more effective technology when compared to traditional means of data collection.

Although there are existent mobile-based behavioral data collection platforms already, none have been validated for use with caregivers, and many can be complicated to use requiring set up by a professional or needing navigation through multiple screens before reaching a datasheet, hence the simplicity of the eBRC and its design. The eBRC required a few button presses to accomplish the desired task. This low response effort, conjoined with inbuilt prompts and the ubiquity of mobile technology, is one suspected reason this platform produced higher response rates.

One potential reason for lower response relates when comparing paper/pencil vs. a mobile-based technology as to why they may not produce satisfactory results may be due to a differential history of reinforcement for engagement with mobile technology vs. paper and pencil. Also, there is a lack of generality programmed into the BRC data collection system itself. There are no salient prompts in the natural environment that are likely to evoke behavior. As

well, the reinforcement for the desired target behavior is far removed, often occurring only when a practitioner returns to a home or has scheduled their next telehealth visit.

In the current study, the participant had the same amount of brief exposure to either condition. One potential limitation is that due to the short duration of this study, it was not possible to explore sustained exposure to either data collection condition. Social praise may function as a reinforcer for data collection during the eBRC condition. However, longer terms may produce satiation to the effects of social approval resulting in behavior drift towards or even below BRC levels.

Further, another limitation in this study is the lack of ability to verify the accuracy of the participant's data collection. It should be noted that the chosen interval for data collection was 3 PM – 6 PM; however, at least one data submission occurred as late as 11:30 PM. In addition to the behavioral data collected, the total duration of interaction with the eBRC per data submission was recorded and is displayed in figure 2. There was a highly variable response duration range of 2.62 minutes with a minimum duration of data collection being .25 minutes and the maximum being 2.87 minutes. However, there was little variability in the child's responding. This duration would represent three hours of behavioral data. Mainly due to the more than doubled rate of the data collection with the eBRC, further study is warranted to identify the accuracy of the data collection. Additionally, further, investigate if response effort as a function of total time spent tracking is a variable affecting the response rate.

One final potential limitation might be a participant's prior experience with data collection methods before beginning the study. This limitation could be reduced by recruiting participants that are unfamiliar with behavior analytic data collection procedures. Future studies should compare these platforms of data collection over time and across a variety of data

collection formats such as ABC data collection and discrete trial training data collection. The last study to investigate an updated style of behavioral recording occurred nearly ten years ago.

Given the ubiquity and functioning state of current mobile technology, this study will be valuable in that it will serve to identify a contemporary and relevant behavioral data collection system for caregivers that may supplant or support traditional pencil-and-paper technology.

With the rise of telehealth during the global Coronavirus Pandemic, now more than ever, there is a need for a portable, versatile, and accessible form of data collection for caregivers. Giving caregivers a way to quickly and accurately track data could improve data collection rates. Up to date behavior graphs were immediately available following the submission of data when using the eBRC but not the BRC. Further studies should investigate the potential for the transformation of stimulus control as related to the visual sight of graphs and the associated private verbal behavior that occurs when conducting a visual analysis as a motivating operation or discriminative stimulus to engage in behavioral intervention activities.

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Figures

Figure 1

A comparison of traditional paper/pencil data collection vs an electronic treatment package

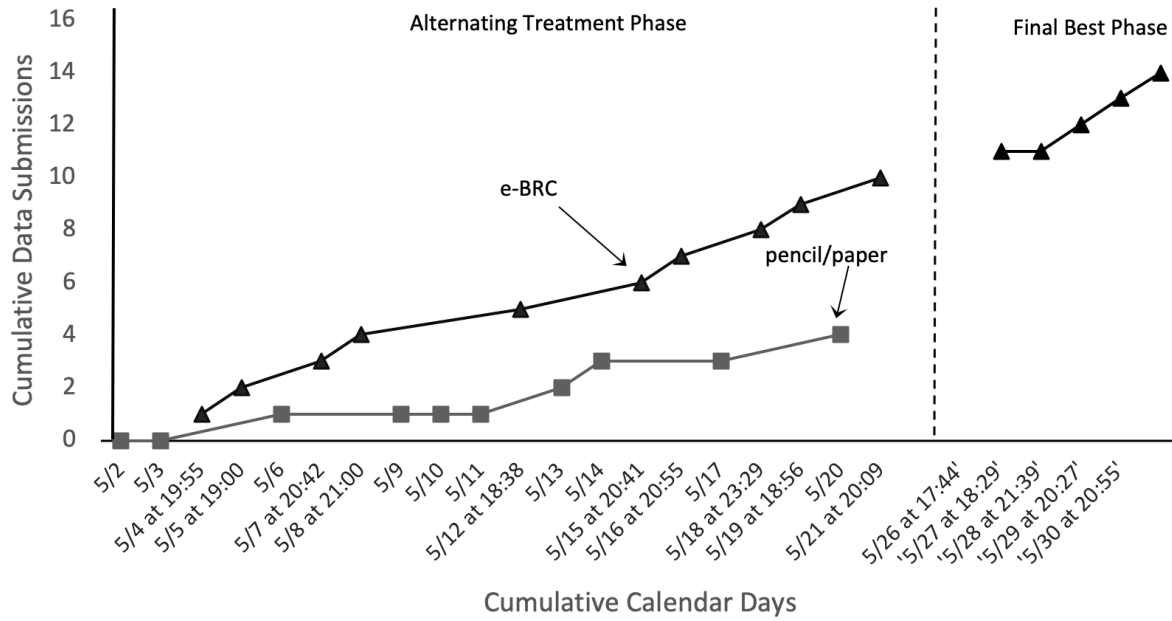


Fig 1. An evaluation of the electronic treatment package composed of a mobile-based app with built-in daily prompts and text based social reinforcement vs traditional paper and pencil data collection with delayed social reinforcement using an alternating treatment design.

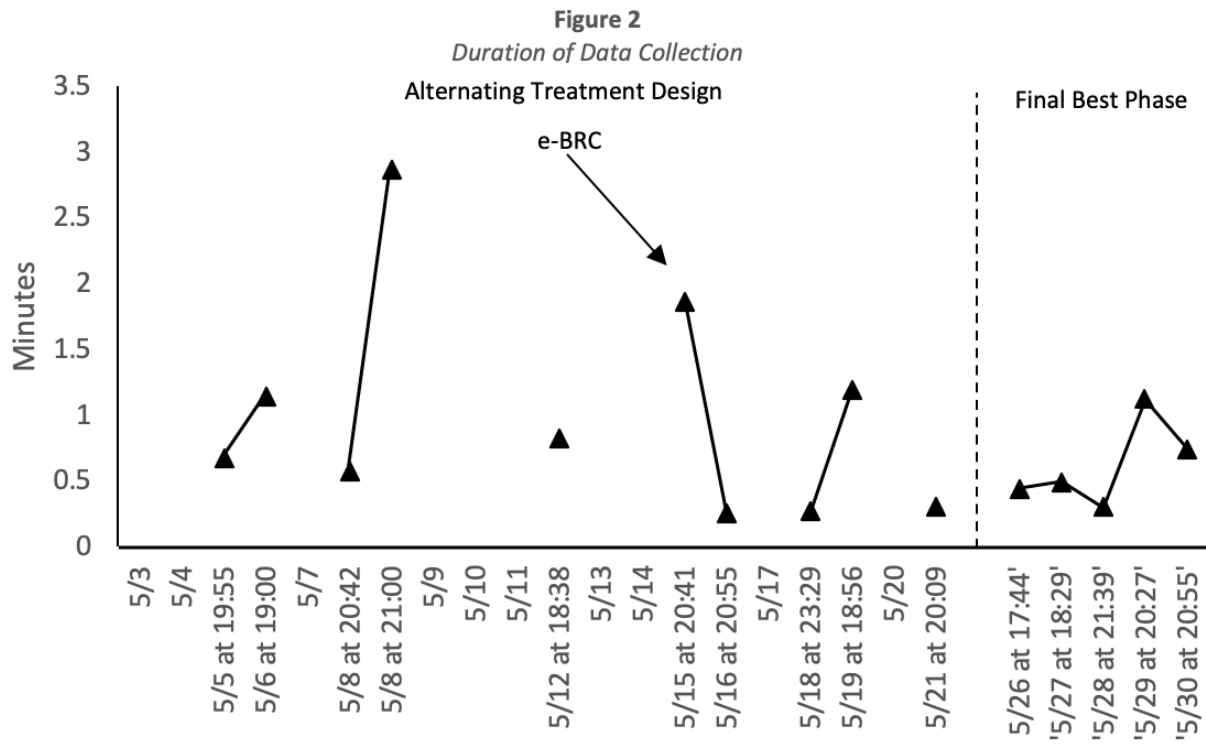


Fig 2. A visual analysis of the total duration of interaction with the electronic Behavior Report Card data collection platform.

Appendices

Appendix A

Behavior Report Card

Behavior Report Card Date:			Behavior Report Card Date:																																																																																												
BX1:	BX2:	BX3:	BX1	BX2	BX3																																																																																										
Tally behaviors as they occur today			Rate this behavior	Rate this behavior	Rate this behavior																																																																																										
			1 – Never occurring	1 – Never occurring	1 – Never occurring																																																																																										
			2 – rarely occurring	2 – rarely occurring	2 – rarely occurring																																																																																										
			3 – Sometimes occurring	3 – Sometimes occurring	3 – Sometimes occurring																																																																																										
			4 - Very often occurring	4 - Very often occurring	4 - Very often occurring																																																																																										
			5 - Always occurring	5 - Always occurring	5 - Always occurring																																																																																										
Behavior Report Card Date: BX1: BX2: BX3: Track behaviors as they occur either + or - <table border="1"> <tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr> <tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr> <tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr> <tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr> <tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr> <tr> <td colspan="5">Total % (+)</td> <td colspan="5">Total % (+)</td> <td colspan="5">Total % (+)</td> </tr> </table>																																																																														Total % (+)					Total % (+)					Total % (+)							
Total % (+)					Total % (+)					Total % (+)																																																																																					

Appendix B

e-Behavior Report Card registration/login screen



Register

Enter email

Enter password

Re-enter Password

Remember these details? ☐

Sign Up

[Already a user? Click here to sign In](#)



Sign In

Enter email

Enter password

Remember these details? ☐

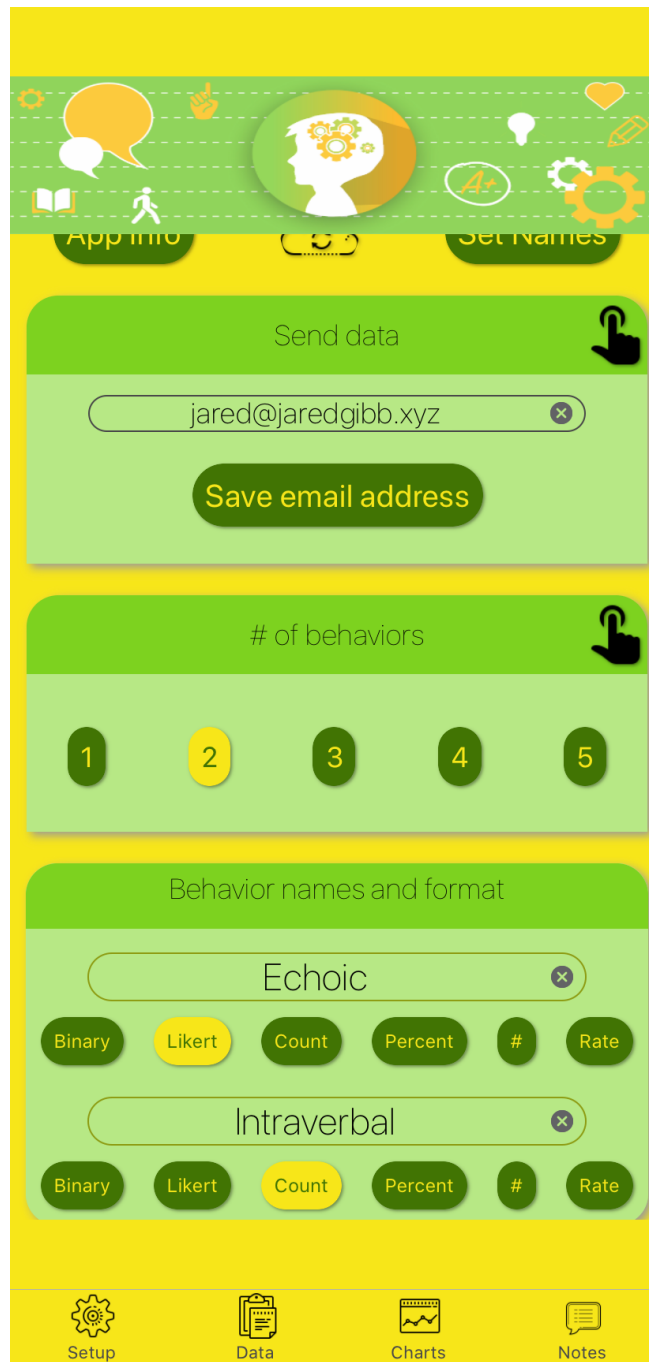
Sign In

[New user? Sign Up](#)

[Forgot Your Password?](#)

Appendix C

e-Behavior Report Card setup screen



The image shows a mobile application setup screen for an e-Behavior Report Card. The screen has a yellow background with a green header bar containing various icons. Below the header, there are three main sections: 'Send data', '# of behaviors', and 'Behavior names and format'. Each section has a green header bar with a title and a hand icon. The 'Send data' section has a text input field with the email 'jared@jaredgibb.xyz' and a 'Save email address' button. The '# of behaviors' section has five circular buttons labeled 1 through 5, with button 2 selected. The 'Behavior names and format' section has two text input fields, one with 'Echoic' and one with 'Intraverbal', each with a 'Binary', 'Likert', 'Count', 'Percent', '#', and 'Rate' button below it. The 'Likert' button for 'Echoic' and the 'Count' button for 'Intraverbal' are selected. At the bottom, there is a navigation bar with four icons: a gear for 'Setup', a clipboard for 'Data', a line graph for 'Charts', and a speech bubble for 'Notes'.

App info

Send data

jared@jaredgibb.xyz

Save email address

of behaviors

1 2 3 4 5

Behavior names and format

Echoic

Binary Likert Count Percent # Rate

Intraverbal

Binary Likert Count Percent # Rate

Setup Data Charts Notes

Appendix D

e-Behavior Report Card datasheet and graphs



Caillou's Datasheet

Rate how much Echos happened today.
1= not at all 5= all day long

Rate me!

Count Little wet as it happens today.

0

Track Successful echos as it happens today.

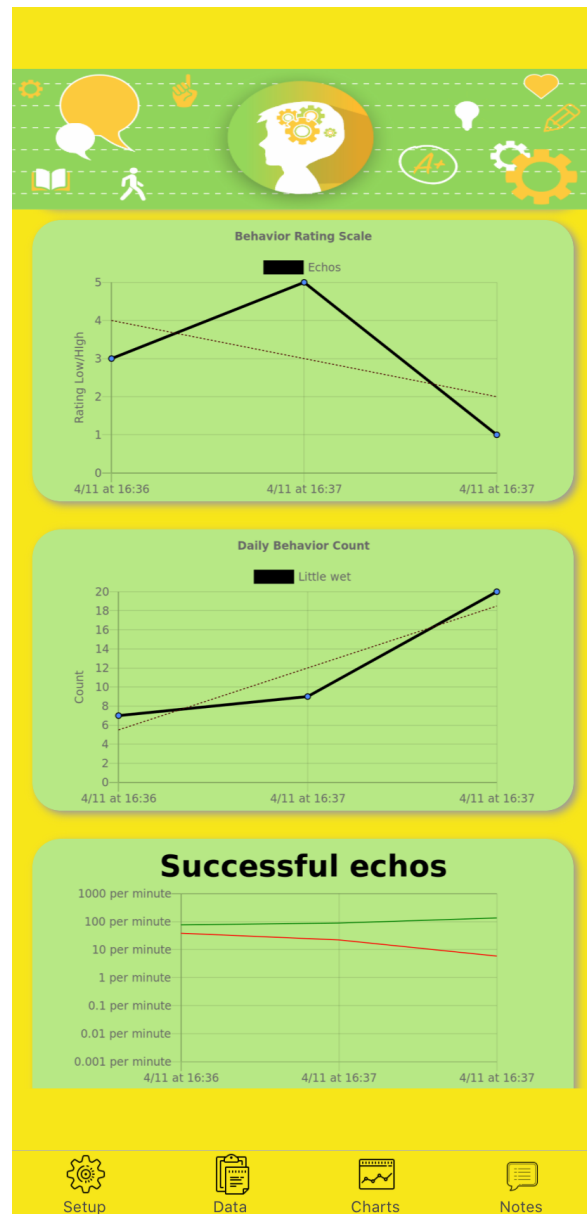
Timer off

C: 01:0

Feel free to leave any notes here

Enter any notes here

 Setup  Data  Charts  Notes



Appendix E

Social Validity Survey

Please fill this out and return it to Jared Gibb (coinvestigator). Your answers will in no way affect your participation in this study. If you have any questions about any of the items below, feel free to ask for clarification. If there is a question you do not want to answer, it is ok to leave it blank, and this will not affect your participation in this study.

To complete this survey, place an on the line that closes corresponds with your response.	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>
1. How often do you currently collect behavioral data? <i>1 = never 3 = often 5 = always</i>	<u> x </u>	<u> </u>	<u> </u>	<u> </u>	<u> </u>
2. How easy do you feel behavioral data collection is? <i>1 = very hard 3 = neutral 5 = very easy</i>	<u> </u>	<u> </u>	<u> x </u>	<u> </u>	<u> </u>
3. Would you prefer a cell phone or pencil/paper-based behavioral data collection system? <i>1 = cell phone 3 = no preference 5 = pencil/paper</i>	<u> x </u>	<u> </u>	<u> </u>	<u> </u>	<u> </u>
4. When asked about your child's behavior, how well do you feel you can accurately describe the <u>previous seven</u> <u>different consecutive days</u> ? <i>1 = not at all 3 = somewhat 5 = very well</i>	<u> x </u>	<u> </u>	<u> </u>	<u> </u>	<u> </u>

Appendix F

Goals and Methods Survey

Please fill this out and return it to Jared Gibb (coinvestigator). Your answers will in no way affect your participation in this study. If you have any questions about any of the items below, feel free to ask for clarification. If there is a question you do not want to answer, it is ok to leave it blank, and this will not affect your participation in this study.

To complete this survey, place an on the line that closes
corresponds with your response.

1 2 3 4 5

1. How well do you feel you understand the purpose of this study?

1 = not at all 3 = somewhat 5 = very well

_____ _____ _____ x _____

2. After completing this study, how confident would you feel if asked to collect further behavioral data for your child?

1 = not at all 3 = somewhat 5 = very confident

_____ _____ _____ _____ x

3. How acceptable do you feel the methods used during this study were?

1 = not at all 3 = somewhat 5 = very acceptable

_____ _____ _____ _____ x

Appendix G

e-BRC Screen Flow

