Journal on Developmental Disabilities
Le journal sur les handicaps du développement
JoDD
Volume 21, Number 1, 2015

Online Training of Discrete-Trials Teaching for Educating Children with Autism Spectrum Disorders: A Preliminary Study

Authors

Alejandra Zaragoza Scherman,[1,2,*]
Kendra Thomson,[1,3]
Ashley Boris,[1]
Lindsay Dodson,[1]
Joseph J. Pear,[1]
Garry Martin[1]

[1] Department of Psychology, University of Manitoba, Winnipeg, MB

[2] Present: Center on Autobiographical Memory Research – CON AMORE, Department of Psychology and Behavioural Sciences, Aarhus University, Aarhus, Denmark

[3] Present: Centre for Applied Disability Studies, Brock University, St. Catharines, ON

[*] This name uses Spanish naming customs; the first or paternal family name is *Zaragoza* and the second or maternal family name is *Scherman*. Please use *Zaragoza Scherman* as the surname for citations.

Correspondence

alejandra@psy.au.dk

Keywords

on-line instruction, Computer-Aided Personalized System of Instruction, Discrete-Trials Teaching, autism spectrum disorders, staff training

Abstract

We evaluated a self-instructional manual supported by an online Computer-Aided Personalized System of Instruction (CAPSI) for teaching Discrete-Trials Teaching (DTT) to university students. During baseline and post-training, five participants taught three tasks commonly taught to children with autism spectrum disorders to a confederate role-playing a child with autistic disorder. During training, participants studied a self-instructional manual using CAPSI to demonstrate mastery of study questions about DTT. Overall mean baseline accuracy was 54.9%, and improved to 84.7% in post-training, a 30% improvement. These preliminary results are suggestive that CAPSI is an effective educational tool for the delivery of the DTT self-instructional manual.

Discrete-Trials Teaching (DTT) is an effective and commonly used approach for teaching children with autism spectrum disorders (ASDs) in early intensive behavioural intervention (EIBI) programs (Lovaas, 1987). With the rising prevalence of ASD and government funded EIBI programs in Canada, there is a severe shortage of well-trained tutors and therapists (Fombonne, 2003; Jacobson & Mulick, 2000; Thomson, Martin, Arnal, Fazzio, & Yu, 2009).

While a number of one-to-one training programs have been demonstrated to be effective in training staff to conduct DTT (e.g., Gilligan, Luiselli, & Pace, 2007; Koegel, Russo, & Rincover, 1977; Ryan & Hemmes, 2005; Sarokoff & Sturmey, 2008), they are usually time consuming and require considerable human resources to be implemented (LeBlanc, Ricciardi, & Luiselli, 2005; see Thomson et al., 2009, for a review). Therefore, effective and cost/time efficient systems to teach tutors and therapists are needed.

Some staff training techniques, using computer software and online learning (e.g., Desrochers & Hile, 1993; Desrochers, House, & Seth, 2001; Granpeesheh et al., 2010; Hu, Pear, & Yu, 2012; Randell, Hall, Bizo, & Remington, 2007; Sailor et al., 1999) have been developed as a result of the increasing demand for highly trained personnel to deliver a range of behavioural services to children with ASDs and other developmental disabilities.

Recently, researchers at the University of Manitoba in Winnipeg, Manitoba, have investigated the use of a self-instructional manual (Fazzio & Martin, 2009; now available from Fazzio & Martin, 2011 at www.dtteaching.com) to teach DTT to mediators, with promising results (Boris et al., 2011; Fazzio,

Martin, Arnal, & Yu, 2009; Thiessen et al., 2009; Thomson et al., 2012; Wightman et al., 2012; Young, Boris, Thomson, Martin, & Yu, 2012).

In these studies, the DTT self-instructional manual was tested with the help of a researcher who was present during the studying of the manual and administered unit tests. In the present study, the help of the researcher has been replaced by an online program, called Computer-Aided Personalized System of Instruction (CAPSI), developed at the University of Manitoba (Pear, Schnerch, Silva, Svenningsen, & Lambert, 2011).

CAPSI is an on-line version (Pear & Crone-Todd, 1999) of Keller's Personalized System of Instruction (PSI; Keller, 1968, 1974). PSI was developed to teach university courses according to behavioral principles. Several core features distinguish PSI courses from more traditional university lecture-style courses: Students in a PSI course can read textual material at the speed they are comfortable with; they are required to take unit tests and master the material to a set mastery criterion before they can move on to subsequent units; and they may attend optional lectures and demonstrations designed to enhance the textual material, but not to add new information. Communication between teacher and students is mainly written. Proctors (students who have passed the course in previous terms) score students' unit tests and provide feedback.

As with PSI, CAPSI allows students to advance through textual learning materials at their own pace. Students are required to demonstrate mastery of the course content by taking a test after each unit of material (typically one or two chapters in length). However, a main difference between PSI and CAPSI courses is that once students have completed a unit test, in CAPSI, the computer assigns his or her completed unit test to two other students (peer reviewers) who have already passed the assigned unit test to be marked. Peer reviewers determine whether a student has demonstrated mastery of the test material and can therefore proceed to the next unit, or whether he or she should re-study and take another unit test at a later time. It is required that both peer reviewers assign a "pass" for the student to advance to the next unit; otherwise the unit test receives a "re-study." If peer reviewers are not available to mark a test, CAPSI sends the unit test to the instructor or a teaching assistant (if any have been assigned to the course). Usually the instructor or the teaching assistant marks the first tests submitted for each unit since no student has yet passed. In CAPSI, peer reviewers are students enrolled in the same course who have passed the unit that the other student is being tested on. During a CAPSI course, students can volunteer to mark other students' unit tests. In order to be assigned a unit test to be marked, students must have previously passed that unit. With peer reviewing, students have the opportunity to be exposed to the material a number of times.

In addition, CAPSI courses may require students to take a mid-term and a supervised final exam. According to Pear and Martin (2004), CAPSI makes use of computer technology to enhance the educational features of PSI by providing: (1) immense information-processing and storage for data on how the course is run; and (2) communication capacities that permit remote online access to the course, and therefore make it available to more people at a lower cost.

CAPSI has been used successfully to teach university courses (Martin, Pear, & Martin, 2002a; Martin, Pear, & Martin, 2002b; Pear, 2002; Pear, Schnerch, Silva, Svenningsen, & Lambert, 2011). Due to its success at teaching students complex behavioural principles and applications, there is an increasing interest at the CAPSI research lab at the University of Manitoba, directed by J. J. Pear, in using CAPSI for training and clinical purposes.

For instance, CAPSI has been used successfully to teach individuals to administer the *Assessment of Basic Learning Abilities* (ABLA) test (Hu, Pear, & Yu, 2012), using a self-instructional manual as the textual material. The ABLA is used to determine what kind of tasks an individual with developmental disabilities might be able to perform, based on the level of imitation and discrimination skills that the individual masters (Martin, Thorsteinsson, Yu, Martin, & Vause, 2008). The present study represents the first attempt to test the efficiency of CAPSI to serve as the method to deliver the unit tests contained on a self-instructional manual that trains individuals to perform DTT to teach children with ASDs. However, it is important to note that DTT is not the only behavioural technique used to teach children with ASDs. Therefore, an individual looking to teach children with ASDs will need to be trained in other techniques,

other than DTT, before he or she is fully trained to work with children with ASDs, under the supervision of a qualified ABA professional. The information above is made available to the readers of the manual in one of its appendixes.

The Present Study

The present study evaluated the use of a training package that combines CAPSI and a DTT self-instructional manual to teach university students to conduct DTT with a confederate role-playing a child with ASD. CAPSI was implemented to replace the presence of a researcher who administered unit tests in past studies, allowing time saving and the training of more individuals at once. The self-instructional manual has been shown to be effective at teaching individuals how to conduct DTT in investigations in which the manual is studied under the supervision of a researcher. It was expected that the use of the self-instructional manual could be substantially facilitated by CAPSI. If the "CAPSI + self-instructional manual" training package proved effective, it could be used to train a large number of DTT teachers at the same time in different locations through the Internet, without the presence of a supervisor. Based on previous studies (Boris et al., 2011; Fazzio et al., 2009; Thiessen et al., 2009; Thomson et al., 2012; Wightman et al., 2012; Young et al. 2012), it was expected that before studying the DTT self-instructional manual, participants' DTT performance accuracy during baseline would be less than 50% on each of three baseline tasks; however, this expectation was not part of the inclusion criteria for the study. It was also expected that after studying the DTT self-instructional manual with the support of CAPSI to administer unit tests, participants would improve to greater than 90% DTT performance accuracy on each of the three baseline tasks. The procedure in this study, described below, received ethical approval from the University of Manitoba Psychology/ Sociology Research Ethics Board.

Method

Participants and Setting

Seven university students were randomly selected from a pool of eligible research participants, who were recruited from a psychology course taught at the University of Manitoba. These students did not have any previous experience with DTT. Five of the seven participants completed the study. Baseline, self-practice, and post-training sessions took place in an assessment room, containing a table and two chairs, at the University of Manitoba. Participants studied the manual in preferred locations, such as their homes. Participants received points towards their course grade for participating in the study.

Instruments and Materials

CAPSI was used to administer tests on the content of the DTT self-instructional manual. During baseline, three one-page abbreviated DTT instructions for tasks commonly taught to children with ASDs in behavioural intervention programs were used. These abbreviated instructions were accompanied by corresponding data sheets for each task (see Arnal et al., 2007, for a detailed description). A 21-item checklist called the DTT Evaluation Form (DTTEF; Babel, Martin, Fazzio, Arnal, & Thomson, 2008; Fazzio, Arnal, & Martin, 2010) was also used to evaluate the accuracy with which participants conducted DTT. A laptop computer with a built-in video camera, data sheets, and pencils were used for data collection purposes. In order to participate in the study, students were required to have a personal computer and an Internet connection to access CAPSI. After baseline, a laptop computer with an Internet connection was used to provide a brief demonstration of how to access CAPSI.

Procedure

Baseline. During baseline participants were tested individually. Each participant was asked to read the summary guidelines, which provided three sets of abbreviated instructions on how to conduct a DTT session with children with ASD. Participants had a maximum of 10 minutes to read the abbreviated instructions for each task and were instructed to tell the researcher when they were finished reading. These tasks included: (1) matching-to-sample, which consisted of presenting an array of three pictures and giving a picture for the child to match with the identical picture from the three-picture array to make a pair; (2) pointing to a picture that was named by the instructor when an array of three pictures was presented; and (3) motor imitation, which involved asking the child to "do this," while the instructor modelled an action such as

touching one's nose or covering one's eyes with one's hands. After reading the instructions for one task, the participant then attempted to teach that task to a confederate role-playing a child with ASD. Participants were allowed to consult the abbreviated instructions while attempting to teach the task. This procedure was repeated two more times until the participant had the opportunity to teach all three tasks. The order of the tasks was randomized across participants to control for possible order effects. Baseline sessions were videotaped and later scored with the DTTEF in order to evaluate each participant's accuracy at performing DTT to teach each of the three tasks.

Training. Immediately after the baseline phase, the participant was given his or her CAPSI username and password to access the online program. Using a laptop with an Internet connection, and in the company of the primary researcher, the participant accessed the CAPSI website and the main CAPSI features were explained to him or her by the researcher. In addition, the participant was shown where to find the CAPSI guide, which explains in detail how the system works. The participant was then given a short demonstration on how to submit and review unit tests. After this demonstration the participant was given a hard copy of the self-instructional DTT manual (Fazzio & Martin, 2009), and time-keeping sheets in which he or she was asked to record the time spent (1) reading the manual, (2) studying the study questions, (3) writing CAPSI unit tests, (4) peer reviewing, and (5) doing the self-practice exercises.

The participant was then told to read the manual at his or her own pace, and logon to CAPSI to write a unit test after studying each unit. Each participant decided when to begin and finish training; that is, training commenced any day after the baseline session, when the participant started reading the manual on his or her own time, and finished as soon as he or she was finished reading the manual, wrote all unit tests, and completed the self-practice exercises.

The manual contained 12 chapters (see Appendix for the manual table of contents; see Fazzio & Martin, 2009); each chapter was one unit in CAPSI. For example, Chapter 2 covers basic behavioral principles and procedures. This chapter contains a total of 14 study questions. Participants were required to read the material for each chapter and pass a unit test on CAPSI before proceeding to the next chapter. Each unit test consisted of three study questions randomly selected by the system from a pool of study questions in the manual for that unit. For example, for Chapter 2, a participant could have received the following questions: (1) define positive reinforcer and give an example; (2) describe the two parts of the principle of positive reinforcement; and (3) describe an example of positive reinforcement following a desirable response, and identify the antecedent, response, immediate consequence, and probable result. Once the participant completed the test, CAPSI sent the completed test to either the principal researcher or to two peer reviewers for feedback. Feedback could either be designated a "pass," in which case the participant was allowed to move on to the next unit, or a "re-study," in which case the participant was asked to go back to the reading material and re-study the study questions. After a re-study period of at least an hour, the participant could request to attempt the test again for that unit.

Participants were also instructed on the peer reviewing process. Specifically, they were informed that they had 24 hours to mark a unit test after its submission; and that because of the unpredictability of when a unit test would be submitted, participants were asked to access CAPSI regularly to check for other participants' unit tests to be peer reviewed. Participants were instructed that the other participants' progress depended on how promptly unit tests were marked.

Chapters 8, 10, and 11 not only required the participant to answer study questions, but also required him or her to conduct a self-practice role-playing exercise on the implementation of DTT and to self-evaluate his or her performance. For each of these units, participants were required to schedule a role-playing session with the primary researcher. During these sessions, participants performed the self-practice exercises contained in the manual, but did not receive feedback on their performance. These sessions were videotaped, and the information on the videotapes was used for observational purposes by the researcher, but was not part of the "pass" requirements for the units. Practice exercise videos were not scored for DTT accuracy. These sessions were mainly designed to ensure that participants performed the role-playing exercises contained in the self-instructional manual.

Post-training. The post-training phase occurred after participants had mastered the content of the DTT manual, by completing the unit tests on CAPSI, and had completed the self-practice sessions. During this phase participants were asked, individually, to teach the same three tasks they taught in baseline to a confederate who role-played a child with ASD as described previously for the baseline phase.

Reliability and Procedural Integrity Checks

Inter-observer reliability (IOR) checks were conducted for 30% of all baseline and post-training sessions across participants. Two investigators observed the videotaped sessions and, independently scored whether the participant completed each step on the DTTEF correctly or incorrectly. A step was scored as an agreement if both observers scored the component identically; otherwise, it was considered a disagreement. Percent agreement was calculated by dividing the number of agreements by the number of agreements plus disagreements and multiplying by 100% (Martin & Pear, 2015). Mean percentage agreement during research sessions was 95.5%, ranging from 88.2% to 100%. Procedural integrity (PI) was also measured with PI checks performed by an observer during 30% of sessions to ensure that the researcher correctly implemented all steps. The percent correct PI for all observed sessions was 100%.

Results

DTT Performance

Five of the seven participants completed the study. Figure 1 shows each participant's DTT performance, represented as the percentage of correct responses for both phases: baseline and post-training. Each pair of bars represents one of the three tasks (matching, pointing, and imitation) that participants were required to teach.

A statistical analysis was performed to evaluate the combined training effects over all DTT tasks. A paired-sample *t*-test was conducted to compare the mean group DTT score during baseline to the mean group post-training DTT performance score. There was a significant difference in the mean scores for baseline (M = 54.9, SD = 12.8) and post-training (M = 84.7, SD = 10.9); $t(4) = 6.01$, $p < .004$). These results

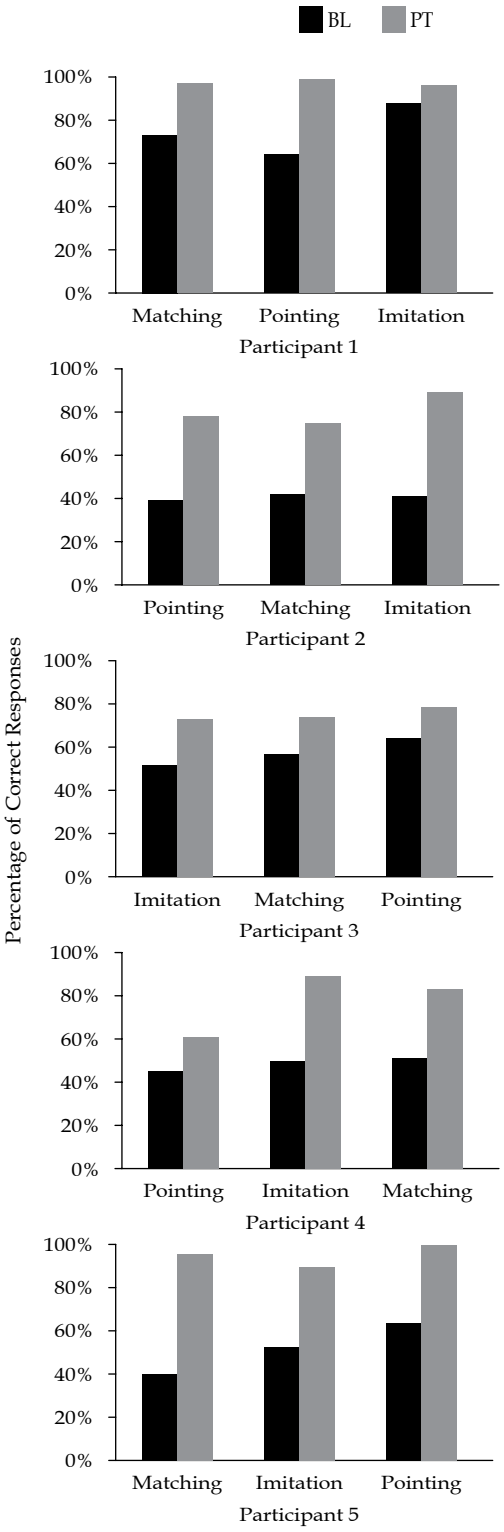

Figure 1. Percentage of correct responses for baseline (BL) and post-treatment (PT) for all three tasks: matching, pointing, and imitation, per participant

indicate that studying the self-instructional manual in combination with CAPSI improved overall DTT performance significantly.

Training effects for each task were also analyzed (see Table 1). Paired-sample *t*-tests were conducted to compare the mean group baseline scores to the mean post-training scores for the matching, pointing, and imitation tasks. There was a significant difference in the mean baseline versus post-training scores across all three tasks. These results indicate that studying the self-instructional manual in combination with CAPSI improved DTT performance significantly for teaching all three tasks.

Study/Researcher Time

Participants reported spending an average of 12 hours and 48 minutes (range: 9 hours and 23 minutes to 19 hours and 21 minutes) to complete all components in the training phase: reading the manual and answering the study questions, taking unit tests on CAPSI and re-taking unit tests when the mastery criterion was not reached, peer reviewing, and doing the self-practice exercises. Experimenter time during training was 10 hours in total for all participants. This time included monitoring CAPSI, marking tests, sending notification e-mails, and role-playing a child with autism during the self-practice exercises. This time was distributed over 55 days. It should be noted that while this study was planned to span an entire academic term, it could be implemented in a shorter period of time.

Discussion

Results from the present study suggest that CAPSI is an effective educational technology to deliver the self-instructional manual to teach university students to perform DTT. Furthermore, CAPSI's capabilities to distribute media content on the Internet could be used to insert visual demonstrations of DTT performance. Therefore, the manual could also be enriched with video and audio files on CAPSI. Alternatively, the contents of the manual could be transformed into an educational video to be distributed along with CAPSI.

In order for CAPSI to be a good addition to the manual for staff training, the procedure needs not only to be effective, but also to be cost/time efficient; that is, it should require less money and time to be implemented than other training procedures. In the present study it took 10 hours of experimenter time to effectively train five participants (excluding the two participants who did not complete the study; a mean of two hours per participant) with the "self-instructional manual + CAPSI" package, while it took Boris et al. (2011) around 20 hours of experimenter time to train three participants (a mean of 6.67 hours per participant), using the self-instructional manual. Furthermore, one of Boris' participants required an extra demonstration and feedback session after post-training phase because the participant failed to reach the mastery criterion (80% accuracy) during post-training assessments. Therefore, the manual alone was effective for only two of the three participants. However, for these two participants in Boris et al.'s study, the improvement between baseline and post-training was greater, from a baseline mean of 44% to a post-training mean of 94%. These results suggest that the "self-instructional manual + CAPSI" package may be more cost/time efficient, but may not lead to as much improvement. It is worth noting that the participants in the present study obtained higher baseline means than participants in Boris et al.'s study. As a result, a smaller improvement from baseline to post-training in the present study might have resulted from a ceiling effect and not

Table 1. Paired Sample t-Tests for the Matching, Pointing, and Imitation Tasks

Tasks	Baseline *M* (SD)	Post-training *M* (SD)	*p*
Matching	52.6 (13.3)	85.0 (11.1)	.008
Pointing	55.2 (12.2)	83.4 (16.4)	.006
Imitation	56.8 (18.1)	85.8 (8.9)	.013

to from the lack of effectiveness of the package. Thus, further study needs to be done to ensure that training using CAPSI will produce at least comparable improvement to training using a self-instructional manual alone in order to take full advantage of the availability of the Internet in training. A potential way to better establish the effectiveness of the "CAPSI + self-instructional manual" training package against that of the self-instructional manual administered by a researcher package could be to compare post-training scores of individuals with matched (and ideally lower than 40%) baseline scores.

As access to computers and the Internet increases, online training seems like a natural transition from standard training methods. Furthermore, the cost of using CAPSI does not increase proportionately to the number of students; consequently, it can be used to train a large number of individuals at the same time in different locations around the world. CAPSI also offers users the convenience of other online-provided services since trainees do not have to commute to receive training, and therefore they can save money and time on transportation, especially when they travel from rural or remote areas. Finally, CAPSI is cost/time efficient in that it does not require one-to-one instruction. Only one instructor is needed to administer a CAPSI course for a large number of people, and the instructor is not required to be present while training occurs. Time invested will depend on the number of students and tests to be marked by the instructor, but in general it is not highly time consuming, and it is certainly less time consuming than one-to-one instruction.

Limitations

One of the limitations of the present study is that it did not include a control group to which a CAPSI group could be compared. Another limitation of this study is that it did not include a generalization phase in which participants were assessed on using DTT to teach children with ASDs.

Future Research

Future research should include one or more control groups and a generalization phase to better evaluate the manual for teaching children with ASDs. For example, a control group could receive the manual as a standalone self-instructional manual, without the CAPSI component and without any supervision from experimenters. It is recommended to have control groups be matched on age, sample size, reading ability, DTT experience, first language, educational background, and gender, if possible.

In the present study, we had the participants schedule a session for the self-practice exercises found in the self-instructional manual at the end of Chapters 8, 10, and 11, in order to ensure that participants performed the exercises; however, this might not be necessary. Future studies could either omit such sessions or find other means of ensuring that participants do the self-practice exercises; for example, participants could record themselves and send the video or upload it to a digital repository or to CAPSI itself for peer reviewing. That way, participants need not meet the researchers during the training phase.

With respect to a generalization phase, researchers should look at testing the manual with other populations, such as parents of children with ASDs, tutors in training, or other paraprofessionals who work with children with ASDs, such as teachers and educational assistants. In the case of tutors in training, it is important to take into account that ABA training programs usually devote 25 to 60 hours to train tutors on DTT (Smith, 2001); therefore future research could investigate whether CAPSI is still effective when implemented in shorter periods of time. Other modifications to be examined include continuous access to a computer during training, a larger number of trainees, and shorter deadlines for peer reviewers to do grade tests.

Future research should also investigate whether there is a more effective order for presenting the teaching tasks to increase participants' DTT performance; for example, perhaps participants who start with a matching task learn the procedure better than participants who start with an imitation task. It would be necessary to determine: (a) whether a particular task is easier to teach than others; and (b) whether there is better skills transference from teaching pointing to matching, than from matching to pointing, etc.

Future studies should incorporate videos from the self-practice sessions into CAPSI for peer reviewing. These videos could serve as both

feedback opportunities and demonstrations. Perhaps participants could benefit from seeing another person perform DTT (e.g., see Thomson et al., 2012; Wightman et al., 2012). Participants might also benefit from using the DTTEF checklist to evaluate DTT performance on videos (e.g., see Arnal et al., 2007).

As an alternative to peer reviewing, another mechanism could be used for marking, such as using fill-in-the-blank questions that can be marked by the computer, providing immediate feedback. Future research could also evaluate CAPSI with other training manuals for ABA–based procedures, such as the ABLA manual (DeWiele, Martin, Martin, Yu, & Thomson, 2011; see Hu et al., 2012), the *Preference Assessment Manual* (Nguyen & Yu, 2009); or with other clinical applications such as mindfulness training. Some research along these lines has already been conducted and, consistent with the present study, has indicated that CAPSI can be an effective tool for teaching behavioural knowledge and procedures (Hu et al., 2012; Oliveira, Goyos, & Pear, 2012).

Conclusion

CAPSI was found to be an effective educational method to teach five individuals to conduct DTT to teach a confederate role-playing a child with ASD, using a DTT self-instructional manual, when they worked on their own, at their own pace, without supervision to write tests.

In the past, CAPSI has been demonstrated to be effective to teach university students complex behavioural principles. This study suggests that CAPSI may also be effective and cost/time efficient to teach behavioural procedures such as DTT. Therefore, the use of a "self-instructional manual + CAPSI" training procedure is recommended for training individuals to teach children with ASDs using DTT. Use of the self-instructional manual can be substantially facilitated by CAPSI, since the latter allows training a large number of people at the same time in different locations around the world through the Internet. At the same time, CAPSI gives participants the flexibility of working on their own and at their own pace, while interacting with a community of learners to obtain and provide feedback through unit tests. Future research should investigate how to make CAPSI even more effective, and whether these results can be generalized to other populations such as ABA tutors, parents, and paraprofessionals working with children with ASDs.

Institutions that provide ABA-based services for children with ASDs and other developmental disabilities could benefit greatly from having effective and cost/time efficient DTT training procedures for their staff, parents, and other paraprofessionals in the field. Effective training programs produce well-trained individuals, which results in better treatment service delivery for children with ASDs and their families, by helping children realize their full potential. In addition, cost/time efficient training programs provide more opportunities for institutions to train personnel at lower costs, in shorter periods of time. This could translate into more available capable human resources to accommodate a larger number of children with ASDs in their programs.

Key Messages From This Article

People with disabilities: Discrete-Trial Teaching (DTT) is a behavioral technique for the education of children with autism spectrum disorders. You deserve access to timely services and well-trained human resources. Online instruction can potentially provide qualified training to a large number of individuals, even in remote areas.

Professionals: Effective and efficient DTT training for tutors, parents, and paraprofessionals can be delivered online, using Computer-Aided Personalized System of Instruction (CAPSI).

Policymakers: Online instruction using computer-aided personalized system of instruction (CAPSI) could be used in a cost-effective manner to train human resources that provide educational services for children with autism spectrum disorders.

Acknowledgements

This paper is based on a thesis submitted to the University of Manitoba in partial fulfillment of the requirements for the M.A. degree by A. Zaragoza Scherman under the super-

vision of J. J. Pear. Preparation of this paper was supported in part by grant KAL 114098 from the Knowledge Translation Branch of the Canadian Institutes of Health Research to J. J. Pear. Written correspondence is to be sent to the first author, Center on Autobiographical Memory Research – CON AMORE, Bartholins Allé 9, Department of Psychology and Behavioral Sciences, School of Business and Social Sciences, Aarhus University, Aarhus C, 8000, Denmark. Phone: +45 87 16 52 91

References

Arnal, L., Fazzio, D., Martin, G. L., Yu, C.T., Keilback, L., & Starke, M. (2007). Instructing university students to conduct discrete-trials teaching with confederates simulating children with autism. *Developmental Disabilities Bulletin, 35*, 131–147.

Babel, D. A., Martin, G. L., Fazzio, D., Arnal, L., & Thomson, K. (2008). Assessment of the reliability and validity of the discrete-trials teaching evaluation form. *Developmental Disabilities Bulletin, 36*, 67–80.

Boris, A., Thomson, K., Murphy, C., Zaragoza Scherman, A., Dodson, L., Martin, G.,… Yu, C.T. (2011). An evaluation of a self-instructional manual for conducting discrete-trials teaching with children with autism. This article was accepted by *Developmental Disabilities Bulletin*, but the journal ceased to exist (in 2015) before the article was published. (Copies can be obtained from Garry Martin. Email: garry.martin@umanitoba.ca)

Desrochers, M. N., & Hile, M. G. (1993). SIDDS: Simulations in developmental disabilities. *Behavior Research Methods, Instruments & Computers, 25*, 308–313.

Desrochers, M. N., House, A. M., & Seth, P. (2001). Supplementing lecture with simulations in developmental disabilities: SIDD software. *Teaching of Psychology, 28*, 227–230.

DeWiele, L., Martin, G. L., Martin, T. L., Yu, C.T., & Thomson, K. (2011). *The Kerr-Meyerson Assessment of Basic Learning Abilities Revised: A self-instructional manual* (2nd ed.). St.Amant Research Centre, Winnipeg, MB, Canada. Retrieved from http://www.stamant.ca/research/abla/

Fazzio, D., Arnal, L., & Martin, G. L. (2010). Discrete-Trials Teaching Evaluation Form (DTTEF): Scoring manual. St.Amant Research Centre, Winnipeg, MB, Canada.

Fazzio, D., & Martin, G. L. (2009). *Discrete-trials teaching with children with autism. A self-instructional manual*. Unpublished manuscript, Winnipeg, Canada.

Fazzio, D., Martin, G. L., Arnal, L., & Yu, D. C.T. (2009). Instructing university students to conduct discrete-trials teaching with children with autism. *Research in Autism Spectrum Disorders, 3*, 57–66. doi:10.1016/j.rasd.2008.04.002

Fombonne, E. (2003). The prevalence of autism. *Journal of the American Medical Association, 289*, 87–89.

Gilligan, K. T., Luiselli, J. K., & Pace, G. M. (2007). Training paraprofessional staff to implement discrete trial instruction: Evaluation of a practical performance feedback intervention. *The Behavior Therapist, 30*, 63–66.

Granpeesheh, D., Tarbox, J., Dixon, D. R., Peters, C. A., Thompson, K., & Kenzer, A. (2010). Evaluation of an eLearning tool for training behavioral therapists in academic knowledge of applied behavior analysis. *Research in Autism Spectrum Disorders, 4*, 11–17. doi:10.1016/j.rasd.2009.07.004

Hu, L., Pear, J. J., & Yu, C.T. (2012). Teaching university students to implement the Assessment of Basic Learning Abilities using Computer-Aided Personalized System of Instruction. *Journal of Developmental Disabilities*, *18*, 12–19.

Jacobson, J. W., & Mulick, J. A. (2000). System and cost research issues in treatments for people with autistic disorders. *Journal of Autism and Developmental Disorders, 30*, 585–593. doi:10.1023/A:1005691411255

Keller, F. S. (1968). "Good-bye, teacher...." *Journal of Applied Behavior Analysis, 1*, 79–89.

Keller, F. S. (1974). Ten years of personalized instruction. *Teaching of Psychology, 1*, 4–9.

Koegel, R. L., Russo, D. C., & Rincover, A. (1977). Assessing and training teachers in the generalized use of behavior modification with autistic children. *Journal of Applied Behavior Analysis, 10*, 197–206.

LeBlanc, M. P., Ricciardi, J. N., & Luiselli, J. K. (2005). Improving discrete trial instruction by paraprofessional staff through an abbreviated performance feedback intervention. *Education and Treatment of Children, 28*, 76–82.

Lovaas, O. I. (1987). Behavioral treatment and normal educational and intellectual functioning in young autistic children. *Journal of Consulting and Clinical Psychology, 55*, 3–9.

Martin, G., & Pear, J. (2015). *Behavior modification: What it is and how to do it (10th ed.)*. Englewood Cliffs, NJ: Prentice-Hall, Inc.

Martin, T. L., Pear, J. J., & Martin, G. L. (2002a). Analysis of proctor marking accuracy in a computer-aided personalized system of instruction course. *Journal of Applied Behavior Analysis, 35*, 309–312.

Martin, T. L., Pear, J. J., & Martin, G. L. (2002b). Feedback and its effectiveness in a computer-aided personalized system of instruction course. *Journal of Applied Behavior Analysis, 35*, 427–430.

Martin, G. L., Thorsteinsson, J. R., Yu, C.T., Martin, T. L., & Vause, T. (2008). The Assessment of Basic Learning Abilities Test for predicting learning of persons with intellectual disabilities: A review. *Behavior Modification, 32*, 228–247. doi:10.1177/0145445507309022

Nguyen, D., & Yu, C.T. (2009). *How to conduct direct preference assessments for persons with developmental disabilities using a multiple-stimulus without replacement procedure: A self-instruction manual.* Unpublished manuscript. Department of Psychology, University of Manitoba, Winnipeg, Canada.

Oliveira, M., Goyos, C., & Pear, J. (2012). A pilot investigation comparing instructional packages for MTS training: "Manual alone" and "manual-plus-computer-aided personalized system of instruction." *The Behavior Analyst Today, 13*, 20–26.

Pear, J. J. (2002). Teaching and researching higher-order thinking in a virtual environment. In J. A. Chambers (Ed.), *Selected papers from the 13th International Conference on College Teaching and Learning* (pp. 143–150). Jacksonville, FL: Florida Community College at Jacksonville.

Pear, J. J., & Crone-Todd, D. E. (1999). Personalized system of instruction in cyberspace. *Journal of Applied Behavior Analysis, 32*, 205–209.

Pear, J. J., & Martin, T. L. (2004). Making the most of PSI with computer technology. In D. J. Moran & R. W. Malott (Eds.), *Evidence-based educational methods* (pp. 223–243). San Diego, CA: Elsevier Academic Press.

Pear, J. J., Schnerch, G. J., Silva, K. M., Svenningsen, L., & Lambert, J. (2011). Web-based computer-aided personalized system of instruction. In W. Buskist & J. E. Groccia (Eds.), *New directions for teaching and learning. Vol. 128: Evidence-based teaching* (pp. 85–94). San Francisco, CA: Jossey-Bass.

Randell, T., Hall, M., Bizo, L., & Remington, B. (2007). DTkid: Interactive simulation software for training tutors of children with autism. *Journal of Autism and Developmental Disorders, 37*, 637–647.

Ryan, C., & Hemmes, N. S. (2005). Post-training discrete-trial teaching performance by instructors of young children with autism in early intensive behavioral intervention. *The Behavior Analyst Today, 6*, 1–12.

Sailor, W., Freeman, R., Britten, J., McCart, A., Smith, C., Scott, T., & Nelson, M. (1999). Using information technology to prepare personnel to implement functional behavioral assessment and positive behavioral support. *Exceptionality, 8*, 217–230.

Sarokoff, R. A., & Sturmey, P. (2008). The effects of instructions, rehearsal, modeling, and feedback on acquisition and generalization of staff use of discrete trial teaching and student correct responses. *Research in Autism Spectrum Disorders, 2*, 125–136. doi:10.1016/j.rasd.2007.04.002

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

Thiessen, C., Fazzio, D., Arnal, L., Martin, G., Yu, C.T., & Keilback, L. (2009). Evaluation of a self-instructional manual for conducting discrete-trials teaching with children with autism. *Behavior Modification, 33*, 360–373.

Thomson, K., Martin, G., Arnal, L., Fazzio, D., & Yu, C.T. (2009). Instructing individuals to deliver discrete-trials teaching to children with autism spectrum disorders: A review. *Research in Autism Spectrum Disorders, 3*, 590–606. doi:10.1016/j.rasd.2009.01.003

Thomson, K. M., Martin, G. L., Fazzio, D., Salem, S., Young, K., & Yu, C.T. (2012). Evaluation of a self-instructional package for teaching tutors to conduct discrete-trials teaching with children with autism. *Research in Autism Spectrum Disorders, 6,* 1073–1082.

Wightman, J., Boris, A., Martin, G. L., Fazzio, D., & Yu, C.T. (2012). Evaluation of a self-instructional package for teaching tutors to conduct discrete-trials teaching with children with autism. *Journal on Developmental Disabilities, 18*, 33–34.

Young, K., Boris, A., Thomson, K., Martin, G. L., & Yu, C.T. (2012). Evaluation of a self-instructional package on discrete-trials teaching to parents of children with autism. *Research in Autism Spectrum Disorders, 6,* 1321–1330.

Appendix: DTT Self Instructional Manual Table of Contents

Daniela Fazzio & Garry Martin (2009)

Table of Contents