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14. ABSTRACT

Autism spectrum disorders (ASDs) are disorders that affect as many 1 in 88 children. Without intensive treatment, the long-term outcomes for children with an ASD remain bleak and are associated with a high divorce rate among parents. Interventions based on applied behavior analysis are well documented, but unfortunately these services are often not available to military-dependent children because of the lack of appropriately training individuals. This project will demonstrate how web-based technologies can increase the availability of this effective treatment. The third year of the award involved the continued recruitment of families with a child with an ASD to evaluate the technology-enhanced parent-training (Experiment 1) and technology-enhanced tutor-training (Experiment 2) curricula as well as the technology-enhanced early-intervention services in family's homes (Experiment 3). The preliminary results for the tutor-training curriculum showed robust and statistically significant improvements in performance, and the training was rated as highly socially acceptable. These data were recently published (Fisher, Luczynski, Hood, Lesser, Machado, & Piazza, 2014). Similar outcomes have been obtained for the participants that completed the parent-training curriculum. We have completed four test-control dyads of children for the early-intervention evaluation, and the initial results showed marked increases in acquired skills for children in the technology-enhanced training group compared to the waitlist-control group for two of four dyads. We are continuing to make progress toward recruiting and enrolling families in the parent-training and early-intervention experiments.

15. SUBJECT TERMS

Applied Behavior Analysis, Autism, Parent Training, Telemedicine, Tutor Training

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Introduction

Autism spectrum disorders (ASDs) are disorders of the brain that affect as many as 1 in 88 children. Without intensive and appropriate treatment, the long-term outcomes for children with ASDs remain bleak and are associated with a high divorce rate among parents and increased risk for mental health disorders among family members. The efficacy of and empirical support for interventions for ASDs based on applied behavior analysis (ABA) is well documented. Unfortunately, these services are often not available to military-dependent children because there are not enough appropriately trained individuals to design and provide ABA services. This project will demonstrate how web-based technologies can increase the availability of effective treatment for military-dependent children with ASDs. By evaluating a technology-enhanced treatment delivery model, military families will be able to receive empirically supported treatment services in a timely manner anywhere in the world. Also, training therapists to implement ABA programs using a web-based model will greatly increase the number of well-trained therapists in areas around many military bases.

Body

Task 2. Complete parent and tutor training and EIBI aims for 5 cohorts, which includes 50 participant families and their ABA tutors (timeframe, Months 12-44).
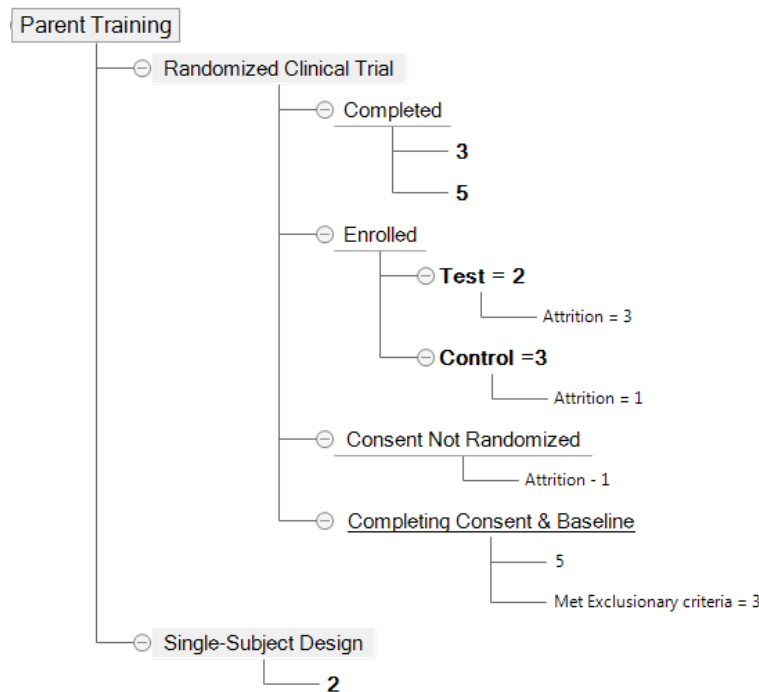
From Statement of Work: *Tasks include three distinct sub-tasks for each cohort. Our training protocol based on E-Learning using the latest web-based and televideo-based instruction will provide an efficient and effective mechanism for training military parents of children with autism anywhere in the world by experts in one location (University of Nebraska Medical Center in Omaha). These trained parents will then be able to implement effective behavior management and teaching strategies with high procedural integrity (90% accuracy). Second, we will use the protocol we developed to train adults to become ABA tutors and to implement early intervention procedures with high integrity (90% accuracy) in areas of the world where such services are unavailable. The training protocol (using web-based E-Learning instructional methods) will be the same for the parents and the ABA tutors, but they will have more extensive curricula (with the curriculum for the ABA tutors being more comprehensive). Third, we will evaluate changes in cognitive, language, social, play, and adaptive skills and decreases in problem behaviors among children with autism in military families who receive technology-enhanced early intervention services that are supervised by our experts. The children in the technology-enhanced early intervention treatment group will show significantly greater improvements than children randomly assigned to a waitlist-control group.*

In each cohort, there will be 10 children with autism recruited with at least one parent (cohort n => 10) and one ABA tutor (cohort n => 10) per child. In the first cohort, 5 of the children and their corresponding parents (n => 5) and ABA tutors (n => 5) will be randomly assigned to the technology-enhanced early intervention treatment group and the other 5 children and their corresponding parents (n => 5) and ABA tutors (n => 5) will be assigned to the waitlist-control group.

We have reported progress for Experiments 1, 2, & 3 in this order.

1. *Randomized Clinical Trial: Recruit, pretest, and train 10 parents in the technology-enhanced test group and 10 parents in the waitlist-control group.* Schematic 1 details the progress for the technology-enhanced parent-training evaluation (Experiment 1).
    Schematic 1.


```
Parent Training
    ⊖ Randomized Clinical Trial
            ⊖ Completed
                    ── 3
                    ── 5
            ── Enrolled
                    ⊖ Test = 2
                            ── Attrition = 3
                    ⊖ Control =3
                            ── Attrition = 1
            ⊖ Consent Not Randomized
                            ── Attrition - 1
            ⊖ Completing Consent & Baseline
                            ── 5
                            ── Met Exclusionary criteria = 3
    ⊖ Single-Subject Design
            ── 2
```

a. We have initial outcome data for the between-subjects comparison with three parents that were randomized to the technology-enhanced group and five parents that were randomized to the waitlist-control group. The difference in the numbers across the groups is due to attrition, as denoted in the schematic. In addition, two parents, who were assigned to the test group, are progressing through the technology-enhanced training while three other parents have been assigned to the waitlist-control group. We will continue to enroll parents as we enroll families for the early-intervention services in Experiment 3. In Figures 1 and 2, we present the initial outcome data for the parents who have completed Experiment 1 to date.

In Figure 1, the type of assessment is depicted on the x-axis. The top panel shows the participants' performance for the Behavioral Implementation Skills for Work Activities (BISWA) assessment and the bottom panel shows the participants' performance for the Behavioral Implementation Skills for Play Activities (BISPA). The gray and white bars denote the average performance across all participants for the test and waitlist-control groups, respectively; the open circles denote the individual performance for each participant in each group. The percentage of trials implemented correctly is depicted on the y-axis, and this measure was calculated by dividing the total number of trials implemented correctly plus the total number of errors, including both errors of commission (implementing a skill incorrectly; e.g., delivering reinforcement following an incorrect response) and errors of omission (failing to implement a skill when required; e.g., omitting descriptive praise following a correct response). This method of scoring provided an overall measure of how accurately the tutors carried out the procedures, regardless of the unequal number of programmed opportunities across the types of confederate responses.

Prior to experiencing the technology-enhanced training, all of the parents' performance was unsatisfactory across both primary dependent measures and comparable across groups, with relatively worse performance for the BISPA. Following the technology-enhanced training, the preliminary results with the three parents show robust improvements in performance. All parents implemented the skills correctly on more than 80% of the trials on the BISWA and BISPA assessments (gray bar on posttest column); by contrast, the performance of the five parents in the control group showed no improvement (white bar on posttest column).

In Figure 2, instead of reporting the percentage of trials implemented correctly on the y-axis, the percentage of skills implemented correctly for each *component skill* (e.g., delivers behavior-specific instructions) is depicted. This method of scoring provided information on which specific skills the parents were implementing with high fidelity and which ones should be targeted for additional training, and this method controlled for differences in the number of programmed opportunities across the types of confederate responses.

As observed in Figure 1, notable differences were observed for the three parents who

received the technology-enhanced training for the BISWA (top panel) and BISPA (bottom panel), and no improvement was observed for the five parents assigned to the waitlist-control group. We plan to apply preliminary statistical tests after at least four parents have matriculated through the training in each group. These data should be obtained by October 1st, 2014.
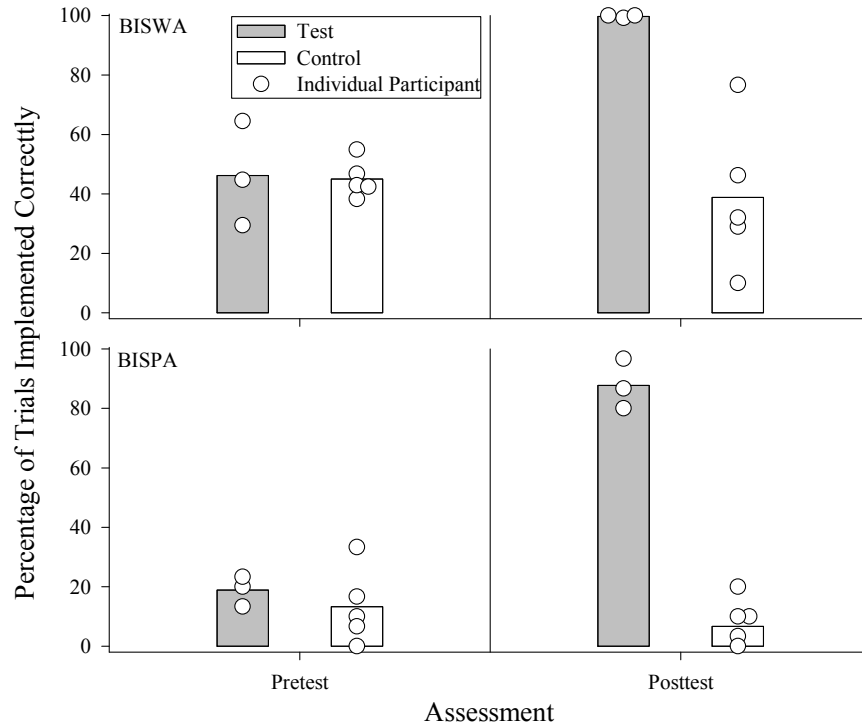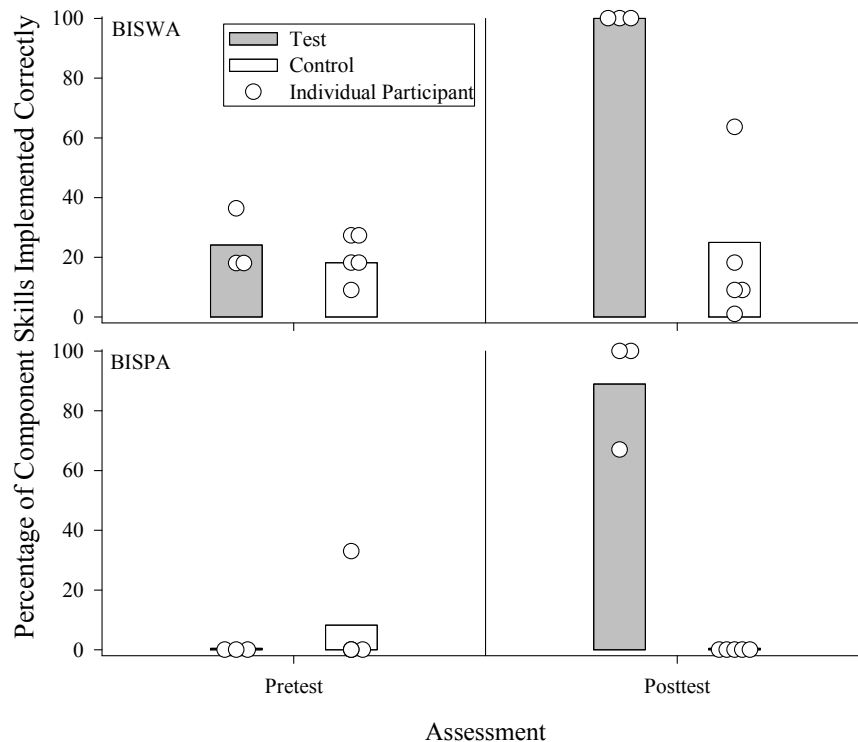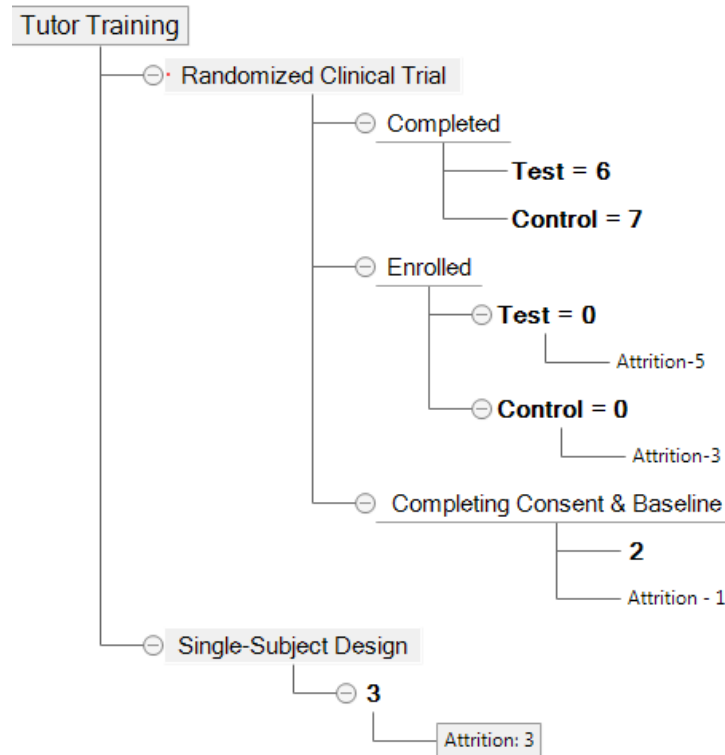
Figure 1.

Figure 2.

2. <u>Tutor-training Evaluation (Experiment 2)</u>

   a. *Randomized Clinical Trial: Recruit, pretest, and train 10 tutors in the technology-enhanced test group and 10 tutors in the waitlist-control group.* Schematic 2 details the progress for the technology-enhanced tutor-training evaluation.

      Schematic 2.

   i. *Efficacy Outcomes*: Since last year's annual report, 13 participants have completed the randomized clinical trial. As a result, we have initial outcome data for the between-subjects comparison with six participants who were randomly assigned to the test group and received the technology-enhanced tutor training and seven participants who were assigned to the waitlist-control group and did not receive training. We have conducted preliminary statistical analyses with the first 4 test-control dyads to complete the evaluation (i.e., the first 8 participants).

      The performances of the four participants in the test and control groups are depicted as group averages in Figure 3 below, and the results from the preliminary statistical tests are summarized. The type of assessment is depicted on the x-axis. The right panel shows the participants' performance for the BISWA assessment and the left panel shows the participants' performance for BISPA. The closed and open data plots show the mean performance for participants in the treatment and control group, respectively. The top panel reports the percentage of trials implemented correctly and the bottom panel reports the percentage of skills implemented correctly for each component skill. The method for calculating these measures is that same as

described above for the parent-training evaluation.

Both groups performed poorly on the BISPA during the pretest (Figure 3, upper-left panel), although the treatment group showed a slightly higher mean percentage of correct trials than did the control group (Ms = 25.8% and 8.3% on the pretest for the treatment and control groups, respectively). However, the difference between the means for the treatment and control groups on the posttest was notably larger (Ms = 88.5% and 13.3% on the posttest for the treatment and control groups, respectively). Due to the observed difference between the groups on the pretest, we analyzed the data with a general linear model using performance on the pretest as a covariable. When statistically controlling for the effects of the pretest, the difference between the treatment and control group means on the posttest was large (i.e., partial eta squared of .765, which is equivalent to a Cohen's d of 3.6) and statistically significant (F = 13.0; p < .05).

Similar results were obtained for the percentage of trials implemented correctly on the BISWA, which are depicted in the upper-right panel of Figure 3. The treatment group showed a slightly higher mean percentage of correct trials than did the control group on the BISWA pretest (Ms = 50.3% and 28.5% for the treatment and control groups, respectively), but the difference was notably larger on the posttest (Ms = 97.5% and 43.3% for the treatment and control groups, respectively). When statistically controlling for the effects of the pretest, the difference between the treatment and control group means on the posttest was large (i.e., a partial eta squared of .766; which is equivalent to a Cohen's d of 3.6) and statistically significant (F = 13.1; p < .05).

The bottom-left panel of Figure 3 shows the mean percentage of component skills mastered for the BISPA across the treatment and control groups. Both groups displayed mastery performance on a small percentage of the skills (Ms = 8.3% and 0% on the pretest for the treatment and control groups, respectively). By contrast, the treatment group had mastered the majority of the component skills by the posttest, whereas the control showed little improvement (Ms = 66.8% and 8.3% on the posttest for the treatment and control groups, respectively). When statistically controlling for the effects of the pretest, the difference between the treatment and control group means on the posttest was large (i.e., partial eta squared of .708; which is equivalent to a Cohen's d of 3.1) and statistically significant (F = 12.1; p < .05).

The bottom-right panel of Figure 3 depicts the results for the mean percentage of component skills mastered on the BISWA. Both groups displayed mastery performance on a small proportion of the component skills (Ms = 25.0% and 6.8% on the pretest for the treatment and control groups, respectively). By contrast, the treatment group had mastered almost all of the component skills by the posttest, whereas the control showed only slight improvement (Ms = 93.3% and 22.5% on the posttest for the treatment and control groups, respectively). When statistically

controlling for the effects of the pretest, the difference between the treatment and control group on the posttest was large (i.e., partial eta squared of .97; which is equivalent to a Cohen's d of 11.4) and statistically significant (F = 128.1; p < .001).

The significant interaction between the pretest and group membership suggests that the tutors in the treatment group who scored relatively higher on pretest tended to show a better response to the treatment. These data were recently published in *Research in Autism Spectrum Disorders* (5-year Impact Factor, 2.665) in their latest issue (Fisher, Luczynski, Hood, Lesser, Machado, & Pizza, 2014).

Since the preliminary analyses with the first eight participants, two and three additional participants have matriculated through the test and control groups, respectively. Similar results have been obtained for these participants.

Figure 3.
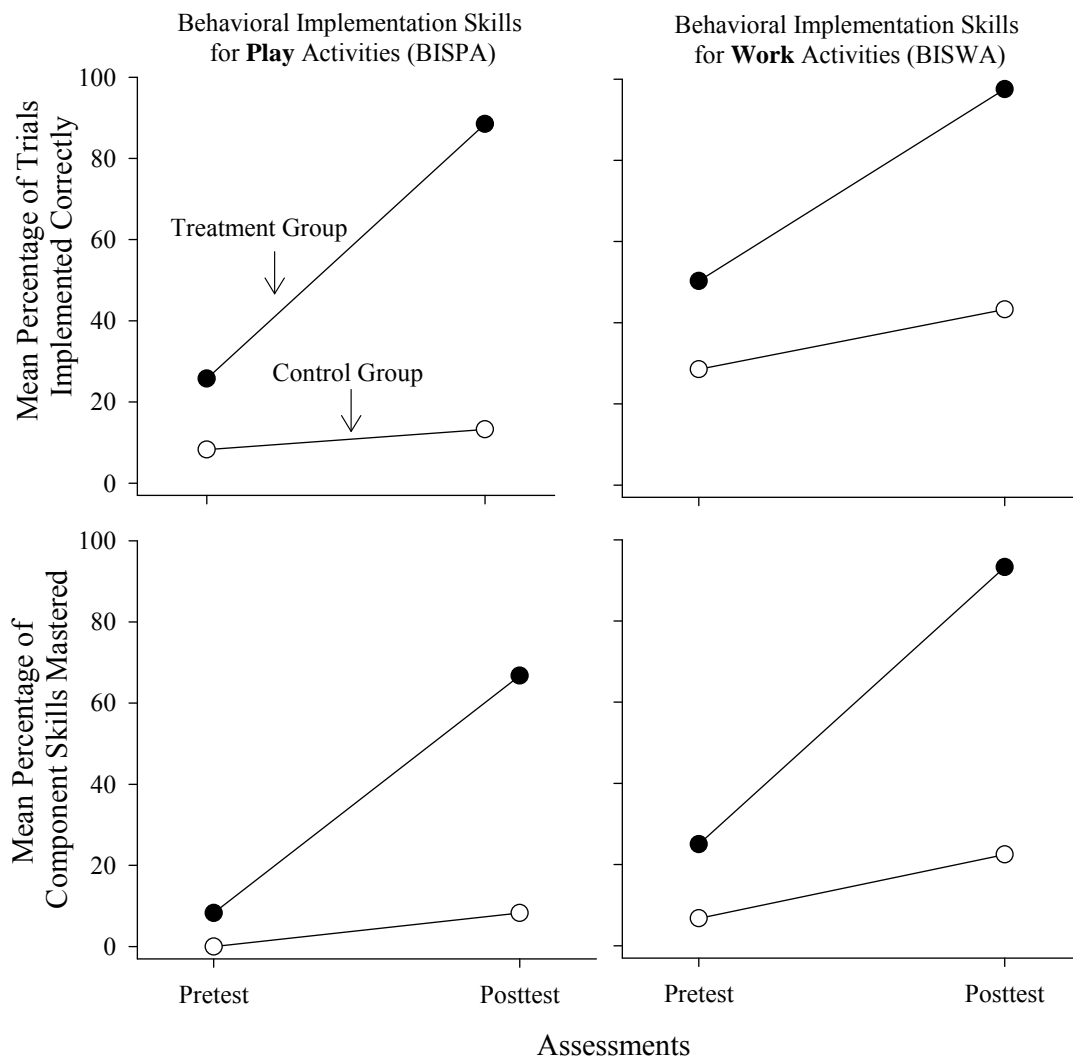
ii. *Social Validity Outcomes*: Following completion of the technology-enhanced training, tutors are asked to provide closed- and open-ended responses (ratings and open-ended comments) regarding their acceptability of the web-based technology, the type of content covered during training, interactions with the consultant and scheduling, and overall impression of the training program. In Table 1 below, we report results for five tutors who have completed the questionnaire. The tutors used a 7-point Likert scale with the following ratings: 7 = strongly agree, 4 = no opinion, 1 = strongly disagree.

The mean satisfaction rating with the web-based technology was 5.6 (range, 4.4 to 6), with the least satisfaction expressed for the use of Blackboard as the medium for accessing the e-learning modules and the most satisfaction expressed for the audio and visual quality during role-play sessions. The mean satisfaction rating with the content of the virtual training program was 6.7 (range, 6.4 to 7), with high satisfaction expressed for all aspects of the training content, including the type of information covered, the role-play component, the quality and organization of the e-learning modules, and the amount learned during training. The mean satisfaction rating for the interactions with the researcher (behavioral consultant) was 6.8 (range, 6.6 to 7), with high satisfaction expressed for all aspects of the interactions, including the consultant's ability to answer questions, the interactions with the consultant, the option of completing the training at the technician's pace, and the flexibility offered in scheduling meetings and role plays. Finally, the mean rating for overall satisfaction with the training was 6.8 (range, 6.8 to 7), and all of the tutors indicated that they would recommend the training to others.

Based on these results, the only area of our technology-enhanced model that has received lower satisfaction ratings is the use of Blackboard as the software platform to remotely deliver our training modules to tutors throughout training. Several tutors (participants 2, 4, & 5) have reported a variety of technical glitches with accessing, downloading, and viewing the modules. In response, we are considering the use of other platforms to deliver the modules. Following a six-month beta test of secure cloud-based platforms, the University of Nebraska Medical Center has recently adopted Box (https://www.box.com) as a secure content-sharing platform for sharing information in clinical practice and research applications. We plan to use Box to share the modules for two participants to determine whether the reported technical issues can be eliminated.

Table 1
Social Validity Assessment and Results for Technology-Enhanced Tutor Training

Questions	Tutor Ratings					
	1	2	3	4	5	*M*
Web-Based Technology						
	7	7	5	4	7	6.0

1. *Prior to interacting with my consultant and conducting virtual meetings, you were asked to setup some technology.* I was satisfied with the process of accessing the GotoMeeting or Adobe Connect meeting room and starting my audio and webcam?						
2. *We conducted virtual meetings, using either Gotomeeting or Adobe Connect, to review the goals for the upcoming week and provide a status update.* I was satisfied with the reliability (e.g., consistent internet connection) and the audio and video quality of these virtual meetings.	7	6	5	4	7	5.8
3. *Virtual meetings were also conducted for teaching during role-plays.* I was satisfied with the reliability (e.g., consistent internet connection) and the audio and video quality during the role-plays.	7	6	6	5	7	6.2
4. *We provided the modules and quizzes through Blackboard's software platform.* I was satisfied with Blackboard as the method to deliver the modules and quizzes.	5	4	6	3	4	4.4

Content Covered during Training

5. *Each module covered the core content of a given topic.* I was satisfied with the amount and type of information covered in the modules.	7	6	7	7	6	6.6
6. *We conducted several role-plays throughout the training and each role-play covered a different topic.* I was satisfied with the role plays as a component of training (i.e., an opportunity to practice the skills and receive real-time feedback).	7	7	7	6	6	6.6
7. I was satisfied with the quality and organization of these modules?	7	7	7	6	5	6.4
8. I was satisfied with the amount that I learned during the training.	7	7	7	7	7	7

Interactions with your Consultant and Scheduling

9. *During role-plays and throughout the training program, you had the opportunity to ask your consultant questions about the content of the curriculum or rationale for certain skills during the role plays.* I was satisfied with my consultant's ability to answer my questions.	7	7	7	7	7	7
10. I am satisfied with the interactions that I had with my consultant (e.g., time to respond to questions, weekly updates).	7	7	7	7	7	7
11. *The training program was arranged so that you could proceed at your own pace.* I was satisfied with option of completing the program at my own pace	7	7	6	7	6	6.6
12. I was satisfied with the flexibility of scheduling meetings and role plays.	7	7	6	7	6	6.6

Overall Training Program

|						
13. Overall, I was satisfied with this program.	7	7	7	7	6	6.8
14. Would you recommend this type of web-based instruction to other individuals who	Y	Y	Y	Y	Y	Yes

are not able to receive on-site instruction?

   b. *Single-Subject Design.* For tutors that withdrew from the randomized clinical trial, we are
      evaluating the effects of the technology-enhanced training within a single subject
      experimental design. This evaluation is currently being conducted with three tutors.
      Within this design, confidence that the technology-enhanced training is responsible for
      the improvement in the tutors' post-training performance will be established by showing
      that increases in BISWA and BISPA only occurs when the training is implemented
      following different baseline lengths for each tutor. This experimental design controls for
      common threats to internal validity (e.g., history, testing; Campbell & Stanley, 1963). The
      results will be interpreted using structured visual inspection procedures developed in our
      lab that are highly reliable (inter-observer agreement = .95) and valid (correlation with an
      expert panel, r = .94).

      We included this design to account for participants who were randomly assigned to
      waitlist-control group and attrition occurred for his or her matched participant in the
      technology-enhanced group. Instead of asking the participant to continue waiting until
      another participant completes the training, the participant will be enrolled in the multiple-
      baseline design. The use of both designs will increase our retention of participants by
      being sensitive to their total time enrolled in the study while also showing experimental
      control over the training curriculum. Two of three tutors have completed the pretests, and
      one tutor has nearly completed the technology-enhanced training. After they finish the
      training, posttest measures will be collected and analyzed.

2. *Recruit, pretest, and train and treat 10 children in the technology-enhanced test group and 10
   children in the waitlist-control group.* Schematic 3 details the progress for the technology-
   enhanced early-intervention services for children with autism (Experiments 3).

   Schematic 3.
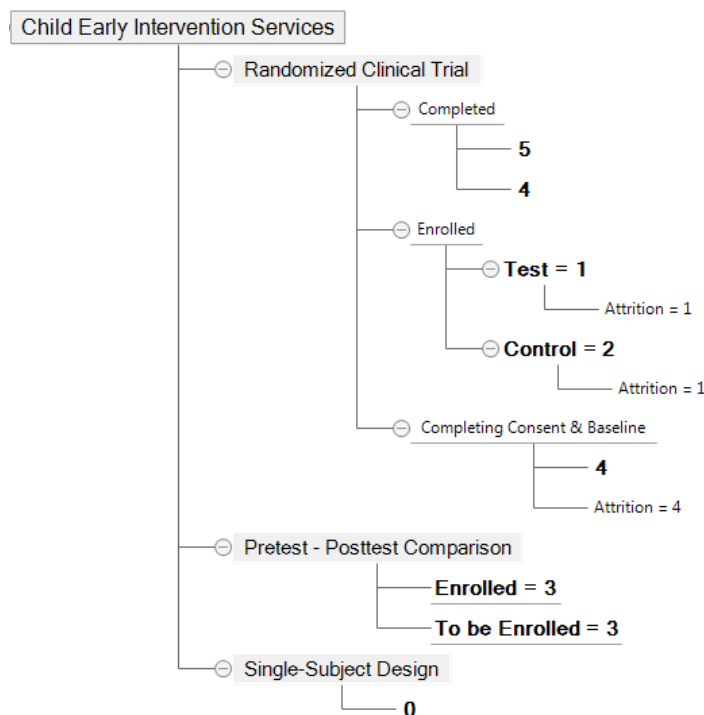
a. Randomized Clinical Trial. We have randomly assigned 12 children to the technology-enhanced training group and waitlist-control groups, resulting in 6 test-control dyads. The duration of in-home services (i.e., dose of ABA therapy) for the six children in the technology-enhanced training group are depicted below in Figure 4 below. The six children are depicted on the y-axis and the dose of in-home services (in months) is depicted on the x-axis. To date, four test-control dyads (i.e., eight participants) have matriculated through the randomized clinical trial (participants 1 - 4), with the training for a fifth child nearly complete. As a result, we have completed the posttest assessments for the four children in the test group as well as the posttests for their peers in the waitlist-control group.

Figure 4.

i. *Skills-based Dependent Measure*: The dependent measures for Experiment 3 include a battery of standardized assessments, including, the Peabody Picture Vocabulary Test, Expressive Vocabulary Test, and Mullen Scale of Early Learning. In addition to these standardized assessments, we also designed an assessment that sampled skill domains for early learners. The skills that were assessed was informed by the domains tested in the Assessment of Basic Language and Learning Abilities.

In Figures 5 and 6 below, the results for each matched test-control dyad on the skills-based dependent measure are depicted. The different skills domains are depicted on the x-axis, and the difference score between the pretest and posttest is depicted on the y-axis. The differences scores were calculated by subtracting the percentage of trials with correct responding on the posttest from the percentage of trials with correct responding on pretest for each domain. Positive scores represent an improvement, and negative scores represent a worsening. Black and white bars denote the child assigned to the test and control groups, respectively.
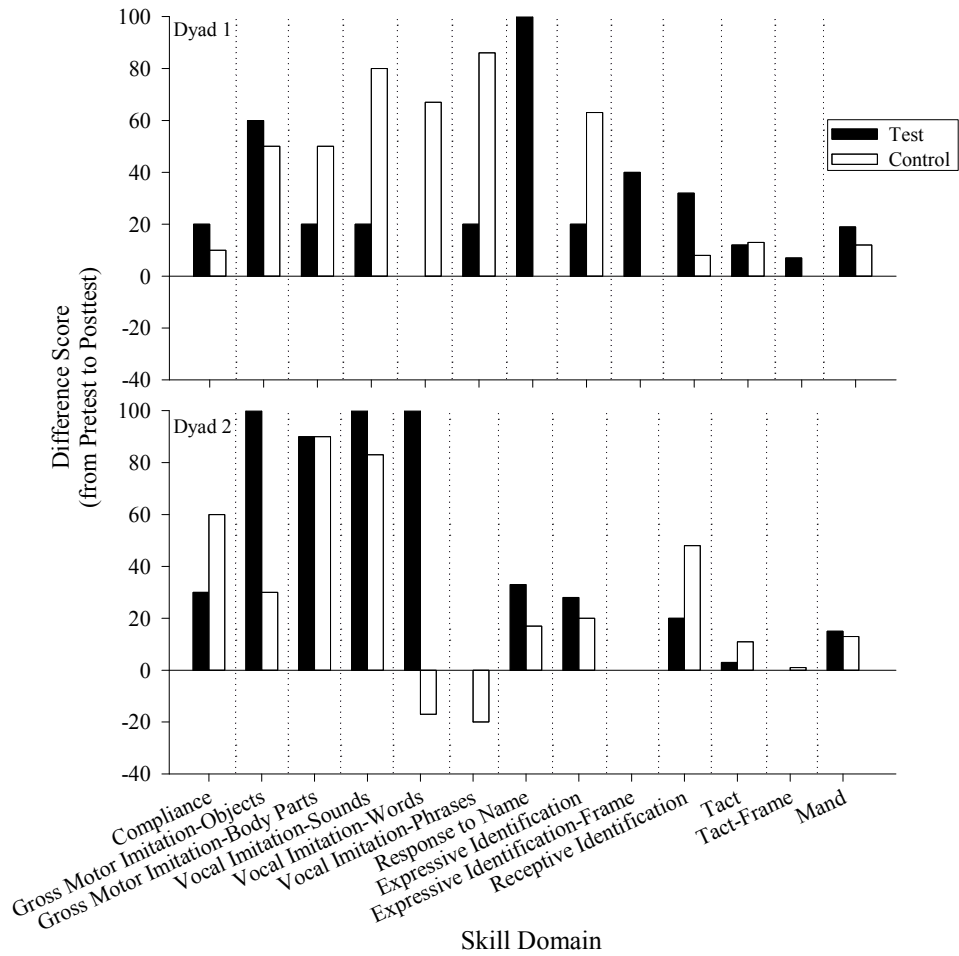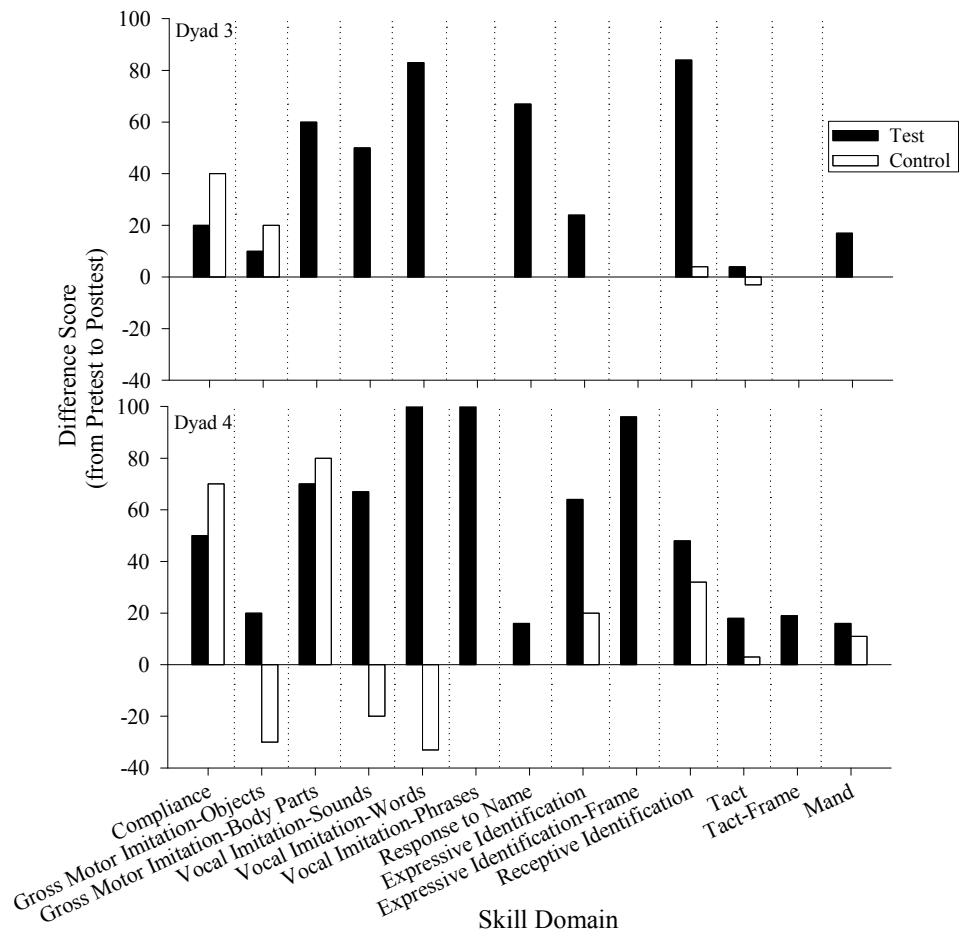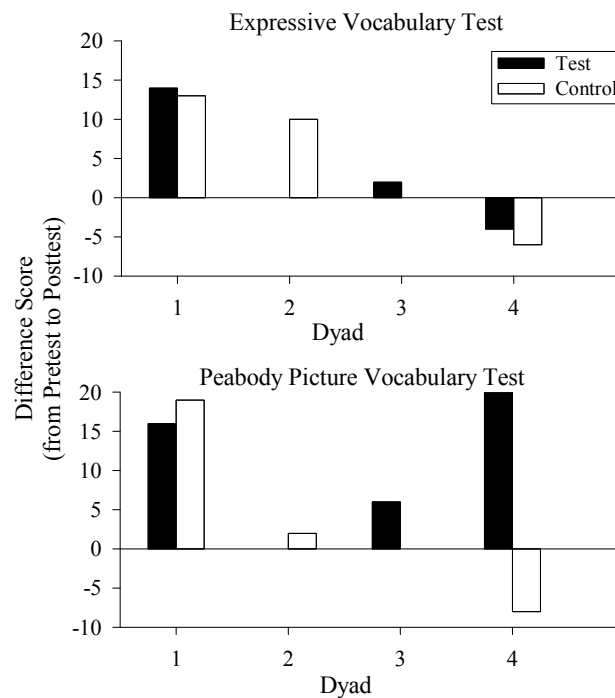
Figure 3.

Figure 4.

For the Dyads 1 (top panel) and 2 (bottom panel) in Figure 3, the children assigned to the technology-enhanced group showed improvement across the majority of skill domains, although the increase in performance was minimal (20% to 30%) for several domains. Unexpectedly, improvement across the skill domains was also observed for children assigned to the waitlist-control group. As a result, increases in performance were similar across children, regardless of group assignment. By contrast, for the two dyads in Figure 4, there were notable skill improvements for the children assigned to the technology-enhanced group compared to their peer in the control group. For Dyad 3, the performance of the child in the test group increased by $\geq$ 20% for 8 skills compared to 2 skills for the child in the waitlist-control group. For Dyad 4, using the same analysis, the number of skills with improvement was 11 for the child in the test group compared to 4 for the child in the waitlist-control group. As a result, the technology-enhanced early-intervention services was associated with increased performance in skills for two children relative to two peers who did not receive the training. The outcomes for Dyads 3 and 4 are examples of the efficacy results we expect in the randomized clinical trial as we continue to increase the number of children enrolled.

ii. *Standardized Dependent Measures*: The results for the Expressive Vocabulary Test (top panel) and Peabody Picture Vocabulary Test (bottom panel) are reported in Figure 5. The four test-control dyads are depicted on the x-axis, and the children in the test and control group for each dyad are denoted by black and white bars, respectively. The difference scores between the pretest and posttest performances are reported on the y-axis, and these scores were calculated by subtracting the raw score on the posttest from the raw score on pretest for each assessment. We did not observe consistent differences between the children assigned to the test and control groups, although the sample size is small at this point.

Figure 5.

The results for the Mullen Scale of Early Learning are reported in Figure 6. The domains in the assessment are denoted on the x-axis, and one of the four test-control dyads is reported in each panel. The difference score between the pretest and posttest is denoted on the y-axis and calculated as described previously. As with the other standardized assessments, consistent differences between the children assigned to the test and control groups were not observe, although the sample size is small at this point.
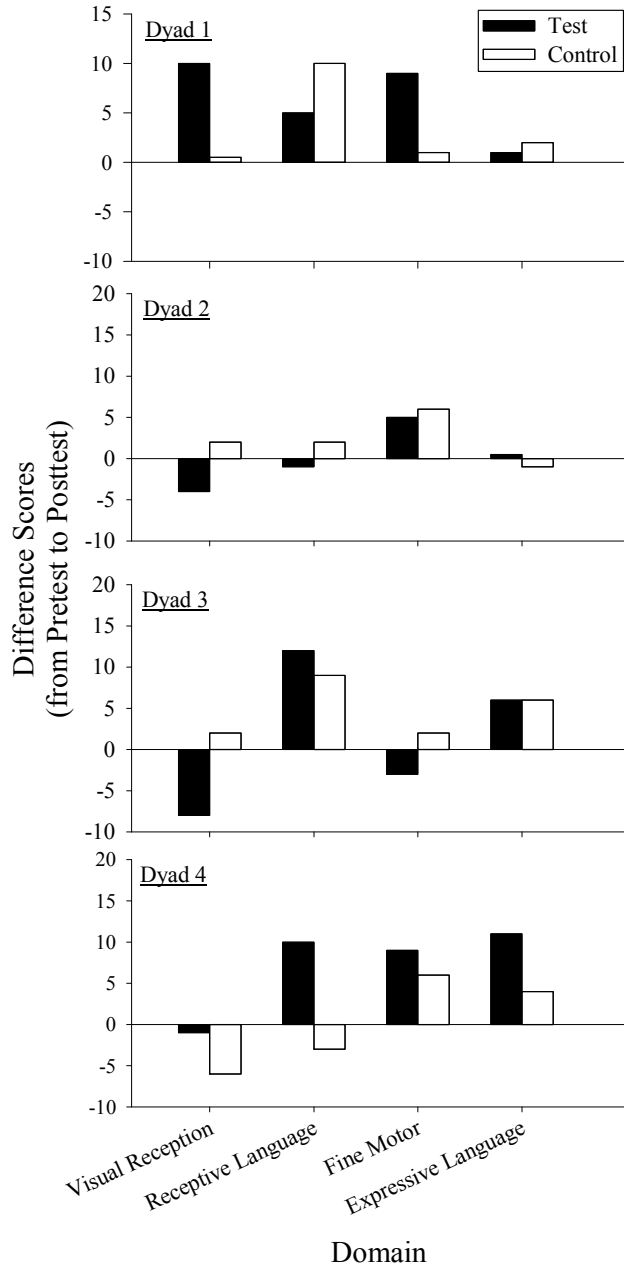
Figure 6.

b. <u>Pretest-Posttest Evaluation</u>. Due in part to the long time it took to gain consensual approval of the human protections plan from the DOD and the UNMC IRB, we are behind the proposed schedule for recruiting, enrolling, and completing the delivery of technology-enhanced early intervention services for families who have a child with an autism spectrum disorder (Experiment 3). In response, after communicating with Dr. Stan Niu, we modified the research methodology to help to address our recruitment shortfall. The research modification is described below.

When the children assigned to the technology-enhanced test group matriculate, the 6 months of early intervention services for their peer in the waitlist-control group will start. We are providing the same 6-month dose of early-intervention services to the children who were in the waitlist-control group and including their data in the statistical analyses of the effects of our technology-enhanced services. This modification will enhance the experimental design in that it will allow for both an across-group comparison between the test and control groups as well as a within-subject comparison prior to and after the provision of our technology-enhanced early intervention services.

The duration of in-home services for five of six children (attrition for one family) who have completed the waitlist-control group are depicted below in Figure 7 below. The five children are depicted on the y-axis and the dose of in-home services (in months) is depicted on the x-axis. To date, three children have started to receive the technology-enhanced training and the 6-month dose of services for one child has been completed. Data analyses will be conducted and reported when more children matriculate through the training.

Figure 7.
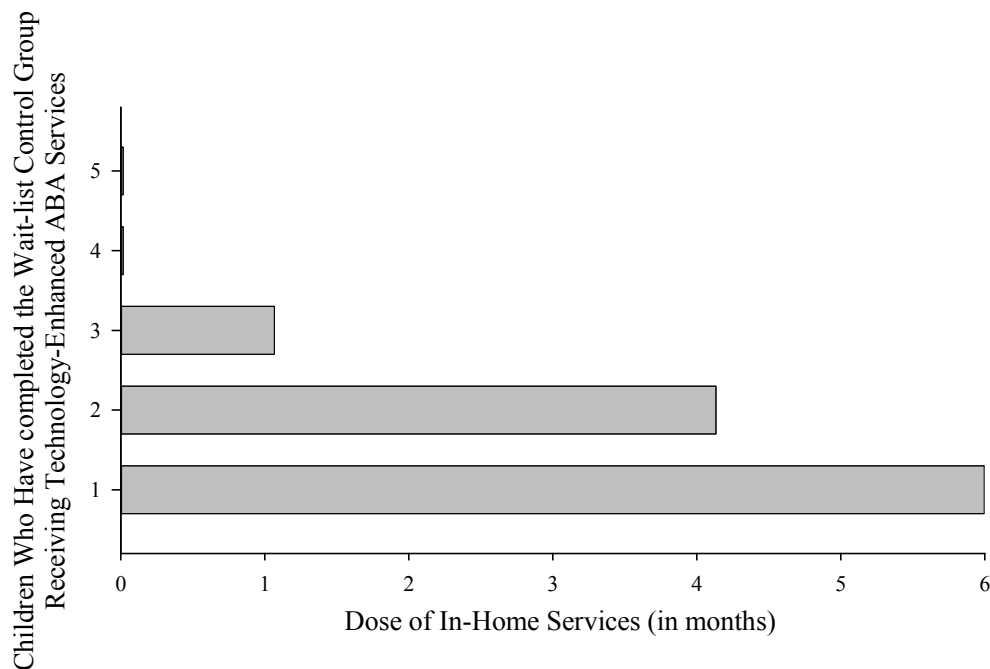
c. <u>Continued Recruitment Efforts</u>. Over the last year, we have made progress in obtaining outcomes for the tutor-training (Experiment 2) and parent-training (Experiment 1) aims. As detailed above, the preliminary outcomes strongly support the efficacy and social acceptability of the technology-enhanced training services for tutors and parents. Given the historical difficulty in increasing awareness about our technology-enhanced in-home services to families, we are excited by our progress toward designing and monitoring early intervention services (10 children who have or will be receiving services). At the same time, as children matriculate through the training, we recognize that recruiting additional test-control family dyads is paramount. Below we list the following developments that may increase our opportunities for recruitment:

 i. Early this year, we spoke with Dr. Ethan Long, who is the executive director of the Virginia Institute of Autism. He is leading a program with a mission to serve families with a child with autism in rural Virginia and his team has recently been in communication with personnel at Fort Lee. The representatives at Fort Lee have indicated that there is large need for parent training and early intervention services for local military families, and Dr. Long has received multiple referrals. Because Dr. Long and his team cannot serve all of these families, he has agreed to refer the families to us for potential participation in our grant.

 ii. Tricare has established an Autism Pilot Program that expands coverage in applied behavior analysis (ABA) to military retirees; prior to this program, only active military members were eligible for reimbursement of ABA services. The pilot program is pertinent to the current grant because a larger number of families are now eligible to participate. We are re-contacting personnel on military bases to describe this opportunity (e.g., exceptional family member program coordinators).

 iii. Dr. Luczynski is serving as the program chair for Division 25 (Behavior Analysis) in the American Psychology Association. One week ago he participated in a leadership training conference in Washington D.C. in which all 54 divisions met collectively. Division 19 is the Society of Military Psychology, and Dr. Luczynski described the aims of the current grant to the program chair (Dr. Nathan Ainspan) and his disappoint associated with the challenge of effectively distributing information about the grant to military families. The chair of Division 19 suggested the following courses of action:

 ▪ He will connect Dr. Luczynski to the current present of the division and several past presidents who have been strong advocates of helping military families with children with special needs.

 ▪ He suggested that we contact public relations agencies who have a strong interest in public service and ask the agencies if they would be willing to help us distribute the information regarding the grant pro bono. He said that this is not uncommon when the cause is noteworthy such as helping military families receive the high-quality services their children with an ASD deserve.

 iv. Toward efforts to increase our recruitment numbers for our technology-enhanced in-home early intervention services locally, we have described the grant in a newsletter that is published by the Olson Center for Women's Health, which reaches over 20,000 families in Nebraska and nearby states.

v.   Pending IRB approval, we will create a recorded video of Dr. Wayne Fisher describing the mission of the grant and the impact it can have on the community of military families with a child with autism. We would also ask families who have received early-intervention services from our center to describe their experiences. This video would be sent to news stations near highly populated military bases. The video may help with recruitment because it will be put a face and story behind who we are and what we are trying to accomplish.

vi.   Two weeks ago, we had a meeting with the Scott Craven, who is the VP, UHC M&V (United Healthcare Military & Veterans) for Behavioral Health operations, Shari Erickson, who is the VP, UHC M&V for Case Management (CM) Operations where the autism programs reside, Tracy Sasso, who is the Associate Director for Complex and Specialized CM, and Catherine Mell, who is the Manager of Specialized CM. During this meeting, we described the aims of the grant and how the grant may benefit families who are not currently receiving applied-behavior-analysis services. All of the meeting attendees were excited about the program. They said that they are going to determine how to effectively distribute information about the grant to the 21 states in the western region that they operate, which include many rural areas with military families.

Key Research Accomplishments

- o <u>Technology-enhanced Tutor-training Curricula</u>: We have completed the preliminary statistical analyses for the randomized clinical trial of the tutor-training curricula (4 test-control dyads), and the results supported the efficacy of the technology-enhanced teaching procedures for improving performance on both primary dependent measures and the tutors were highly satisfied with the training procedures, content covered, and interactions with the consultant.

- o <u>Technology-enhanced Parent-training Curricula</u>: Three parents in the technology-enhanced group and five parents in the waitlist-control group have matriculated through the evaluation. As observed for the tutor-training evaluation, the results supported the efficacy of the web-based teaching procedures. After additional participants complete the evaluation, we will conduct preliminary statistical analyses and submit the results for publication.

- o <u>Technology-enhanced Early-intervention Services</u>: Four test-control dyads of children have matriculated through the evaluation. Initial results provide partial support for the technology-enhanced early-intervention services. The completion of additional dyads is needed prior to conducting preliminary analyses.

Reportable Outcomes

We have presented the preliminary results of the randomized clinical trial for the tutor-training curriculum at our national conference this may, the Annual Conference of the Association for Behavior Analysis International. In addition, these data were recently published in published in Research in Autism Spectrum Disorders (5-year Impact Factor, 2.665) in their latest issue (Fisher, Luczynski, Hood, Lesser, Machado, & Pizza, 2014).

Conclusions

Although the results of our preliminary studies and the early results of the randomized clinical trial are encouraging, it is premature to draw any firm conclusions at this juncture of the award.

References

Fisher, W. W., Luczynski, K. C., Hood, S. A, Lesser, A. D, Machado, M. A., & Piazza, C. C. (2014). Preliminary findings of a randomized clinical trial of a virtual training program for applied behavior analysis technicians. *Research in Autism Spectrum Disorders, 8*, 1044-1054.

Luczynski, K. C., Fisher, W. W., Hood, S. A., Lesser, A. D., Machado, M. A. (2014, May). *Preliminary findings of a randomized clinical trial of a virtual training program for applied behavior analysis technicians.* Paper to be presented at the 40th Annual Convention for the Association for Behavior Analysis International, Chicago, IL.

Appendix 1

See appended copy below of the published manuscript.

Preliminary findings of a randomized clinical trial of a virtual training program for applied behavior analysis technicians ☆

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ABSTRACT

As the demand for applied behavior analysis (ABA) services for children with an autism spectrum disorder continues to grow, it is critical to develop efficient, effective, and widely accessible procedures for training technicians to implement ABA interventions. One approach would be to develop efficacious training programs that could be delivered over the Internet via a virtual private network (VPN). In the current study, we developed a 40-h virtual training program in which participants completed e-learning modules and also received behavioral skills training over a VPN to implement behavior reduction and skill acquisition protocols in both discrete-trial and play-based formats. This virtual training program was evaluated in a randomized-clinical trial (RCT) using direct-observation measures on the implementation of discrete-trial training and play-based procedures as the primary dependent variables (which were also collected via a VPN). Participants in the treatment group showed robust and statistically significant improvement in their implementation of behavior reduction and acquisition programs under both discrete-trial and play-based formats, and they rated the training as highly socially acceptable. These preliminary results from an ongoing RCT suggest that this effective, convenient, and socially acceptable virtual training program has the potential to extend access to ABA services to families in rural and other underserved areas or populations.

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1. Introduction

Autism spectrum disorder (ASD) is a disorder of the brain that involves impairments in social relatedness and language and inflexible or repetitive behaviors. Prevalence estimates have grown more than 20 fold since the 1980s, and ASD currently affect about 1 in 88 children in the United States (Burd, Fisher, & Kerbeshan, 1987; Centers for Disease Control and Prevention, 2012). Moreover, a recent study in South Korea used more aggressive case-ascertainment methods than most prior studies and reported a prevalence of 2.6% or about 1 in 38 children (Kim et al., 2011). These increases in the number of diagnosed cases of ASD have greatly expanded the demand for intervention services (Dave & Fernandez, 2012). This

increased demand is also due, in part, to the long-term outcomes that have been reported to typically occur for children with ASD in the absence of effective treatment.

Without intensive and appropriate treatments, the long-term outcomes for children with ASD remain grim. In a long-term follow-up study of adults affected by an ASD, only 26% had friends, 13% had independent jobs (mostly low paying positions), and 4% lived on their own (Howlin, 2005; Howlin, Goode, Hutton, & Rutter, 2004). It is fairly common for individuals with ASD to live with and be dependent upon parents, siblings, or both throughout their adult life. The burden and stressors placed on families with a child with an ASD are substantial. The divorce rate among parents of children with an ASD has been estimated to be above 80%, and immediate family members are at increased risk for the development of stress-related mental health disorders (Dumas, Wolf, Fisman, & Culligan, 1991; Feldman et al., 2007; Lofholm, 2008). The rapid growth in the prevalence of ASD, combined with the deleterious effects the disorder has on affected children and their families, has to led to a spike in demand for effective autism services, and, in particular, for services with strong empirical evidence supporting treatment efficacy (National Autism Center, 2009).

The treatment for ASD that has the most empirical support is called applied behavior analysis (ABA; Eikeseth, 2009; Eldevik et al., 2009; Howlin, Magiati, & Charman, 2009). Early intensive behavioral intervention (EIBI) is a specific approach to the treatment of young children with ASD that applies the basic tenets of ABA (Baer, Wolf, & Risley, 1968). ABA is based, in part, on the principle of "selection by consequences" in which responses that produce favorable outcomes become more probable and ones that produce unfavorable outcomes become less probable. In EIBI services, the procedures from the field of ABA are used to (a) reduce the symptoms and problem behaviors associated with ASD and (b) replace those problem behaviors with appropriate skills in language, socialization, play, cognition, academics, motor development, and daily living skills. Thus, in an EIBI program, events in the environment are re-arranged such that appropriate behaviors are learned and re-occur and problem behaviors are decreased or eliminated.

A substantial and growing number of investigations have found that EIBI produced marked gains in IQ (average increases of about 20 IQ points; Rogers & Vismara, 2008). In addition, a number of empirical studies have found that ABA-based programs are more effective than eclectic therapies (e.g., Howard, Sparkman, Cohen, Green, & Stanislaw, 2005). For example, Howard et al. compared the effectiveness of EIBI to an "eclectic" form of therapy, which consisted of a variety of therapy methods (e.g., sensory integration therapy, picture-exchange communication, and general preschool activities). Both groups received a minimum of 25 h of therapy per week. Program effectiveness was evaluated by comparing child outcomes on a variety of measures, including intellectual functioning, non-verbal problem solving, language, and adaptive skills. Across each measure, children who received EIBI scored higher than those who received the eclectic form of therapy. Moreover, these gains were evident during follow-up evaluations conducted at an average of 14 months after conclusion of the study. These outcomes, combined with those of other evaluations, suggest that EIBI models represent the most effective form of therapy for children with ASD (Rogers & Vismara, 2008). In a report by the American Academy of Pediatrics (Myers & Johnson, 2007), they noted that, "The effectiveness of ABA-based intervention in ASDs has been well documented..." (p. 1164). They also noted that EIBI and functional analysis were two of the approaches to the treatment of ASD that had the most empirical support, and that a minimum of 25 h per week of EIBI and a low child-to-therapist ratio (i.e., 1:1) were important variables affecting the success of the treatment programs.

Most EIBI services are delivered using a tiered model in which the professional behavior analyst designs and supervises treatment protocols that are delivered by a behavioral technician (Behavior Analyst Certification Board, Inc. [BACB], 2012). This tiered model facilitates the cost-effective delivery of EIBI services at effective intensity levels (e.g., 25 or more hour per week) that have strong empirical support (Myers & Johnson, 2007), because the professional behavior analyst can manage multiple cases and most of the direct service is provided at a lower cost by the technician (BACB). However, few if any criteria or guidelines are available for determining what training and skills technicians should receive prior to working with children with ASD, although the BACB has announced plans to offer a new credential for these direct-line staff called the "Registered Behavioral Technician."

Rispoli, Neely, Lang, and Ganz (2011) recently reviewed the extant literature on training technicians to implement interventions for persons with ASD and found only 12 experimentally sound studies. These studies evaluated the effects of technician or paraprofessional training using single-case designs and involved a total of 39 participants. Nine of the studies were conducted in schools, and none of the studies involved technicians who were implementing EIBI services in the homes of children with ASD, where there is typically infrequent on-site supervision from a professional. All of the studies involved training the participants on a specific procedure (e.g., discrete-trial training), despite the fact that technicians are typically expected to implement multiple types of behavior-reduction and skill-acquisition protocols. Finally, none of the studies evaluated the effects of technician training using an RCT. These findings suggest that additional research is needed on technician training that (a) promotes more convenient and cost-effective training methods, (b) expands the number and variety of skills taught to technicians, (c) assesses procedures for training technicians to implement home-based ABA programs, and (d) evaluates the effects of technician training using an RCT.

Heitzman-Powell, Buzhardt, Rusinko, and Miller (2014) recently reported on a virtual, e-learning program for training ABA principles and procedures to parents of children with ASD, thus providing preliminary evidence on a potentially cost-effective training method. In their initial study, seven parents completed the Online and Applied System for Intervention Skills (OASIS) program within a pretest-posttest design (Buzhardt & Heitzman-Powell, 2005). The OASIS program consists of eight modules covering topics such as an introduction to behavioral treatment, defining and measuring behavior, skill assessment and intervention, and stimulus control. During the first section of each module, the parent completed an online,

interactive tutorial designed to improve knowledge on the target topic. Parents were then required to score 90% or better on a 20-item test prior to beginning the second section of the module, which consisted of the parent practicing the skills targeted in the module with their child while receiving coaching and feedback from a professional via a telehealth connection. Other quasi-experimental studies have used similar methods to teach knowledge of behavioral intervention procedures or to train therapists to implement the Early Start Denver Model (Hamad, Serna, Morrison, & Fleming, 2010; Vismara, Young, Stahmer, Griffith, & Rodgers, 2009). We have found only one study in which an RCT was used to evaluate virtual training in the principles and procedures of ABA, but the dependent variable for that study was knowledge of ABA as measured on a multiple-choice test (Jang, Dixon, Tarbox, Granpeesheh, Kornack, & de Nocker, 2012). Thus, the extent to which the participants could accurately implement a variety of ABA procedures remains unknown. Therefore, the purpose of the current investigation was to extend these prior studies on virtual training by using an RCT to systematically evaluate the effectiveness of a more comprehensive virtual program for training technicians to both understand and implement a variety of ABA principles and procedures used in EIBI services for young children with ASD.

2. Method

2.1. Participants and settings

Eight participants (seven females, one male) ranging in age from 21 to over 50 years old were recruited by the Munroe-Meyer Institute's Virtual Care Program at the University of Nebraska Medical Center (UNMC) as part of an ongoing multi-study project aimed at demonstrating that virtual technologies and skills-training strategies can be used to expand and enhance the availability of EIBI services to children with an ASD. The participants (henceforth called technicians to distinguish them from the confederates described subsequently) were recruited to provide direct services (after training was complete) to active military families with children with an ASD through the Autism Demonstration Project (Defense Health Agency, 2008). Therefore, we called the Exceptional Family Member Program-Coordinators (EFMP-C) at all military bases throughout the United States (i.e., Army, Air Force, Marine Corps, and Navy) to explain the purpose of the study. We recruited technicians via flyers that were sent to the EFMP-Cs at each base. In addition, we contacted all directors of University Centers for Excellence in Developmental Disabilities and sent them recruitment flyers to distribute. We also recruited behavioral technicians that were hired through the Center for Autism Spectrum Disorders Clinic at UNMC's Munroe-Meyer Institute to provide in-home, EIBI services.

We enrolled technicians if they (a) were at least 19 years of age; (b) completed, or were enrolled in, an associate's or bachelor's degree program in psychology or a related field; (c) completed at least 12 semester credit hours at an accredited college or university; and (d) had no prior training in implementing ABA interventions. Technicians were excluded if they did not meet the aforementioned inclusion criteria or could not complete the physical requirements of the tasks involved in ABA therapy, which require therapists to be able to speak, hear, see, sit, stand, walk, and lift 40 lbs. All procedures were approved by the Institutional Review Boards at UNMC and the Autism Research Program at the Congressionally Directed Medical Research Program within the Department of Defense. Each technician provided written consent to participate in the study. Technicians completed the training in their home or at a nearby location where they had access to a high-bandwidth Internet connection (e.g., a study room in a college library).

3. Dependent measures

The two primary dependent measures were the *Behavioral Implementation of Skills for Work Activities (BISWA)* and the *Behavior Implementation of Skills for Play Activities* (BISPA). The BISWA and BISPA are direct-observation measures designed to assess the technician's skill at implementing ABA procedures in a discrete-trial format and a play-based format, respectively. The technician, whose skills were assessed, was at one location (e.g., their home) along with a friend or colleague who was recruited to play the role of a child with an ASD during the assessment (henceforth called the confederate; written consent to participate was required). The researcher verbally directed the responses of the confederate from another location (e.g., an office at UNMC) via a virtual private network (VPN; i.e., a password protected and encrypted connection between a computer at the technician's location and a computer at UNMC). We mailed the technician a bluetooth earpiece, webcam, and materials needed for conducting the BISWA and BISPA, and, if needed, a laptop computer. The confederate wore the bluetooth earpiece that was connected to the VPN on the computer or phone, which allowed the researcher to give verbal instructions to the confederate without the technician hearing the instructions (through the earpiece) or to both the technician and the confederate (through the computer speaker).

The BISWA assessment consisted of 36 trials and the BISPA assessment consisted of 20 trials. The assessments were video recorded for subsequent scoring. At the start of an assessment session, the technician had a set of stimulus cards (previously sent through the mail) that were used to teach the confederate receptive-identification skills (e.g., pointing to the picture of a dog after the technician said "Touch dog."). On each trial, the researcher instructed the confederate (via the bluetooth earpiece) to respond to the technician in a number of different ways representative of the range of possible responses a technician would typically encounter when working with a child with an ASD. Over the course the assessments, the confederate responded with an independent correct response and no problem behavior following the initial instruction on four trials that were interspersed in a quasi-random fashion over the course of the assessment. On an additional 16 trials

following the initial instruction, the researcher directed the confederate to challenge the technician by displaying (a) no response, (b) an incorrect response, (c) stereotypy, or (d) other problem behavior (aggression, disruption, echolalia, and negative vocalizations). Within these same 16 trials, we further challenged the technician by having the confederate display one of the following responses after the confederate made an error: (a) a prompted correct response, (b) a prompted incorrect response, (c) no response, or (d) other problem behavior.

After the session, trained observers scored the video recording, which was recorded via the computer, of the technician's responses in each BISWA assessment for the occurrence of correct and incorrect implementation of behavioral procedures (e.g., gains child's attention, provides clear instruction, provides descriptive praise, provides tangible or edible reinforcement, and ignores problem behavior). The top half of Table 1 shows the programmed confederate responses, and the bottom half shows the target responses that were scored for the technician.

The BISPA was similar to the BISWA except that the technician skills were assessed during a play-based, naturalistic training context in which the technician was instructed to increase the confederate's appropriate behavior and decrease problem behavior. As with the BISWA, at prescribed times, the researcher instructed the confederate to display various responses. For 10 of these proscribed occasions, interspersed over the course of the session in a quasi-random fashion, the confederate emitted each of the following response twice: (a) engaged in a bid for joint attention, (b) initiated conversation, (c) engaged in functional play, (d) described an emotion displayed by the technician, and (e) initiated play with the technician. On the remaining 10 occasions, the researcher directed the confederate to engage in each of the following problem behaviors twice: (a) aggression, (b) disruption, (c) echolalia, (d) negative vocalizations, and (e) stereotypy. Trained observers subsequently scored the video recording of the technician's correct and incorrect responses to these confederate behaviors. That is, the observers scored whether the technician responded to appropriate confederate behaviors with descriptive praise and reinforcement and to the confederate's problem behavior with extinction. The top half of Table 2 shows the programmed confederate responses, and the bottom half shows the target responses that were scored for the technician.

Although the BISPA did not consist of discrete trials initiated by the technician, we divided each session into a series of trials demarcated by the occurrence of a programmed confederate response for scoring purposes. For example, if the first programmed response was for the confederate to display aggression 20 s into the session, the first trial started when that aggressive response was emitted by the confederate and continued until the next programmed confederate response occurred. Observers scored whether the technician responded correctly or incorrectly to each of the confederate's programmed responses. For example, if the programmed confederate response was a negative vocalization (e.g., a scream), the correct technician response was to ignore the scream and continue with the ongoing activity. If the programmed confederate response was functional play (e.g., rolling a car), the correct technician response was to provide descriptive praise and reinforcement (e.g., "That was super! You rolled the car a long way!", and then immediately roll the car back to the confederate).

Table 1
Behavior Implementation of Skills for Work Activities (BISWA).

Dependent measures	Operational definition
Programmed confederate responses	
Independent correct	Touching the target stimulus card within 5 s of the instruction
Prompted correct	Touching the target stimulus card within 5 s of the model prompt
Incorrect	Touching a nontarget stimulus card stimulus within 5 s of the instruction
Prompted incorrect	Following a model prompt, touching a nontarget stimulus
No response	Not touching a stimulus or engaging in problem behavior within 5 s of the instruction
Stereotypy	Repetitive body rocking or contorting hand in front of face
Problem behavior	
Aggression	Hitting the technician with body or objects
Disruption	Banging surfaces, throwing or swiping of instructional materials
Echolalia	Repeating one or several words said by the technician
Negative vocalization	Crying or screaming at a volume above conversational level
Technician responses	
Instructions	
Behavior specific	The action and target stimulus is stated (example, "Touch dog;" nonexample, "Show me what you know")
Clear	Only the action and target stimulus is stated (example, "Touch dog;" nonexample, "That is a pretty dog, touch dog")
Phrased as a demand	The action and target stimulus is stated as a direct imperative and not as a question or declarative (example, "Touch dog;" nonexamples, "Will you touch dog?" and "It's time to touch dog")
Gain the child's attention	Prompt the confederate to look at the technician or the stimulus cards prior to the instruction
Following a correct response	
Descriptive praise	Vocal praise in which the action and target stimulus is stated (example, "Super smart touching dog;" nonexample, "Nice work")
Reinforcement delivery	Delivery of a high preferred item (i.e., an edible or tangible) within 5 s of the correct response
Following the first error	
Model prompt	Touch the target stimulus
Following the second error	
Physical prompt	Hand-over-hand physical guidance to the target stimulus

Table 2
Behavior Implementation of Skills for Play Activities (BISPA).

Dependent measures	Operational definition
Programmed confederate responses	
Appropriate behavior	
Joint attention	Any vocal or gestural response to direct the technician's attention toward an object or activity
Initiates conversation	Appropriate spoken verbalization that is not in direct response to a technician's question and does not involve requests for tangible or edibles items
Functional play	Independent use of play materials in a manner consistent with their intended purpose
Describes others emotions	Appropriate vocalizations that describes, asks about, or shows empathy for the emotions of the technician
Initiates play with technician	Any vocal or gestural response to begin a play activity with the technician
Problem behavior	
Aggression	Hitting the technician with body or objects
Disruption	Banging surfaces, or throwing, swiping instructional materials
Echolalia	Repetition of words or phrases said by the technician
Negative vocalizations	Crying or screaming at a volume above conversational level
Stereotypy	Repetitive body rocking or contorting hand in front of face
Technician responses	
Descriptive praise	Vocal praise in which the skill emitted by confederate is stated
Reinforcement delivery	Delivery of a high preferred item (i.e., an edible or tangible) within 5 s of the correct response
Extinction	Absence of a stimulus change following problem behavior

4. Interobserver agreement, observer blinding, and procedural integrity

Interobserver agreement was calculated by having two independent observers simultaneously and independently collect data on technicians' responses for a percentage of the BISWA and BISPA assessments and then comparing the observers' records. During the pretest, all observers were blind to group membership because technicians were randomly assigned to the treatment or control groups after the pretest was completed. For 50% of the posttests, a trained observer who was blind to group membership and the study's hypotheses scored technician responses from the video recordings of the BISWA and BISPA. For purposes of calculating interobserver agreement, each assessment was divided into a series of trials as described above, and the total number of trials on which the two observers agreed was divided by the total number of trials scored and the resulting quotient was converted to a percentage. An agreement was scored if both observers recorded the same technician skill as having occurred or not occurred during each trial.

In both the groups, interobserver agreement was scored for 56% of the pretest and posttest sessions. Mean agreement levels across participants were 86% and 83% for the BISWA and BISPA, respectively. Mean agreement levels between the observer who was blind to group membership and study hypotheses and the unblinded observer were 85% and 86% for the BISWA and BISPA, respectively. Thus, no evidence of observer bias was discovered.

Procedural integrity on the confederates' implementation of the role-play activities was scored for 100% of the pretest and posttest sessions. Mean procedural integrity levels across confederates were 94.4% (range, 81–100%) and 99.8% (range, 95–100%) for the BISWA and BISPA, respectively. These data indicate that the confederates completed the prescribed responses with high levels of accuracy, which was expected because researchers provided real-time guidance.

5. Procedure

Training for technicians included: (a) completing e-learning modules (described subsequently) at times convenient to their schedule and (b) receiving real-time direct instruction with descriptive feedback from researchers. Regarding the latter, technicians observed researchers modeling the target skills, and the technicians behaviorally rehearsed those procedures with coaching and feedback from researchers via a video-conference-meeting platform (i.e., GoToMeeting). Each technician was provided with a webcam (Logitech C525 or C615), bluetooth headset (Plantronics Voyager Pro), ethernet connection cords, and the materials needed for the training. During the study, technicians were free to proceed through the e-learning modules at their own pace; however, the researchers encouraged the technicians to set a goal each week and provided positive feedback for meeting the goal.

5.1. Pretest

Prior to random assignment to either the treatment or control groups, technicians completed an initial assessment to determine their baseline skill levels using the BISWA and BISPA assessments as described above.

5.2. Randomization

After technicians completed the BISWA and BISPA assessments, they were matched into pairs (based on how closely in time they completed the pretests) and then randomly assigned to either the treatment or control group. Technicians assigned to the treatment group completed the virtual training program immediately; technicians in the control group were

placed on a waitlist and did not receive training until their matched partner completed the training program and both technicians completed a second set of BISWA and BISPA assessments (i.e., posttest).

5.3. Virtual, e-learning program

The e-learning training program consisted of 17 multi-media modules, each lasting 40–60 min, and was divided into three sections. The content of the modules was designed to provide an overview of a behavior-analytic principles and strategies related to applying ABA to child behavior as well as demonstrations of training strategies through pictures, video, and narration for each slide. Technicians accessed each module from UNMC's Blackboard website and completed the modules in a sequential fashion. Blackboard is a content delivery service commonly used by universities. The modules in Section 1 included: (a) Ethics, Least Restrictive Environment, and Vulnerable Populations; (b) Extinction; (c) Punishment; (d) Preference Assessments and Positive Reinforcement; (e) Stimulus Control and Motivating Operations; and (f) Stimulus Generalization and Maintenance. The modules in Section 2 included: (a) Introduction to Verbal Behavior, (b) Discrete-Trial Training, (c) Matching-to-Sample and Discrimination Training, (d) Response Prompting, and (e) Response Chaining. The modules in Section 3 included: (a) Natural Environmental Training, (b) Assessment and Treatment of Problem Behavior, (c) Compliance, (d) Preventing Problem Behavior, (e) Putting it Together I-Integrating Structured Training Strategies, and (f) Putting it Together II-Integrating Play-Based Training Strategies. A 10-item, multiple-choice quiz was created for each module and technicians had to correctly answer 80% or more of the questions before proceeding to the subsequent module.

5.4. Scripted role-plays

Role-plays were programmed for six of the modules and were designed to provide technicians with opportunities to practice the skills that were covered in the module. For the role-plays, the researcher, technician, and a confederate established a virtual meeting and bluetooth audio connection as described above for the pretests and posttests. At the beginning of the role-play, technicians were instructed to show the researcher how to implement the target skill based on the instructions and visual exemplars provided in the module. For example, for one situation during the role-play for the Response Prompting module, technicians were asked to implement a full-physical prompt with a 5-s prompt delay. Each role-play consisted of several situations (or multiple exemplars; Sprague & Horner, 1984; Stokes & Baer, 1977; Stokes & Osnes, 1989) for which the researcher instructed the confederate (via the earpiece so that the technician would not hear the instruction) to emit the child responses scripted for each situation (i.e., trial). Each confederate response was programmed multiple times to obtain repeated opportunities for the technician to practice the response and receive feedback. If the skill was implemented incorrectly, the researcher provided descriptive feedback by detailing the correct response and, on occasion, by modeling correct implementation of the skill via the live-video connection; next, another opportunity to practice was arranged. For the final two role-play modules (Putting it Together I-Integrating Structured Training Strategies and Putting it Together II-Integrating Play-Based Training Strategies), role-play training continued until the technician demonstrated independent mastery of the skills at 80% or above.

5.5. Posttest

The posttest was identical to the pretest except that it occurred after the treatment group completed the virtual training program as described above. That is, after a technician in the treatment group finished the training, researchers conducted a posttest with that technician and the matched technician in the control group.
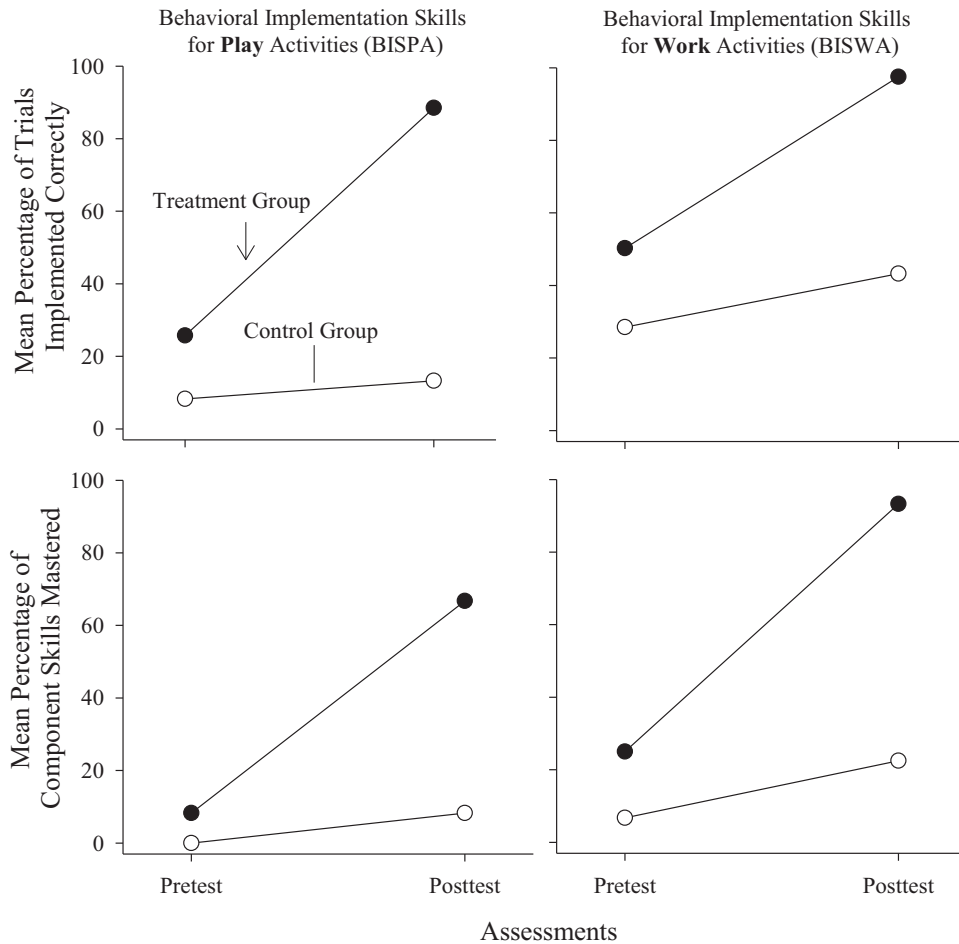
5.6. Social-validity measures

We developed a 14-item, social-validity questionnaire to measure technicians' satisfaction with three major aspects of the virtual training program as well as their overall satisfaction with the program. In particular, we asked technicians to provide ratings about their experiences with (a) the web-based technology (i.e., the process of using a virtual meeting platform, the quality of the video and audio during the meetings and role-plays, and the use of Blackboard to deliver the content through the Internet); (b) the content (i.e., the breadth of information covered, the amount learned from the modules, the use of quizzes, and the organization of the modules); (c) their interactions with the consultant (e.g., feedback during role-plays and weekly updates; scheduling flexibility); and (d) their overall satisfaction with the program and whether they would recommend it to others who are not able to receive on-site training. Each item was scored on a 7-point, Likert scale ranging from 1 for strongly disagree to 7 for strongly agree, with higher numbers reflecting greater satisfaction with that aspect of the virtual training program.

6. Results

6.1. Direct-observation measures

We analyzed performance on the BISPA and the BISWA assessments using two scoring methods, one that calculated the percentage of correct trials and another that calculated the percentage of component skills mastered.

Behavioral Implementation Skills
for **Play** Activities (BISPA)

Behavioral Implementation Skills
for **Work** Activities (BISWA)

Fig. 1. The closed circles denote the average performance of the four technicians randomly assigned to the (technology-enhanced) treatment group, and the open circles denote the average performance of the four matched technicians assigned to the waitlist-control group. The top panels display performance based on the percentage of trials implemented correctly, and the bottom panels display performance based on the percentage of component skills mastered.

6.2. Percentage of trials implemented correctly

With this method, we scored the percentage of trials implemented correctly by dividing the total number of trials implemented correctly plus the total number of errors, including both errors of commission (implementing a skill incorrectly; e.g., delivering reinforcement following an incorrect response) and errors of omission (failing to implement a skill when required; e.g., omitting descriptive praise following a correct response). This method of scoring provided an overall measure of how accurately the technicians carried out the procedures.

The mean percentage of trials implemented correctly for the treatment and control groups during pretest and posttest of the BISPA are shown in the upper-left panel of Fig. 1. Both groups performed poorly on the BISPA during the pretest, although the treatment group showed a slightly higher mean percentage of correct trials than did the control group (Ms = 25.8% and 8.3% on the pretest for the treatment and control groups, respectively). However, the difference between the means for the treatment and control groups on the posttest was notably larger (Ms = 88.5% and 13.3% on the posttest for the treatment and control groups, respectively). Due to the observed difference between the groups on the pretest, we analyzed the data with a general linear model using performance on the pretest as a co-variable. The top panel of Table 3 shows the results of this analysis. As can be seen, when statistically controlling for the effects of the pretest, the difference between the treatment and control group means on the posttest was large (i.e., partial eta squared of .765, which is equivalent to a Cohen's d of 3.6) and statistically significant (F = 13.0; $p < .05$).

Similar results were obtained for the percentage of trials implemented correctly on the BISWA, which are depicted in the upper-right panel of Fig. 1. The treatment group showed a slightly higher mean percentage of correct trials than did the control group on the BISWA pretest (Ms = 50.3% and 28.5% for the treatment and control groups, respectively), but the difference was notably larger on the posttest (Ms = 97.5% and 43.3% for the treatment and control groups, respectively).

Table 3
Between-groups inferential statistics.

	Type III SS	df	Ms	F	Sig.	Partial eta squared	Noncent. parameter	Observed power
Mean percentage of trials implemented correctly								
Behavioral Implementation of Skills for Play Activities (BISPA)								
Corrected model	11,399.29	3	3799.76	24.53	.005	.948	73.59	.990
Intercept	2865.87	1	2865.87	18.50	.013	.822	18.50	.888
Group	2017.61	1	2017.61	13.03	.023	.765	13.03	.769
Pretest	73.99	1	73.99	.478	.527	.107	.478	.084
Group × pretest	24.09	1	24.09	.156	.713	.037	.156	.061
Error	619.68	4	154.90					
Total	32,725.00							
Corrected total	12,018.88							
Behavioral Implementation of Skills for Work Activities (BISWA)								
Corrected model	5957.09	3	1985.70	16.73	.010	.926	50.19	.947
Intercept	7390.25	1	7390.25	62.26	.001	.940	62.26	1.00
Group	1557.13	1	1557.13	13.12	.022	.766	13.12	.772
Pretest	59.33	1	59.33	.500	.519	.111	.500	.086
Group × pretest	40.60	1	40.60	.342	.590	.079	.342	.074
Error	474.783	4	118.70					
Total	46,053.00							
Corrected total	6431.88							
Mean percentage of component skills mastered								
BISPA								
Corrected model	8318.58	2	4159.29	13.10	.010	.840	26.20	.912
Intercept	7003.44	1	7003.44	22.06	.005	.815	22.06	.959
Group	3854.30	1	3854.30	12.14	.018	.708	12.14	.794
Pretest	1474.08	1	1474.08	4.64	.084	.481	4.64	.415
Group × pretest	.000	0				.000	.000	
Error	1587.42	5	317.48					
Total	21,156.00							
Corrected total	9906.00							
BISWA								
Corrected model	11,497.31	3	3832.43	60.31	.001	.978	180.93	1.00
Intercept	13,472.71	1	13,472.71	212.01	.000	.981	212.01	1.00
Group	8139.64	1	8139.64	128.09	.000	.970	128.09	1.00
Pretest	553.40	1	553.40	8.71	.042	.685	8.71	.606
Group × pretest	768.91	1	768.91	12.10	.025	.752	12.10	.740
Error	254.19	4	63.55					
Total	37,516.00							
Corrected total	11,751.50							

The second panel of Table 3 shows the results of statistical analyses for the percentage of trials implemented correctly on the BISWA. When statistically controlling for the effects of the pretest, the difference between the treatment and control group means on the posttest was large (i.e., a partial eta squared of .766, which is equivalent to a Cohen's d of 3.6) and statistically significant ($F = 13.1$; $p < .05$).

6.3. Percentage of component skills mastered

With this method, we calculated the percentage of skills implemented correctly for each component skill (e.g., delivers behavior-specific instructions) using the formula described for the other method. Next, we counted the total number of component skills mastered (i.e., implemented with 90% accuracy or better), divided that number by the total number of component skills, and converted the resulting proportion to a percentage. This method of scoring provided information on which specific skills the technicians were implementing with high fidelity and which ones should be targeted for additional training.

The bottom-left panel of Fig. 1 shows the mean percentage of component skills mastered for the BISPA across the treatment and control groups. Both groups displayed mastery performance on a small percentage of the skills ($Ms = 8.3\%$ and 0% on the pretest for the treatment and control groups, respectively). By contrast, the treatment group had mastered the majority of the component skills by the posttest, whereas the control group showed little improvement ($Ms = 66.8\%$ and 8.3% on the posttest for the treatment and control groups, respectively). The third panel of Table 3 shows the results of the statistical analyses based on the mean percentage of component skills mastered. When statistically controlling for the effects of the pretest, the difference between the treatment and control group means on the posttest was large (i.e., partial eta squared of .708, which is equivalent to a Cohen's d of 3.1) and statistically significant ($F = 12.1$; $p < .05$).

The bottom-right panel of Fig. 1 depicts the results for the mean percentage of component skills mastered on the BISWA. Both groups displayed mastery performance on a small percentage of the component skills (Ms = 25.0% and 6.8% on the pretest for the treatment and control groups, respectively). By contrast, the treatment group had mastered almost all of the component skills by the posttest, whereas the control showed only slight improvement (Ms = 93.3% and 22.5% on the posttest for the treatment and control groups, respectively). The bottom panel of Table 3 shows the results of the statistical analyses conducted on the mean percentage of component skills mastered. When statistically controlling for the effects of the pretest, the difference between the treatment and control group means on the posttest was large (i.e., partial eta squared of .97, which is equivalent to a Cohen's d of 11.4) and statistically significant (F = 128.1; $p < .001$). It is also noteworthy that on this measure the effects of the pretest were statistically significant (F = 8.7; $p < .05$), as was the interaction between pretest performance and group membership (F = 12.1; $p < .05$). These results suggest that technicians who scored relatively higher on the pretest also tended to score relatively higher on the posttest. Finally, the significant interaction between the pretest and group membership suggests that the technicians in the treatment group who scored relatively higher on pretest tended to show a better response to the treatment.

7. Social-validity measures

The mean satisfaction rating with the web-based technology was 5.4 (range, 4.5–6), with the least satisfaction expressed for the use of Blackboard as the medium for accessing the e-learning modules and the most satisfaction expressed for the audio and visual quality during role-play sessions. The mean satisfaction rating with the content of the virtual training program was 6.8 (range, 6.8–7), with high satisfaction expressed for all aspects of the training content, including the type of information covered, the role-play component, the quality and organization of the e-learning modules, and the amount learned during training. The mean satisfaction rating for the interactions with the researcher (behavioral consultant) was 6.9 (range, 6.8–7), with high satisfaction expressed for all aspects of the interactions, including the consultant's ability to answer questions, the option of completing the training at the technician's pace, and the flexibility offered in scheduling meetings and role plays. Finally, the mean rating for overall satisfaction with the training was 7.0, and all of the technicians indicated that they would recommend the training to others.

8. Discussion

The first eight participants enrolled in an ongoing RCT to test the effects of a virtual training program for training ABA technicians were randomly assigned to either the treatment or the control group. Technicians in both groups performed relatively poorly during the pretest with the direct-observation measures (the BISPA and BISWA), both when we analyzed the percentage of trials implemented correctly and the percentage of component skills mastered. Following exposure to the virtual training program, technicians in the treatment group showed marked and statistically significant improvement on these direct-observation measures during the posttest relative to the control technicians who did not receive the training. In addition, social-validity ratings were uniformly high for the content of the training and the interactions with the behavioral consultant and were moderately high for the web-based technology (e.g., GoToMeeting). Finally, all technicians who received the training rated their satisfaction with the programs at the top of the Likert scale (i.e., all rated it as a 7 on a 7-point scale), and all technicians indicated that they would recommend the training to others.

Several studies have evaluated similar virtual programs for training parents or technicians to implement behavioral interventions for children with ASD (Buzhardt & Heitzman-Powell, 2005; Hamad et al., 2010; Jang et al., 2012; Vismara et al., 2009). The current results replicate and extend the findings of those prior studies in several ways. First, the prior studies and ours, taken together, show that virtual technologies can be used to provide effective, convenient, accessible, and socially-valid training in EIBI or other early intervention methods. In the current study, the technicians in the treatment group completed the e-learning modules on their own, at their own pace, and in their own home or community environment. This component of the training required little time or effort on the part of the researchers (after the development of the e-learning modules was completed). Obviously, the role-play sessions required active participation from a researcher, but overall, the virtual training program was reasonably time efficient. In addition, neither the technicians nor the researchers had to travel in order to implement the virtual training program, thus saving both time and money. Therefore, the current virtual training program could potentially be used to train ABA technicians anywhere there is sufficient broadband Internet access.

Second, only one prior study has evaluated a virtual training program using an RCT (Jang et al., 2012), and that investigation targeted knowledge of behavioral procedures as measured by a multiple-choice quiz. Technicians in the current study completed a 40-h virtual training program designed to teach knowledge about ABA principles and procedures as well as train the technicians to implement a variety of behavioral protocols with high procedural integrity. The technicians in the treatment group were required to obtain a score of 80% correct or better on multiple-choice quizzes administered at the completion of each e-learning module, and they received scripted role-play practice with feedback in implementing behavior-reduction and skill-acquisition procedures implemented in both discrete-trial and play-based formats. Thus, the current virtual training program was considerably more comprehensive than most, if not all, of the virtual training programs evaluated in prior studies. In fact, after completion of the training, all four technicians met the qualifications to work as a behavioral tutor under the rules of the Tricare Autism Demonstration Project (TriCare Operations Manual – 6010.56-M, Chapter 18, Section 8, C-101, June 25, 2013).

Another unique and potentially interesting aspect of the current study was that behavioral skills training (BST) procedures used during the role-play sessions were completed without any on-site support from a trained professional or technician. BST is a widely used method for training individuals to implement ABA procedures that has strong empirical support (see Thompson, Martin, Arnal, Fazzio, & Yu, 2009 for a review). The four primary components of BST are instruction, modeling, rehearsal, and feedback. These training procedures have been almost always implemented with the trainer and trainee at the same physical location.

Wacker and colleagues have pioneered the use of similar procedures to train and guide professionals to conduct controlled functional analyses at remote sites using fiber-optic telecommunications system (Barreto, Wacker, Harding, Lee, & Berg, 2006) and VPNs (Wacker et al., 2013a, 2013b). However, their procedures have included trained, on-site assistants that provided support to the parents who implemented the functional analyses or functional communication training in a hospital or clinic located near the family. In addition, procedural integrity data were not reported; as a result, the extent to which the parents implemented the procedures with fidelity remains uncertain. By contrast, in the current study, all components of BST were conducted remotely using a VPN, and at posttesting, the technicians in the treatment group generally implemented the procedures accurately (i.e., 97.5% of trials implemented correctly on the BISWA, and 88.5% of trials implemented correctly on the BISPA). Similarly, the confederates also performed their activities with high procedural integrity, probably because the behavioral consultant verbally guided the confederates as they played the role of a child with an ASD (i.e., 94.4% of trials were correctly programmed for the BISWA, and 99.8% of trials were correctly programmed for the BISPA).

These findings should be regarded as preliminary and interpreted with appropriate caution, given the limitations of the investigation. We reported on only the first eight technicians enrolled, and only four of these technicians received the treatment. A related limitation is that the treatment technicians, as a group, scored higher on the pretest measures than did the control technicians, which can occur in RCTs when the sample sizes are small. We controlled for this difference statistically in our analyses, but on one of the measures we observed an interaction between the pretest and group membership, suggesting that individuals with higher pretest scores tended to respond better to the intervention. Thus, it is possible that the effect size would have been somewhat smaller for this dependent measure if the groups had been better equalized at pretest. As we continue to enroll technicians, we will use the process of minimization to produce more equal groups going forward. That is, technicians will be assigned one at a time with an 80% chance of being assigned to the group that would minimize the Kullback–Leibler divergence index using the MinimRan virtual program with the pretest scores on the BISWA and BISPA as the co-variables (Xiao, Huang, Yank, & Jun Ma, 2013). This procedure should produce equivalent means for the pretest measures in the final report of this ongoing investigation.

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