The Effects of Electronic Data Collection, Immediate Graphic Feedback, and Automated Scheduled Prompts on Data Collection Adherence

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THE EFFECTS OF ELECTRONIC DATA COLLECTION, IMMEDIATE GRAPHIC FEEDBACK, AND AUTOMATED SCHEDULED PROMPTS ON DATA COLLECTION ADHERENCE

by

Cody Morris

A thesis submitted to the Graduate College in partial fulfillment of the requirements for the Degree of Master of Arts Psychology Western Michigan University June 2016

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While data are essential to behavior analysis, collecting the type of data that behavior analysts often require can be a labor-intensive and time-consuming task. There have been many attempts to reduce the amount of time and effort required to collect behavioral data; most research in this area has been focused on computerized or electronic ways to do this (Dixon, 2003). While electronic data collection seems to be gaining popularity within applied behavior analysis, many obstacles still exist. The purpose of this project was to design a data collection system that is cost-efficient, adaptable, easy to use, and effective at increasing data collection adherence. All the programmed technology used in this study is free and can be downloaded onto any device that runs Apple iOS, Google Android, or Microsoft Windows. This study used a customized data spreadsheet with embedded immediate graphic feedback using the Microsoft Excel® app and automatic scheduled prompts using a calendar app. This study used an A-B design to examine the effects of an electronic data sheet, immediate graphic feedback, and automated scheduled prompts on data collection adherence.
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-It takes a village to raise a graduate student.

Cody Morris
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INTRODUCTION

Data collection adherence is vital in the practice of applied behavior analysis because behavior analysts rely heavily on data to make informed clinical decisions (Jackson & Dixon, 2007). One of the reasons behavior analysts focus on data is that when implementing behavior change programs, the data collected allow behavior analysts to maintain direct and continuous contact with the targeted behavior and monitor progress over time (Cooper, Heron, & Heward, 2007). This constant monitoring of data and the targeted behavior allows behavior analysts to assess and adjust treatment as needed. In their seminal article, Baer, Wolf, and Risley (1968) discussed the importance of data in determining if a procedure was responsible for a behavior change. This appreciation and valuing of data makes data collection a hallmark of the field of behavior analysis. Data collection is a key component in developing effective treatment strategies, implementing treatment effectively, and controlling for extraneous variables (Dixon, 2003; Sulzer-Azaroff & Mayer, 1991). If data on which behavior analysts rely are inaccurate, incorrect conclusions about a client’s progress and the intervention’s effectiveness may be drawn (Taber-Doughty & Jasper, 2012).

While data are essential to carrying out effective behavioral treatments, collecting the type of data that behavior analysts often require can be a labor-intensive and time-consuming task (Dixon, 2003). It is common for behavior analysts to create data sheets and behavior tracking systems and then assign the data collection task to others. The individuals who are responsible for collecting data—typically behavior technicians—are often the same people who are responsible for implementing the strategies outlined in behavior treatment plans. By requiring behavior technicians to collect data using a labor-intensive and time-consuming
process in addition to an already arduous task of administering behavioral programs, the behavior analyst may be contributing to the problem of poor data collection accuracy and poor treatment fidelity (Hagermoser-Sanetti & Kratochwill, 2008; Dixon, 2003).

There have been many attempts to reduce the amount of time and effort required to collect behavioral data; most recently, these efforts have focused on computerized or electronic processes of data collection (Dixon, 2003). Electronic data collection has been a growing area of interest in applied behavior analysis. Electronic systems have the potential to improve reliability and accuracy of data recording relative to traditional methods, as well to improve the efficiency of data calculation and graphing. Using computers for recording and analyzing data has become increasingly important for both clinical work and research (Kahng & Iwata, 1998). Previously, the cost for devices and programs for the devices to collect data were excessive, which prevented many from using electronic means of data collection. As technology continues to advance and lower in price, more behavior analysts are likely to begin utilizing these devices for data collection purposes (Whiting & Dixon, 2012).

While electronic data collection seems to be gaining popularity within applied behavior analysis, many issues for this type of data collection still exist. Limitations with the current technologies for electronic data collection include price, adaptability, ease of use, and compliance with privacy and security guidelines. While the price of programs for electronic data collection have lowered significantly as more programs have been developed, they are still more expensive than paper and pencil data collection. Adopting and implementing electronic data collection requires purchasing devices that will run the data collection software, as well as purchasing the application or program that will be used to collect and store data. Agencies providing services to individuals exhibiting severe aggression or property destruction may need
to factor in cost of replacing devices frequency due to damage. In addition to sometimes being costly, many data collection programs can be rigid and inflexible to specific data needs. As a result, behavior analysts frequently design customized data collection procedures to fit their clients’ needs, suggesting that inflexible programs can place limitations on what modifications behavior analysts can make to data collection. Finally, current standardized programs may lack user-friendliness. In attempting to meet a variety of clinical needs, data collection systems may have too many features and appear too complex. For instance, a behavior analyst may ask a behavior technician to collect partial-interval target behavior data using an electronic system that has multiple options that are not applicable to the data collection needs. This means the behavior technician must sort through all of the functions and options before they can enter the data they need to. This complexity may result in lower data collection accuracy or even lower overall data collection because it takes more time, is distracting, and requires upfront effort to learn the system.

Even with the current limitations, electronic data collection is continuing to gain popularity among practitioners, so it may be beneficial to attempt to find solutions to existing issues. One potential solution is a low-cost electronic data collection program that can be customized to the data collectors’ needs. Currently, there is a limited body of literature on this topic. Dixon (2003), Jackson and Dixon (2007), and Whiting and Dixon (2012), all described task analyses on how to write and create programs for data collection. While writing and creating a customized program may address the issue of lack of adaptability, writing and creating an entire program may be too daunting for behavior analysts who may not have programming skills. A potential solution may be to construct electronic data collection systems within already-existing, commonly-used software. This solution may also have the benefit of allowing the
behavior analyst more flexibility in adapting software to his or her needs on an ongoing basis.

The current study evaluated an electronic data collection system which did not require specialized programming and coding skills to develop. This electronic data collection system used the Microsoft Excel® app and could be used on mobile devices (e.g., smartphones, tablets). Using the pre-existing Microsoft Excel® app helped address potential affordability limitations because the application was free and downloadable on any type of mobile device supported by Apple iOS, Google Android, or Microsoft Windows. Using a program that can be downloaded on any device was an advantage because it allows practitioners the flexibility to find devices that fit their price range, which increases the accessibility of the technology. Using the Microsoft Excel® app also addressed the issue of adaptability because the data being collected could be completely customized within the confines of Microsoft Excel®. Many behavior analysts already use Microsoft Excel® to graph client data and to create paper data collection sheets, so adapting data sheets within Microsoft Excel® could be relatively simple. Finally, using the Microsoft Excel® app also addressed the issue of ease of use because the practitioner would have complete control over the customized data sheet within the app.

In addition to using a customized spreadsheet in the Microsoft Excel app, the current study assessed the combined effects of two features that were added to the electronic data sheet to form a treatment package. These additional features were chosen because they could be programmed into the device to function automatically and both utilize two common behavior change techniques. The additional features were feedback and prompts, both of which have been shown to encourage behavior change (Bekker et al., 2010; Clayton & Helms, 2009; Squires et al., 2008).

Immediate graphic feedback was built into the electronic data sheet to occur
automatically as part of the treatment package. Two studies by Goomas (2012) showed that a technology-based intervention with immediate auditory and visual feedback was effective at reducing employee error and increasing performance productivity. A study by Moon and Oah (2013) showed that using an automated feedback system produced a substantial improvement on the targeted behavior of safe sitting posture with office workers and a literature review by Alvero, Bucklin, and Austin (2001) supports performance feedback as a means of increasing performance in a variety of settings. As increasing adherence and completeness of data collection were the goals of the study, adding a component that has been shown to be effective in increasing targeted behaviors and requires no extra cost or time for a supervisor were appropriate.

In addition to the electronic data sheet with immediate graphic feedback in the Microsoft Excel app, the data collection system also utilized automated scheduled prompts using a calendar app on the device. While Alvero, Bucklin, and Austin (2001) and Moon and Oah (2013) both support feedback as a means of increasing performance and reducing errors, both recommend combining feedback with an antecedent-based intervention, such as prompting for the best and most consistent results. A study by Van Houten and Sullivan (1975) also showed the efficacy of auditory prompting by demonstrating an increase in teacher praise rate. Adding an automated scheduled prompt through a calendar app was also of no extra time or financial cost to supervisors, but fit the goals of the study. Automated scheduled prompts consisted of an automatic reminder that produced an auditory prompt on the tablet by making a notification sound and a written description of what the behavior technician needed to do (e.g. “please enter 9:00AM to 9:15AM data”) every time participant was required to enter data.

The purpose of this study was to examine the effects of an electronic data collection
system consisting of an electronic data sheet, immediate graphic feedback, and automated scheduled prompts on data collection adherence with behavior technicians working in an intensive residential treatment facility for children with autism.

**METHOD**

**Setting and Materials**

This study took place in the residential portion of an intensive treatment facility for children with autism. This facility provides intensive behavior interventions to children with autism who have significant behavioral challenges. The staff at this facility were behavior technicians, who were mainly made up of college students. The behavior technicians’ main responsibilities were to implement recommended behavioral interventions and to collect target behavior data using a paper/pencil, 15-minute partial interval system. The behavior technicians’ training consisted of an intensive, multiple-week long program that went over behavior interventions and company policies. This treatment facility was chosen for the study because they reported persistent issues with data collection fidelity, and they were seeking to pilot an electronic data collection system.

Each observation lasted 1 hour and took place around the client’s scheduled classroom time (i.e., 9:00am to 11:00am). Classroom time was chosen for observations because it was the most consistent part of the schedule which would help control for variables related to activities. While observations were scheduled to take place during the specified classroom time, if irregularities in scheduled resulted in staff data collection occurring outside of the classroom, observations were still conducted. Observers noted when observations occurred outside of the classroom on the data collection adherence form (see Appendix C). Observations were usually conducted for 1 hour a day, 4 days a week, but irregularities in the schedule sometimes caused
data collection to end early or be prevented all together. For example, the client whose data collection system was being monitored had doctors’ appointments, visiting family, and school changes that delayed or prevented his presence during scheduled observations.

Observations consisted of the researcher and research assistants observing a group of behavior technicians and clients. During observations, the researcher and research assistants would stand in the corner of a room and away from activities. Most observations (73%) took place at least partially in the classroom. Groups typically consisted of 3 to 6 behavior technicians with 3 to 7 clients. As a group, behavior technicians were responsible for collecting data and implementing behavior plans for each client in their group.

During the study, participants utilized all the materials that behavior technicians use on a regular basis at the treatment facility. These materials included materials for clients (e.g., reinforcers and PECS books) and paper data sheets (see Appendix E). In addition to the typical materials used, one password protected tablet computer (Samsung Tab® 4) with the Microsoft Excel® and the standard Samsung® calendar app was utilized. The tablet was protected by a full-body, water resistant case to prevent and minimize damage. The tablet was used to replace the traditional data collection system which involved paper data sheets stored and carried in binders. Within the Microsoft Excel® app on the tablet, an electronic data collection system was created that included every component of the traditional data sheet (see Appendix F).

The electronic data sheet consisted of all of the components of the paper data sheet, but it also included immediate graphic feedback built into the data sheet. These electronic data sheets on the Microsoft Excel® app were saved onto the tablet, and then uploaded onto the facility’s secured Google Drive™ account using a computer at the facility. In addition, automated scheduled prompts were programmed into a calendar app on the tablet. The tablet also had a task
analysis on how to enter data using the system set as the home screen and lock screen background. This task analysis was the same one used when staff were trained to use the new electronic data collection system (see description below). Within the tablet, other apps could be accessed, but the Microsoft Excel® app was the only app set on the home screen.

Data collection adherence forms (see Appendix C) were used by the observers to record data on staff’s data collection adherence.

**Subject Recruitment/ Consent Waiver Process**

All behavior technicians who worked with the client and worked first shift participated in this study. This client was selected based on the amount of time he was expected to stay at the center (i.e. they weren’t expected to leave in the next 4 months) and that they attended school at the center. Inclusion criteria for the behavior technician participants were (a) they were employees of the facility, (b) they worked with the client whose data collection system was being monitored, and (c) they worked on the first shift.

This study was considered a program evaluation. Thus, at the beginning of the study, behavior technicians were provided information about the study. The researcher explained that the information collected would be protected, de-identified, and averaged with all other staff data. It was also explained that the information collected may be disseminated. The student investigator then provided and explained the consent waiver forms to the behavior technicians. The consent waiver forms explained that data would be taken on all staff who use the data collection system, but all data would be averaged to examine the overall staff performance, not individual performance. This process for informing the behavior technicians of the study and waiving the consent process because all data would be averaged, was approved by the university’s Human Subject Institutional Review Board.
Design and Experimental Analysis

This study utilized an A-B design. The A-B design consisted of an initial baseline phase in which the treatment was absent, and an intervention phase in which the treatment was introduced (Cooper, Heron, & Heward, 2007). Baseline data on staff using the standard paper data collection were first collected until stability was shown in the data. Once baseline data were stable, the electronic data collection system was introduced.

The research plan involved the implementation of a multi-element or reversal design to examine the effects of the electronic data collection system on the dependent variables. However, due to the participant’s unavailability for the remainder of the study (discussed later), this was not possible. As a result, this study utilized a naturalistic A-B design to examine the effects of an electronic data sheet, immediate graphic feedback, and automated scheduled prompts on data collection adherence. The effects of the intervention package were assessed by comparing data collection adherence before and after the implementation of the electronic data collection system.

Dependent Variables

The facility’s data collection system required data to be collected using a 15-minute partial interval system that was further broken down into 5-minute intervals. That is, while staff were instructed to collect data every 15 minutes, the data sheets were broken into 5-minute intervals, in which staff were required to indicate whether the behavior occurred within each specific 5-minute interval (see Appendix D). Each 5-minute interval on the paper data sheet allowed behavior technicians to indicate if specific target behaviors (e.g. aggression or self-injurious behavior) occurred during that interval. The primary dependent variable was data collection adherence by behavior technicians. For the purposes of this study, data collection
adherence was defined as recording data following the facility’s data collection requirements. This was measured in three ways.

The first way data collection adherence was measured was by determining if the behavior technicians collected data on time. On-time data collection was defined as the behavior technician recording data within 2 minutes of the end of the 15-minute interval. For example, to record data on time for the 9:15am to 9:30am interval, the behavior technician must enter data for that interval sometime between 9:30am and 9:32am. Data collection was not considered on time if it occurred any time before or after the 2-minute data collection window.

The second way data collection adherence was measured was by assessing if the behavior technicians recorded the occurrence of a target behavior within the correct 5-minute interval in which the target behavior actually occurred. For example, if aggression occurred during the 9:15am to 9:20am interval, the behavior technician would need to indicate that aggression occurred during that specific interval to be considered correct. An entry was considered incorrect if the behavior technician recorded target behaviors as occurring during a 5-minute interval that did not contain target behaviors or if they did not record target behaviors during a 5-minute interval that did contain target behaviors.

The third way data collection adherence was measured was by recording whether the behavior technicians indicated the correct frequency of 5-minute intervals that contained target behaviors. For example, if aggression occurred during 2 different intervals (e.g., 9:30am to 9:35am and 9:35am to 9:40am), the participant would need to indicate that 2 different 5-minute intervals contained aggression to be considered correct.

Overall staff performance of data collection adherence for one client’s data collection system were divided into bins of ten 15-minute intervals. Aggregating and averaging the
behavior technician’s data collection adherence data into bins of 10 intervals was selected because it provided a consistent means of grouping the data together to allow it to be averaged and analyzed. In addition, participant data were aggregated instead of using individual participant data because inconsistencies with staff scheduling made individual data collection unfeasible. Similarly, other barriers to data collection such as changes in the client’s schedule made the number of intervals that could be observed vary from one day to the next.

**Interobserver Agreement**

Interobserver agreement (IOA) was conducted by having an independent observer collect data on the dependent variables using the same data collection methods and definitions as the primary observer. For observations during which IOA data were collected, data obtained by the primary observer were compared to data obtained by the independent observer. Agreements in the data were counted when both observers coded the same occurrences within the same interval. A disagreement occurred when one observer recorded anything that was not recorded by the other observer in the same interval. IOA was calculated using a point-by-point agreement ratio method. Agreement was calculated by dividing the number of intervals that contained agreement by the total number of intervals, then multiplied by 100.

IOA data were collected during 32.5% of baseline observations and 52.5% of treatment observations. The overall IOA score for the study was 99.6% with a range of 93-100%.

**Experimental Conditions and Independent Variable**

**Baseline.** During baseline, each behavior technician was asked to collect data as usual using the paper/pencil recording system typically used in the center. Baseline resembled what a normal day for the behavior technicians looked like except the student investigator was
collecting data on their performance. There was no additional training given to behavior technicians on data collection outside of the typical facility training.

A typical day for a behavior technician in this setting consisted of working in a group with 2 to 5 other behavior technicians and 3 to 7 clients. In this group, behavior technicians were responsible for collecting target behavior data and implementing interventions from clients’ behavior plans, as well as guiding the clients through their daily routines. Typically, supervisory staff delivered no prompts or performance feedback to the behavior technicians regarding their data collection adherence. Clocks, watches, and cell phones were used by the staff to track the time for data collection.

Data collection requirements for the behavior technicians consisted of completing 15-minute scheduled interval data on target behaviors for each client. The data sheets (see Appendix E) consisted of 5-minute intervals within the required 15-minute interval, where staff were required to indicate each 5-minute interval that contained target behavior by circling the appropriate target behavior that occurred (see Appendix K). In addition to indicating intervals that contained target behavior, the behavior technicians were required to write their initials to indicate who supervised the client during that interval and enter a severity score for any problem behavior that occurred. Severity scores were used to indicate the intensity of the target behaviors that occurred.

Treatment. Treatment included all of the components of the baseline condition, except that participants used an electronic data system that included every aspect of the paper data sheet. The electronic data collection system consisted of an electronic data sheet, immediate graphic feedback, and automated scheduled prompts. Together, these constituted the independent
variable in the current study. During the treatment phase, the electronic data collection system was used continually during the first shift, Monday through Friday.

Behavior technicians were trained by the student investigator on how to use the data collection system prior to the implementation of treatment. The training did not include any information about correct data collection tactics. Instead, training specifically focused on how to navigate the electronic data collection system and oriented the behavior technicians toward the automatic graphic feedback component of the intervention. Using a behavioral skills training (BST) approach to training, the researcher described the electronic data collection system and modeled how to use the electronic data collection system. Then staff practiced using the electronic data collection system while the researcher provided feedback on their navigation and use of the electronic system (not on their accuracy of recording). Training was complete when each staff member successfully entered sample data into the data sheet independently. This training was completed by all behavior technicians in one session during the course of a weekly staff meeting.

The electronic data sheet was made to reflect the paper data system, but also included conditional formatting. The conditional formatting consisted of cells that turned red when behavior technicians indicated that target behaviors occurred during that interval. Also, the severity score cell was conditionally formatted to turn yellow for each interval that contained target behavior (see Appendix G). All data were entered by selecting from dropdown menus programed into each cell on the Microsoft Excel® table. The only step that required information to be typed into a cell was when the behavior technicians entered their initials to indicate that they supervised that interval.
The electronic data sheet included built-in immediate graphic feedback. The immediate graphic feedback consisted of graphic displays of behavior technicians’ on-time and late/early data entries. One graphic display showed if data were entered on-time or not for each 15-minute interval and another showed the average of number of times data were on-time or late/early by hour (see Appendix H). In addition, graphic feedback on the client’s target behaviors were also visible to participants throughout the day (see Appendix I).

The last component of the treatment package was the use of automated scheduled prompts programmed through a calendar app on the tablet. Automated scheduled prompts consisted a notification sound which was activated every time the participant was required to enter data (i.e., at the end of every 15-minute interval). A reminder notification appeared on the tablet once every interval and provided an instruction (see Appendix J). For instance, at 1:15PM an automated scheduled prompt chimed and a visual prompt also appeared on the tablet’s screen that said “please enter 1pm to 1:15pm data.”

**Methods of Data Collection**

Data collection consisted of the researcher and/or research assistant directly observing the behavior technicians conducting typical sessions at the treatment facility and recording the dependent measures during 1-hour observations sessions every morning, four times a week. The observations took place in the residential portion of the facility. The observers remained out of sight during sessions and did not interact with any participant or client. Before data collection began, the researcher described the purpose of the study to all the behavior technicians during a weekly staff meeting.

Prior to any observations, the researcher and research assistants took part in the treatment facility’s orientation training. The research assistants were college students enrolled for
practicum credit through a program at the treatment facility, who were chosen to help with the study because of their familiarity with and experience at the facility. The orientation training instructed observers on what to do if an emergency or dangerous situation occurs.

Following the facility's orientation training and before collecting baseline data, the researcher trained the research assistants on how to collect data on data collection adherence. The data collection adherence training consisted of the researcher showing the research assistants the data collection adherence forms, the researcher modeling how to use the form, and the research assistants practicing taking data on the form while the researcher provided feedback. Training was complete when each research assistant correctly used the data sheet to record data when the researcher provided verbal data collection scenarios.

Baseline data were collected on behavior technician data collection adherence with one client’s data collection system. During treatment, the data collection system was changed from the paper data collection system to the electronic data collection system for the selected client’s system only. All other client data collection systems remained the same.

**Fidelity of the Electronic Data Collection System**

Fidelity data were collected on the functioning of the electronic data collection system. Data were recorded on whether the automated scheduled prompts occurred at the appropriate times (see Appendix C) and on whether the tablet correctly displayed the immediate graphic feedback for data being entered on-time. Fidelity data were taken in 100% of the observations. As a result of a lot of ambient noise in the environment, observers only heard the automated scheduled prompts’ notification sound 55% of the time. While the notification sound was not always heard by the observers, there was no reason to suspect that it was not working or occurring. The researcher checked the tablet at least three times per week and the notification
volume was at the maximum setting each time. The graphic feedback was 100% accurate for data being entered on-time during observations.

Social Validity

Social validity was measured using a 7-point Likert scale questionnaire (see Appendix B). The social validity questionnaire was provided to the behavior technicians following the study. The questions were presented as multiple choice with the option to comment for each question. The social validity questionnaire evaluated the acceptability of the electronic data sheet, immediate graphic feedback, and automated scheduled prompts.

RESULTS

Figure 1 shows the percentage of on-time data entries, intervals that behavior technicians correctly labeled as containing target behavior, and intervals where the behavior technicians correctly indicated the frequency of intervals that contained target behaviors within bins of ten 15-minute observations. During baseline, stable, low levels were observed for on-time data entries and intervals that behavior technicians correctly labeled as containing target behavior. On-time data entries occurred an average of 7.75% of the time, with a range of 0 to 20%. Intervals that the behavior technicians correctly labeled as containing target behaviors occurred an average of 39.75% of the time with a range of 33 to 50%. Intervals where the behavior technicians correctly indicated the frequency of intervals containing target behaviors were at a variable, moderate-to-high level with a downward trend. Behavior technicians indicated the correct frequency of intervals an average of 52.25% of the time with a range of 33 to 75%.

When the electronic data collection system was first implemented, stable, high percentages of correct data were observed across all three measures of data collection adherence. On time data entries occurred an average of 95% of the time with a range of 90 to 100%, and intervals that
the behavior technicians correctly labeled as containing targets behaviors and intervals where the behavior technicians correctly indicated the frequency of intervals containing target behaviors occurred each averaged 91.5% of the time with a range of 83 to 100%.

After two data points were obtained during the electronic data collection phase of the study, the schedule of the client whose data collection system was being observed changed abruptly. As Figure 2 shows, following the schedule change, levels of all three measures of data collection adherence dropped significantly and remained at low and stable levels. On time data entries occurred an average of 25% of the time with a range of 20 to 30%. Intervals in which the behavior technicians correctly labeled as containing target behaviors occurred an average of 42% of the time with a range of 39 to 45%. Intervals where the behavior technicians correctly
**Figure 2. Data Collection Adherence**

indicated the frequency of intervals containing target behaviors occurred an average of 44.5% of the time with a range of 44 to 45%.

Behavior technician responses to the social validity questionnaire were fairly neutral across almost all questions. On the 7-point Likert scale, the scores ranged between 3.17 and 5.5 (see Appendix M) Two questions received the lowest ratings of 3.17. These questions asked if behavior technicians thought the electronic system was easier to use than the paper data system and if the electronic data collection system helped them collect data more accurately. The question that received the highest rating of 5.5 asked if they thought the graphic feedback was easy to understand. All other questions fell in the range of 3.5 and 4.42.
DISCUSSION

The purpose of the current study was to assess the effects of an electronic data collection system consisting of an electronic data sheet, immediate graphic feedback, and automated scheduled prompts on data collection adherence with behavior technicians working in an intensive residential treatment facility for children with autism. Results indicated that the electronic data collection system initially proved to be effective at increasing data collection adherence. However, when a schedule change occurred, these results did not maintain. Another schedule change then occurred, which made the client whose data collection system was being observed unavailable for observation. Thus, further data collection on data collection adherence was not possible. Because of the limited data and the A-B design, the data obtained in the study are inconclusive.

While all three measures of data collection adherence significantly increased when the electronic data collection began, unexpected changes in the schedule of the client whose data collection system was being observed significantly impacted the data. After only two data points were obtained during the electronic data collection phase of the study, the client began attending an outside school during a portion the observation period. The scheduled observations could not be changed because the electronic data collection system had only been built for the first shift. The targeted time period for data collection during the first shift was one that the researchers felt would be most consistent and structured. All other activities during the first shift were highly unstructured and variable, which could have caused variability in the data that was spurious to the research question. As a result of the change in schedule, the amount of time that observers could collect data significantly decreased. Only two additional data points were obtained
following the change in the client’s schedule before the client’s time at the school increased, which prevented any further observations.

In addition to the reduced amount of opportunities to conduct observations, the schedule change may have affected data collection adherence in other ways. After the client began attending the outside school in the mornings, all three measures of data collection adherence decreased significantly. This sudden decrease in data collection adherence could have been caused by many factors, but there were three factors that seemed most apparent. One factor that may have affected data collection adherence was the behavior technicians having to adjust to a client rejoining the group. The assignment of who works with the client within the context of the larger group became more unpredictable and less structured during this time. During observations before the school change, behavior technicians were assigned to specifically work with the client. After the school change occurred, a behavior technician would have to stop their current task to begin working with the client when he returned from the outside school. These transitions were often delayed and appeared disorganized. Thus, there may not have been clear guidance on who was responsible for the client’s data collection on these days. Anecdotally, another factor that may have influenced data collection adherence was that the client began displaying much higher rates of problem behavior when he began attending the outside school, even when he returned to the facility. As a result, the number of opportunities for the behavior technicians to collect data also increased. It is also possible that the staff were so busy attending to the problem behaviors that they could not attend to data collection. That is, the target behaviors may have been so frequent that they competed with data collection. The third factor that may have contributed to reduced data collection adherence after the schedule change was that there were no behavioral consequences associated with the graphic feedback. Loewy and
Bailey (2007) and Balcazar, Hopkins, and Suarez (1985) both described that feedback must be tied to behavioral consequences to be effective. During this study, when the behavior technicians saw the graphic feedback for on-time data entries decrease with no consequences, any motivation that the graphic feedback provided previously would be lost.

When the study began, the researcher intended to use an alternating treatments design with individual participants, but was unable to collect an appropriate amount of data. Staff turnover at the center made collecting individual behavior technician data unfeasible, so the design of the study was changed to an A-B-A reversal design where all behavior technician data were aggregated and averaged. The researcher then used an A-B-A reversal design, but was unable to collect return to baseline data due to the unexpected schedule changes. The A-B design limits our conclusions about electronic data collection systems, because no functional relation can be drawn between the electronic data collection system and the increase in data collection adherence. While the significant increase in data collection adherence occurred at the onset of implementing the electronic data collection system, we cannot claim a functional relation without verification and replication (Cooper, Heron, & Heward, 2007). In addition to design flaws, the restricted amount of data collected is also a major limitation of the study. The start of the electronic data collection system began to show positive effects with two significantly increased data points for all three measures of data collection adherence, but the amount of data collected during the treatment phase was not sufficient to draw strong conclusions about the effects on data collection adherence.

Other limitations of this study consist of weaknesses of the electronic data collection system. This study evaluated the combined effects of an electronic data collection system as a whole, so there was no way to evaluate the effects of the individual components (i.e., electronic
data sheet, immediate graphic feedback, and automated scheduled prompts). Also because this study did not look at the individual component effects, it was difficult to assess if the behavior technicians came into contact with the individual components. While the immediate graphic feedback was displayed directly next to the section where the behavior technicians entered data on the tablet, there was nothing set in place to guarantee that they oriented to the feedback. Also, it was difficult to assess if the automated scheduled prompt notification sound could be heard at all times by the behavior technicians. The classroom where the study took place had a tendency to be loud, so there were likely times that the behavior technicians could not hear the notification sound. During the observations, the observers recorded hearing the notifications 55% of the time, but were not nearly as close to the tablet as the behavior technicians.

Future researchers interested in using a similar electronic data collection model should consider evaluating individual components of the data collection system. Isolating individual components of the data collection system by conducting a component analysis would be beneficial for understanding what aspects of the electronic data collection system are crucial for producing effects on data collection adherence (Ward-Horner & Sturmey, 2010). A component analysis would also be helpful in determining if there are aspects of an electronic data collection system that have effects on the data collection adherence, but are not the anticipated beneficial components. A component that may be of interest, but was not assessed during this study, is response effort and time it takes to use for using the electronic data collection system compared to the paper data collection system. A study by Tarbox et al., (2010) showed that a data collection system they investigated did not increase data collection accuracy, but did increase the amount of time it took to enter data. The amount of relative response effort and time it takes to enter data, may affect data collection adherence. While investigating response effort and the
amount of time it takes to enter data on electronic and paper data collection systems, it would be interesting to compare the response effort and amount of time it takes to enter data on time versus backfilling in and entering late data.

Any further research on electronic data collection systems should assess for generalization and maintenance of the effects. The current study only evaluated the effects of the electronic system on data collection adherence using 15-minute partial interval system for one client. Future research should evaluate an electronic data collection system for other types of data collection (e.g. frequency) and use it with more clients. Maintenance of data collection adherence should be assessed during structured and unstructured times in the schedule. The results of the significant change in schedule during this study may indicate that electronic data collection systems can only be effective at increasing data collection adherence during a structured time because data collection adherence significantly decreased when things became unstructured. It will be important to find out if an electronic data collection system can improve data collection adherence in unstructured and tumultuous environments. The results of this study also indicated that data collection adherence may be affected by the amount and level of challenging behavior. Future should assess data collection adherence across different amounts and levels of challenging behaviors. In addition, it is important to assess the maintenance of the effects over time. This researcher was unable to collect enough data to determine whether the increases in data collection adherence would have continued over time if uninterrupted.

Finally, further research should assess the secondary effects of increasing data collection adherence. Possible secondary effects of increased data collection adherence that may be important to evaluate are treatment fidelity and the impact on client outcomes. While accurate data seem important, if the client does not benefit by receiving better treatment and having their
outcomes improved as a result, increasing the data collection adherence may not be socially significant. Research that measures treatment fidelity along with data collection adherence and compares the amount of target behaviors that occur before and after the implementation of a data collection system, could determine if accurate data collection and data collection adherence benefit the client.
REFERENCES

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APPENDIX A

HSIRB Approval
Date: September 29, 2015

To: Stephanie Peterson, Principal Investigator
    Cody Morris, Student Investigator for thesis

From: Amy Naugle, Ph.D., Chair

Re: HSIRB Project Number 15-09-03

This letter will serve as confirmation that your research project titled “The Effects of Electronic Data Collection Immediate Graphic Feedback and Automated Scheduled Prompts on data collection Accuracy” has been approved under the expedited category of review by the Human Subjects Institutional Review Board. The conditions and duration of this approval are specified in the Policies of Western Michigan University. You may now begin to implement the research as described in the application.

Please note: This research may only be conducted exactly in the form it was approved. You must seek specific board approval for any changes in this project (e.g., you must request a post approval change to enroll subjects beyond the number stated in your application under “Number of subjects you want to complete the study”). Failure to obtain approval for changes will result in a protocol deviation. In addition, if there are any unanticipated adverse reactions or unanticipated events associated with the conduct of this research, you should immediately suspend the project and contact the Chair of the HSIRB for consultation.

Reapproval of the project is required if it extends beyond the termination date stated below.

The Board wishes you success in the pursuit of your research goals.

Approval Termination: September 28, 2016
APPENDIX B

Electronic Data Collection Acceptability Rating Form
Electronic Data Collection Acceptability Rating Form

Did you prefer using the electronic data collection system to the paper data collection system?

<table>
<thead>
<tr>
<th>Not at</th>
<th>Neutral</th>
<th>Very Much</th>
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<tbody>
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</table>

Comments:

Do you think the electronic data collection system was easier to use than the paper data system?

<table>
<thead>
<tr>
<th>Not at</th>
<th>Neutral</th>
<th>Very Much</th>
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<tbody>
<tr>
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</table>

Comments:

Do you think the electronic data collection system helped you collect data more accurately?

<table>
<thead>
<tr>
<th>Not at</th>
<th>Neutral</th>
<th>Very Much</th>
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</table>

Comments:

Did you find the graphic feedback provided in the electronic data sheet to be helpful?

<table>
<thead>
<tr>
<th>Not at</th>
<th>Neutral</th>
<th>Very Much</th>
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</thead>
<tbody>
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</table>

Comments:

Did you find the graphic feedback provided in the electronic data sheet to be easy to understand?

<table>
<thead>
<tr>
<th>Not at</th>
<th>Neutral</th>
<th>Very Much</th>
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Comments:

Did you find the automated scheduled prompts (notifications) to be helpful?

<table>
<thead>
<tr>
<th>Not at</th>
<th>Neutral</th>
<th>Very Much</th>
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</table>

Comments:

Would you like to continue using the electronic data collection system?

<table>
<thead>
<tr>
<th>Not at</th>
<th>Neutral</th>
<th>Very Much</th>
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<tbody>
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</table>

Comments:
Would you recommend the electronic data collection system to other behavior technicians?

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<tr>
<th></th>
<th>Not at All</th>
<th>Neutral</th>
<th>Very Much</th>
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</table>

Comments:

Overall Comments:
APPENDIX C

Data Collection Adherence Form
## Data Collection Adherence

Primary Observer: 
Secondary Observer: 

Date: 
IOA Score: 

### Observer/Participant Data

<table>
<thead>
<tr>
<th>Time</th>
<th>Intervals of Target Behavior- 1st 5 min</th>
<th>Intervals of Target Behavior- 2nd 5 min</th>
<th>Intervals of Target Behavior- 3rd 5 min</th>
<th>Did the staff record a severity score?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Aggression</td>
<td>Elopement</td>
<td>SIB</td>
<td>P/D</td>
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</table>

### Time

- Did the interval take place in the classroom?
- Did staff collect data within 2 minutes of the interval?
- Did the notification occur?
- Was the tablet with the staff member?

*If partially, indicate time in or out

- Fully
- Partially
- Not at all

<table>
<thead>
<tr>
<th>Time</th>
<th>Did this interval take place in the classroom?</th>
<th>Did staff collect data within 2 minutes of the interval?</th>
<th>Did the notification occur?</th>
<th>Was the tablet with the staff member?</th>
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<tbody>
<tr>
<td></td>
<td>*</td>
<td>Yes</td>
<td>NA</td>
<td>No</td>
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<td>*</td>
<td>Yes</td>
<td>NA</td>
<td>No</td>
</tr>
</tbody>
</table>

### Definitions of Target Behavior

**Aggression:** Defined as the act of hitting with open or closed fist, biting, pinching, kicking, pulling another's hair, scratching or squeezing another person, or placing both hands around another's neck.

**Self-injurious behavior:** Defined as the act of hitting oneself with open or closed hand, pinching or biting himself, forcefully throwing his body or any body parts (e.g. arm/elbow) against furniture or walls that could cause damage to himself.

**Property Destruction:** Defined as any instance that XXX throws an object not directed toward another person, kicking objects, and striking objects with an open or closed fist.

**Elopement:** Leaving or attempting to leave staff supervision without prior consent, or attempting to gain access to unavailable areas.
APPENDIX D

Example of 5-Minute Intervals within the 15-Minute Partial Interval
<table>
<thead>
<tr>
<th>Start</th>
<th>End</th>
<th>Staff Supervising initials</th>
<th>5 minute Partial Interval</th>
<th>Severity Score (0-3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>7:00</td>
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**Target Behaviors**

- A (Agg), Self-Injurious Behavior (SIB), Elopement (E), Property Destruction (PD)
  
- (DEPENDENT ON CHILD)
APPENDIX E

Standard Paper Data Sheet
### Data Sheet – 1st Shift: Date__________

- **Supply Checklist**
  - I have the following items: Edibles_____

#### 5 minute Partial Interval

<table>
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<tr>
<th>Start</th>
<th>End</th>
<th>Staff Supervising initials *</th>
<th>Target Behaviors</th>
<th>Severity Score (0-3)</th>
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<tbody>
<tr>
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<td>Agg (A), Self-Injurious Behavior (SIB), Elopement (E), Property Destruction (PD) (DEPENDENT ON CHILD)</td>
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</table>

*Staff with resident must notify med passer that the following are due and initial when completed: 9:00am______BMcheck_____

<table>
<thead>
<tr>
<th></th>
<th></th>
<th>A</th>
<th>E</th>
<th>PD</th>
<th>A</th>
<th>E</th>
<th>PD</th>
<th>A</th>
<th>E</th>
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<td>11:45</td>
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</tbody>
</table>

39
Phases: PECS____

*Initials on this data sheet indicate that this staff was supervising the individual with at least one eye on check during that 15 min increment.

End of shift supply checklist: Edibles____
(If missing supplies, explain why)

Phases: PECS____

Definitions of Target Behaviors (Dependent on child)

Aggression:

Self-Injurious Behavior:

Eloppement:

Property Destruction:

Intensity rating for aggression/SIB:

- 0: behaviors did not occur or did not pose any risk to ___ or others (e.g., ____ hit staff on the arm causing no redness or bruising)
- 1: behavior resulted in a visible mark not requiring first aid (e.g., redness, minor bruising, scratching that did not draw blood)
- 2: minor first aid (e.g., band aid for scratch, ice for bruising) required as a result of the behavior OR any actual or attempted bite or hair pull not requiring formal medical attention
- 3: formal medical attention required (e.g., doctor or ER visit) OR physical management procedure requiring supervisor's approval was required as result of the behavior
APPENDIX F

Electronic Data Collection Table
<table>
<thead>
<tr>
<th>Date</th>
<th>Feb 4th</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>15 Minute Partial Interval</td>
</tr>
<tr>
<td></td>
<td>Instances of Target Behavior: 1st 5 min</td>
</tr>
<tr>
<td></td>
<td>Aggression</td>
</tr>
<tr>
<td>Time</td>
<td></td>
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<td>7:00 - 7:15</td>
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<td>7:45 - 8:00</td>
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<td>1:00 - 1:15</td>
<td></td>
</tr>
<tr>
<td>1:15 - 1:30</td>
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</tr>
<tr>
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<td></td>
</tr>
<tr>
<td>1:45 - 2:00</td>
<td></td>
</tr>
<tr>
<td>2:00 - 2:15</td>
<td></td>
</tr>
<tr>
<td>2:15 - 2:30</td>
<td></td>
</tr>
</tbody>
</table>

Data Collection Schedule:
- Staff with resident must notify passer that the following are due and initial when completed.
- 9:00AM → Initial
- BM check → Initial

42
APPENDIX G

Example of Conditional Formatting
<table>
<thead>
<tr>
<th>Aggression</th>
<th>Elopement</th>
<th>SIB</th>
<th>PD</th>
<th>Aggression</th>
<th>Elopement</th>
<th>SIB</th>
<th>PD</th>
<th>Aggression</th>
<th>Elopement</th>
<th>SIB</th>
<th>PD</th>
<th>Severity Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
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<td>No</td>
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</table>

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APPENDIX H

15-Minute Interval and 1-Hour Graphic Feedback
APPENDIX I

Target Behavior Graphs
APPENDIX J

Automated Prompt-Notification
Event

Please enter 1pm to 1:15pm data

1:15PM - 1:17PM Sun, 03/27/2016
APPENDIX K

Example of Filled in Paper Data Sheet Data
<table>
<thead>
<tr>
<th>Start</th>
<th>End</th>
<th>Staff Supervising Initials*</th>
<th>5 minute Partial Interval</th>
<th>Severity Score (0-3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>7:00</td>
<td>7:15</td>
<td>CM</td>
<td>A</td>
<td>SIB</td>
</tr>
<tr>
<td>7:15</td>
<td>7:30</td>
<td>A</td>
<td>SIB</td>
<td>E</td>
</tr>
<tr>
<td>7:30</td>
<td>7:45</td>
<td>A</td>
<td>SIB</td>
<td>E</td>
</tr>
<tr>
<td>7:45</td>
<td>8:00</td>
<td>A</td>
<td>SIB</td>
<td>E</td>
</tr>
<tr>
<td>8:00</td>
<td>8:15</td>
<td>A</td>
<td>SIB</td>
<td>E</td>
</tr>
<tr>
<td>8:15</td>
<td>8:30</td>
<td>A</td>
<td>SIB</td>
<td>E</td>
</tr>
<tr>
<td>8:30</td>
<td>8:45</td>
<td>A</td>
<td>SIB</td>
<td>E</td>
</tr>
<tr>
<td>8:45</td>
<td>9:00</td>
<td>A</td>
<td>SIB</td>
<td>E</td>
</tr>
</tbody>
</table>

Staff with resident must notify med passer that the following are due and initial when completed: 9:00am_____BMcheck_____
APPENDIX L

Electronic Data Collection Training - Treatment Integrity Form
GLCATR Electronic Data Collection Training Checklist

**Entering Data**

- [ ] Did the experimenter provide rationale for using electronic data collection systems?
- [ ] Did the experimenter provide instruction on how to enter data into the electronic data collection system?
- [ ] Did the experimenter model entering data into the electronic data collection system?
- [ ] Did the experimenter allow all behavior technicians to practice using the electronic data collection system?
- [ ] Did the behavior technicians successfully enter data using the electronic data collection system?
APPENDIX M

Electronic Data Collection Acceptability Rating Form - Results