RESEARCH ARTICLE

Discrete Trial Teaching: A study on the comparison of three training strategies

Nichola Booth[1*] **and Michael Keenan**[2]

[1]School of Social Sciences, Education, and Social Work, Queens University, Belfast, Northern Ireland
[2]School of Psychology, Ulster University, Coleraine, Northern Ireland

Abstract

Discrete trial teaching, as a teaching method, has been used to teach a variety of skills in many early intervention programmes for children with a diagnosis of autism spectrum disorder. Often, parents use these programmes in the absence of supervision by a behaviour analyst. This can cause problems in maintaining the integrity of the programmes. In this pilot study, two experiments examined three procedures designed to help parents/carers of children with a diagnosis of autism identify errors in videos simulating mock discrete trial sessions – written Text, a PowerPoint presentation, and an Animated lesson. Results suggested that the use of animations was superior in helping identify errors while the use of text alone was least effective. These preliminary findings suggest that traditional text-based methods for teaching need to be updated to take advantage of opportunities provided by new technology

Keywords

Discrete trial teaching, education, training, multimedia, animation, autism

Citation: Booth, N and Keenan M. Discrete Trial Teaching: A study on the comparison of three training strategies. *Interdisciplinary Education and Psychology.* 2018; 2(2):3.

Received: June 05, 2018
Accepted: September 24, 2018
Published: October 5, 2018

Corresponding author:
Nichola Booth, School of Social Sciences, Education, and Social Work, Queens University, Belfast, Northern Ireland
E-mail: n.booth@qub.ac.uk

Introduction

Discrete-trial teaching (DTT) is an instructional teaching method with its ethos lying in the experimental analysis of behaviour; it is not to be confused with the scientific discipline of Applied Behaviour Analysis (ABA). It is a common instructional technique that has been a part of many Early Intensive Behavioural Interventions Programmes (EIBI) programmes for children diagnosed with an autism spectrum disorder (ASD) (Lovaas, 1987, 2003; Smith, 2001). DTT has been proven to significantly help with both developmental and educational attainments for children with ASD as well as other developmental delays (McEachin, Smith, & Lovaas, 1993). Smith (2001) refers to Discrete Trial Teaching as "…one of the most important instructional methods for children with autism" (p. 86). It is an educational tool that is used to help individuals move from the acquisition of new targets through to maintenance and generalisation (Simpson, 2005). It has been shown to be effective in teaching a number of different skills across a number of different skill domains including social, communication and academic skills (Sturmey & Fitzer, 2007).

In a DTT procedure, skills are presented repeatedly until they are mastered. Initially, the trials begin with simple tasks, such as colour identification with only one stimulus, progressing to more complex targets individualised for each student, colour, size and shape discrimination from an array of stimuli. Trials are presented in a fast-paced manner (lasting approximately 5 to 20 seconds), with each trial consisting of three discrete components - an instruction (discriminative stimulus (S^D)), a response (R) and a consequence (S^R) (Figure 1). All three need to be present to constitute a discrete trial. In essence, the procedure constitutes the application of the three-term contingency (Skinner, 1945). Prompting, reinforcement, inter-trial intervals (ITI) and continuous assessment to shape behaviour and guide programme development are also components of a DTT procedure (Ghezzi, 2007).

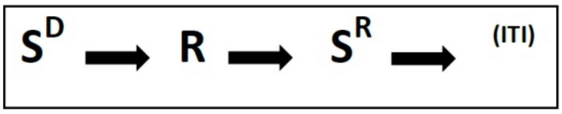

Figure 1. A visual representation of the DTT procedure with an inter-trial interval

The discriminative stimulus is presented to the child upon appropriate attending behaviour, i.e., the child is sitting appropriately and is not manipulating stimuli on the table but is ready to learn. Initially, the S^D is quite simple, concise and consistent (Heflin & Alaimo, 2007) with minimal language used (e.g. “give me red”), gradually increasing in complexity to more natural paradigms (“give me the big red circle”). If, following the S^D, the desired response does not occur the parent-therapist implements a prompting procedure. A prompt acts as an antecedent stimulus (Asmus et. al., 1999) that increases the likelihood of the correct response occurring following the S^D. By providing prompts to generate the correct response, a higher density of reinforcement can be provided – the child will receive more reinforcement contingent on appropriate responses, which helps to strengthen desired behaviours. Figure 2 is a visual representation which includes the optional prompt that may occur following the S^D if the desired response does not occur in previous trials.

Figure 2. A visual representation of the DTT procedure with optional prompt

Reinforcement is contingent on appropriate responding with differential levels of reinforcement dependent on the response. A prompted, correct response may result in a lower level of reinforcement (“Good try”) than an independent correct response (praise and presentation of motivating activity). This schedule of reinforcement must be defined and adhered to as it can be an essential element of the success of an educational programme (Cooper et al., 2007). The inter-trial interval immediately follows the consequence (be it a correct or incorrect response) to signify the end of one trial and the gap between the next. It has been suggested that the inter-trial interval be no more than a few seconds (Malott & Trojan-Suarez, 2004).

Components identified from the literature (Green, 1996; McClannahan & Krantz, 1993; Smith, 2001) that enable the implementation of a successful discrete trial procedure are shown in Table 1.

Table 1. Components that are required for a successful Discrete Trial procedure

- Having the correct teaching materials ready
- The teacher making eye contact with the student for at least 1 second prior to delivery of a verbal instruction
- Giving no verbal instruction until the student shows appropriate attending
- Delivering instructions with clear articulation
- Implementing the predetermined correction procedure within 3–5 seconds of the verbal direction after failure of the student to respond
- Providing appropriate and immediate reinforcement for correct responses
- Using behaviour-specific praise
- Recording data following each trial

These components enable maximum learning opportunities for the individual (Ghezzi, 2007). Most research to date has only focused on the performance of the individual when implementing the DTT procedure (Belfiore, Fritts, & Herman, 2008; LeBlanc, Ricciardi, & Luiselli, 2005; Bolton & Meyer, 2008) whilst ignoring support skills such as session preparation and managing behaviour, skills that are required to ensure the procedure can be implemented correctly for maximum student learning. Downs and Downs (2012) stipulate that instructors should be able to 'manage challenging behaviour, keep to a timely and efficient schedule, and manage curricular materials and programs' (p. 213), all whilst implementing the DTT procedure.

Research has indicated that parents can be effective implementers of behavioural, social and communication programmes for their children with autism (Koegel et al., 1996). A central point in this evidence-based intervention literature is the importance of training parents of children on the autism spectrum in skill development across a variety of domains such as early self-injury (Fodstad et al., 2018), problem behaviour (Pennefather et. al. 2018), feeding difficulties (Johnston et. al., 2018) and social skills (Dogan et al., 2017).

In a context where more families are undertaking home-based ABA programmes, it would be judicious to explore effective and efficient methods on how to successfully implement DTT programmes (Lafasakis & Sturmey, 2007; Crockett, Fleming, Doepke, & Stevens, 2007). Different methods that have been used to teach DTT include combinations of behavioural skills training, video and *in-vivo* DTT sessions, role-play, and feedback on correct implementation of the DTT procedure. However, it should be noted that these methods were both time intensive and cost intensive to achieve competency for independent application, with some taking 25 hours to achieve this (Koegal, Russo, & Rincover, 1977), whereas others taught the procedure in 10-minute sessions (Sarokoff & Sturmey, 2008). Other researchers (Johnson & Hastings, 2002; Symes, Remington, Brown & Hastings, 2006) found that many staff members and parents struggled to achieve high levels of procedural integrity when implementing a discrete trial procedure.

One method that has been proven effective is the use of a self-instruction manual (Fazzio & Martin, 2006). Participants typically read through the manual and are then quizzed on key elements by a proficient instructor. Results often report high levels of treatment integrity in subsequent implementation (Thompson et al., 2012). However, these findings have also identified that further training is required to ensure generalisation of skills following training (Fazzio et al., 2009). Another method that has demonstrated success is the use of a behavioural skills training package providing instruction, modelling of both examples and non-examples of target skills, rehearsal opportunities and feedback on performance (Sarokoff & Sturmey, 2008; Lerman et al., 2008; Ward Horner & Sturmey, 2008). With advancements in technology, subsequent training events have added video instructions with feedback to behavioural skills training events, generating positive results (Ryan & Hemmes, 2005; Crockett, Fleming, Doepke, & Stevens, 2007). Catania, Almeidia, Liu-Constant, and Digennaro Reed (2009) showed that video modelling, as a stand-alone procedure, was effective at training novice instructors how to implement DTT.

Further technological advancements have demonstrated that DTT can be successfully taught to naïve participants in the absence of a professional being physically present. The progression of faster broadband services has enabled online training packages to be developed that encompass an evidence-based training tool with technology. One such package, developed by Serna *et. al*. (2016), shows that a self-paced, 'anytime, anywhere' pre-designed training package was effective at teaching participants how to accurately implement a DTT session following completion of an online training package. Computerised training packages for successful DTT implementation have also been reported by Higbee *et. al.*(2016), Eldevik *et. al,* (2013) and for behavioural intervention training, Serna *et. al.*(2015), Hamad *et. al.* (2010). Kazemi & Stedman-Falls (2016) demonstrated that the use of a humanoid robot was effective at teaching students how to implement preference assessments correctly.

Information on autism can be overwhelming for parents of children with an ASD diagnosis. It is important, then, to identify a method that is not time intensive but nevertheless results in skill acquisition for delivering DTTs. The purpose of this study was to compare three different procedures for helping identify errors within a DTT procedure. Research to date has focused on the error correction procedures that are used for incorrect or non-responding behaviours within a DTT sessions (Carroll et al., 2015; Carroll et al., 2018). By teaching parents to identify errors that may occur within sessions there is the potential that in the natural context, they should be able to address these errors and successfully implement a DTT session. In the first experiment, three procedures were examined. These were a simple textual description of DTTs, a PowerPoint describing the features of the procedure and an animation showing the

DTT procedure. Across all procedures, the exact same script was used.

Experiment 1

Participants

Five participants were selected from a group of parents of children with a confirmed or suspected diagnosis of autism spectrum disorder. These participants were about to start their home-based ABA programme with an ABA provider or they had received two visits from a behaviour analyst. This inclusion criterion was used in order to ensure that all participants had minimal or no knowledge of DTTs. Due to the time intensive nature of this experiment, the setting for all of the participants was their own home. The five participants were as follows; MR was the father of a 7-year old child with autism who had just started receiving ABA support in his home, BT was the Mother of a 3-year old girl with a suspected diagnosis of autism spectrum disorder. The third participant, CF, was a mother of a 6-year-old girl with autism, who had received two home visits from a behaviour analyst as part of her ABA home programme and participant four, SB, was the father of a 5-year-old boy with a confirmed ASD diagnosis about to begin availing of ABA service provision. The fifth participant was DM had a child who was approximately 3 years of age waiting for an ASD assessment but who wished to avail of ABA support whilst waiting.

Procedure

An alternating treatment design was used. This would help determine whether one of the procedures, as detailed below, was more effective at teaching participants how to identify errors within a DTT session. Each participant experienced all three procedures, but these were randomly allocated in their order of presentation. This counterbalancing was to help control the order effects of the procedure presentation. This allocation was done by identifying all of the possible ways that the procedures could be feasibly presented so that participants were exposed to all procedures in an orderly manner but not in the same way as another participant.

Text

The first procedure (Text) was a text-based script that provided a written instruction of how to implement a DTT procedure. This text introduced participants to the theory behind DTTs as well as materials that may be required during a teaching session. The text then elaborated on the different stages within a DTT session including information on data collection and data recording. The text for this procedure was used for developing the other two procedures.

PowerPoint

The second procedure was a standard PowerPoint presentation on how to implement DTTs. The presentation explained systematically how to implement DTTs using text from the previous procedure to guide the development of the presentation and simple graphics from the Microsoft PowerPoint programme; no video or audio was included. This procedure was loaded on to a laptop computer by the researcher and presented to each participant who moved through this at their own pace – total presentation time was based on individual control of the presentation.

Animation

The final procedure (Animation) was an animated lesson on DTTs that was taken from a section of a commercially available online multimedia tutorial on ABA (Simple Steps, 2015). This was a 3D-animated media-rich tutorial that began with an overview of the discrete trial procedure using a traditional lecture format with accompanying animations supporting the presenter's narration. This tutorial progressed with two additional lessons and showed participants the structure of a DTT lesson (colour identification) and was supplemented by animation to support the audio. The animation progressed to show moving from teaching one stimulus (mass trial stage) to teaching discrimination of colours with multiple stimuli (random rotation stage). Visual representations of how to record data on specific DTT datasheets were also included within this animation. Screenshots from these lessons are shown in Figure 3.

Figure 3. Screenshots from the animation procedure used to teach DTT

Mock videos for testing

Pairs of videos were recorded (six videos in total) and each pair was allocated to a particular procedure as seen in Table 2. Two videos for each procedure were created in order to keep the duration of the videos short (to reduce fatigue) as well as to ensure that enough errors were presented to test for DTT error identification. These videos represented mock DTT sessions with an adult acting as the student and with deliberate errors embedded based on recommended components required for success (Table 3). These videos represented a number of different skills that could be taught at a table using DTT such as object recognition, colour discrimination and word discrimination.

Table 2. Video pairs used with each procedure

Procedure	Video Pairs
Text	1a and 1b
PowerPoint	2a and 2b
Animation	3a and 3b

Table 3. Errors embedded within the video pairs for each procedure

Text (21 errors in total)	
Errors in Video 1a • Ineffective use of reinforcement • Satiation effects of high tangible reinforcer • Reinforcing inappropriate behaviours • Not prepared for child not understanding fine motor skill • No data collection • Not rotating stimuli • Always presenting target item in same position • Inadvertent use of prompts • Grabbing reinforcer from individual	Errors in Video 1b • Ineffective use of reinforcement • No clear S^D • No distinction between S^D and verbal praise • Repetition of questions • Not organised for sessions • Reinforcement of inappropriate behaviours • No data collection • No clear distinction on desired response • Low level of reinforcement • Missing correct responses • Delay in correct behaviour and presentation of reinforcer • Inadvertently prompting correct response
PowerPoint (19 errors in total)	
Errors in Video 2a • Not prepared for session • Reinforcing inappropriate behaviours • Did not establish attending prior to S^D • Ineffective use of prompt • Delay between reinforcement too long • Missing opportunities to reinforce behaviours • Verbal reinforcement not reinforcing	Errors in Video 2b • Not prepared for session • Too much stimuli on the table • S^D not clear • Eye prompti ng to correct answer • Did not establish attending prior to S^D • Issuing the S^D too many times • Snatching reinforcer away from child • Not rotating stimuli • No data collection • Reinforcing of inappropriate behaviour (snatching) • Use of threats • Trying to remember responses afterwards for data collection
Animation (12 errors in total)	
Errors in Video 3a • No differentiation between volume and S^D • Inter-trial interval too long • Reinforcement not appropriate • Not attending to the individual • Unclear instruction	Errors in Video 3b • Giving too much of the reinforcer • Snatching reinforcer off child • Inter-changing use of S^D • Accepting inappropriate responses • Using reprimands • Not enough reinforcement following correct responses • Missing appropriate behaviours to reinforce

Participants recorded their results on an individual answer booklet

Based on procedure allocation, participants were informed of the structure of the experiment. They were informed that they would either read some Text, watch a PowerPoint presentation or watch an Animation on Discrete Trial Teaching. Once they had completed the procedure, they were then shown two short videos of mock DTT sessions where they were to identify any errors/mistakes within the videos. As shown in Table 3 each pair of videos had its own content and errors unique to them – participants were expected to identify the errors within the video pair. It was envisaged that the information within each procedure, suggesting how a DTT should be implemented for optimal teaching, would enable participants to be identify obvious errors that were presented within the mock videos sessions. On individual data sheets, each participant recorded the numbers of errors that they could see within each video. Each viewing of the video pairs was classified as one trial and percentage correct was calculated. Mastery was defined as correctly identifying at least 80% of the errors within each trial. Participants were informed of the percentage of errors they correctly identified within each trial and if this was less than the mastery criterion then the video pairs were shown again. This was repeated until mastery was reached, whereupon the next allocated procedure was introduced.

Inter-observer agreement

Interobserver checks were conducted on the results from all participants by another behaviour analyst. An Inter-observer agreement (IOA) score for each participant was calculated by dividing the total number of agreements by the total number of agreements plus disagreements and multiplying the result by 100%. The mean IOA score across participants was 80%.

Results

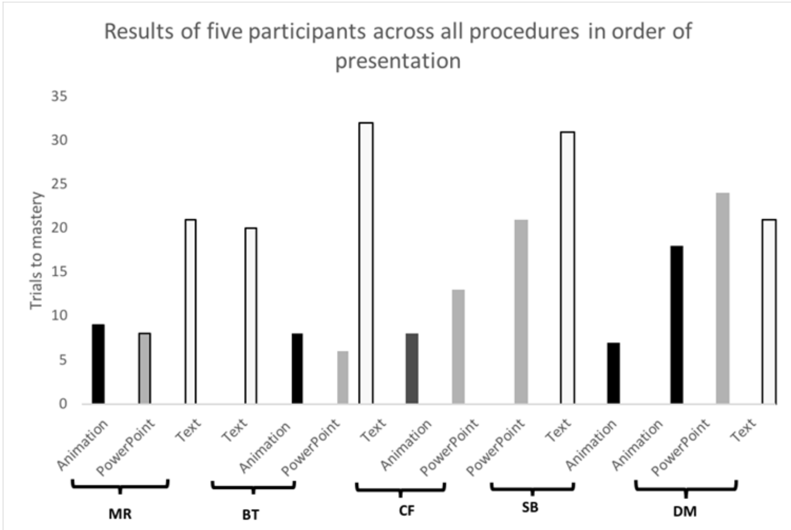

Figure 4. Results for all participants in each procedure in order of presentation

The sequence of procedures for MR was Animation, PowerPoint, and Text. Upon watching the Animation videos, MR reached mastery within 9 trials. The next procedure, PowerPoint, saw MR correctly identify the errors within 8 trials. The final procedure (Text) was then introduced to MR and it took 21 trials to achieve mastery.

The procedures were presented to BT in the following order, Text, Animation, and PowerPoint. With the introduction of the Text procedure BT was able to reach mastery in 20 trials. Upon introduction of the Animation procedure BT reached mastery criterion within 8 trials. Once the final procedure for BT was introduced, PowerPoint, mastery was achieved within 6 trials.

For CF, the first procedure, was the Text procedure. It took 32 trials for her to reach mastery. The second procedure for CF was the Animation and it took 8 trials to achieve mastery. Finally, CF watched the PowerPoint presentation and reached mastery within 13 trials.

The first procedure for SB was PowerPoint. Following this procedure, he was able to reach mastery within 21 trials. Next, he was given the Text procedure and it took 29 trials to achieve mastery. The last procedure for SB was the Animation where he reached mastery within 7 trials.

During the first procedure, Animation, DM reached mastery within 18 trials. During the PowerPoint procedure it took 22 trials to reach mastery. Finally, in the Text procedure, mastery was achieved within 19 trials.

With all five participants there were no carryover effects in any of the procedures. Regardless of procedure presentation no participant was able to identify all of the errors within the video pairs immediately, numerous viewings were required in order to do so.

Discussion

This experiment examined three different procedures to teach participants how to identify errors within a Discrete Trial Teaching session. Three procedures (Text, a PowerPoint presentation, and an Animation) were shown to participants to determine which medium was the most effective in helping identify errors in mock videos of DTT sessions. Results suggest that the Text procedure required the greatest number of trials for participants to achieve mastery (averaging 24.2 trials across participants). The trends for the other two procedures were quite similar but the Animation procedure appeared to be marginally superior – averaging 10 trials to mastery compared to 14 trials for the PowerPoint procedure. Verbal reports from participants revealed that they all preferred being trained using the Animation. Interestingly, only two participants (BT & SB) improved across procedures, eventually showing a smaller number of trials to criterion during their last procedure.

Although procedures were randomly allocated, the videos were not. Each procedure had a pair of videos assigned, which all participants watched. Although the results suggest that the Animation procedure was slightly more effective at helping participants reach a level of competency, with the Text procedure the least effective, there are issues with generalising these findings. It could be argued that the generally poor performance with the Text procedure arose because of the video pairs that were used for that procedure. Therefore, in an attempt to determine whether the videos impacted on the results, the same experiment was run again with the video pairs allocated to different procedures.

Experiment 2

The results of the previous experiment indicated that the Animation procedure was marginally superior to both the PowerPoint procedure and the Text procedure in helping participants identify errors within a Discrete Trial Teaching session. To examine whether the presentation of the mock DTT videos impacted on the results, the experiment was repeated with five different participants and with the videos previously assigned to the text procedure now allocated to a different procedure.

Method

Participants

Five different participants took part in this experiment. All participants were parents/carers of children with a confirmed diagnosis of Autism or those nearing the end of their assessment for an autism diagnosis. As with the participants in Experiment 1 these participants had either just begun to avail of ABA home support or who had received a maximum of two visits from a behaviour analyst. As in Experiment 1, this inclusion criterion was used to ensure that participants had minimal or no knowledge of DTTs. Due to the time intensive nature of this experiment, the setting for all of the participants was their own home. The five participants within this experiment were RMG, a grandmother of a 7-year-old girl with an autism diagnosis, participant 2 was CG, a single Mother of a 6-year-old boy with a confirmed diagnosis of ASD who had received one previous ABA home visit. Participant 3 was EF, a single Mother of 3 children, 2 of whom have an ASD diagnosis, who wanted to access behaviour support from an ABA provider. The fourth and fifth participants were, respectively, TM, a Mother of a 4-year-old girl who was near the end of her assessment for ASD, this was her second visit with a behaviour analyst and LT, the Mother of a 9-year-old boy with a confirmed ASD diagnosis.

Materials

The general method used in Experiment 1 was replicated here. The procedures used in each condition remained the same – a Text comprising the script used in the other procedures, a PowerPoint presentation describing how to implement a DTT procedure, and the Animation from the Simple Steps Multimedia Training Pack (Simple Steps, 2015). The mock DTT videos, however, were assigned to different procedures. These new pairings can be seen in Table 4.

Table 4. Video pairs used with each procedure

Procedure	Video Pairs
Text	3a and 3b
PowerPoint	1a and 1b
Animation	2a and 2b

Figure 5. Results for all participants for each procedure in order of presentation

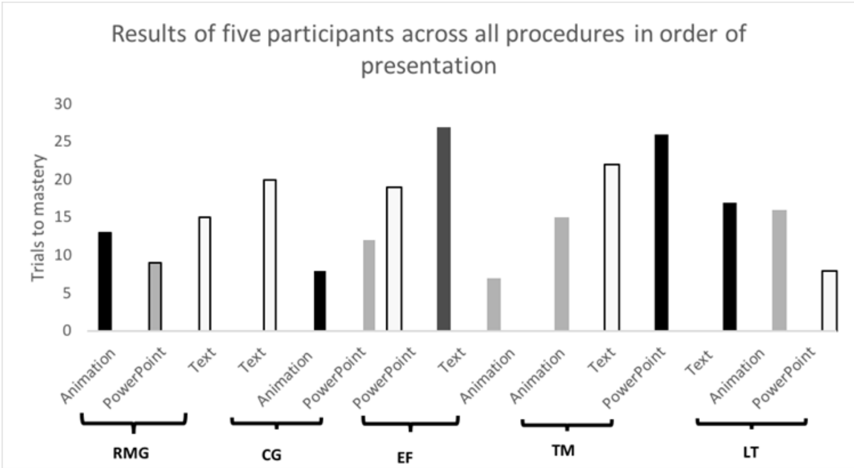

Figure 5 shows the results of all participants (RMG, CG, EF, TM, & LT) in all three procedures in order of presentation, with the new video pairings as described in Table 4.

After exposure to the Animation procedure RMG was able to reach mastery within 13 trials. The second procedure was the PowerPoint presentation, which took her 9 trials to achieve mastery while the last procedure, Text, took 15 trials to achieve mastery.

The first procedure for CG was Text, which took 20 trials to achieve mastery. Animation, the next procedure to be introduced, took 8 trials to achieve mastery. The final procedure, PowerPoint, was shown and 12 trials were required for achieving mastery.

The first procedure that EF was exposed to was the PowerPoint presentation, which took 19 trials to achieve mastery. The second procedure EF was exposed to was Text, with 27 trials taken to achieve mastery. The final procedure was the Animation which took 7 sessions to reach mastery.

TM was introduced to the Animation procedure first. It took 15 trials for TM to achieve mastery in the Animation procedure before the introduction of the next procedure, Text. This took 22 trials to reach mastery level. The last procedure, PowerPoint, took the most trials for achieving mastery, 26 trials.

The first procedure for LT was Text. 17 trials were required for her to reach mastery. The Animation procedure was then introduced, and 16 trials were required for her to be able to reach mastery criterion. The final procedure, PowerPoint, took 8 trials for her to correctly identify the errors - the least amount of trials required across the three procedures for her to achieve mastery.

Discussion

The aim of this experiment was to determine whether the video pairings assigned to the procedures where responsible for the differences observed in Experiment 1. This was done by replicating the general method but with the video pairs now assigned to different procedures. For all participants in Experiment 1, the Text procedure produced the poorest performances, but it was unclear whether the videos assigned to this procedure compromised the results. The results in this experiment were similar to those found in Experiment 1 in that the least effective procedure was the Text. The trends for the other two procedures, PowerPoint and Animation, were similar to those in Experiment 1 with once again, the Animation procedure appearing to be marginally superior in helping participants achieve mastery with an average of 11.8 trials required compared to 14.8 trials for the PowerPoint procedure; two participants, RMG and LT, performed better in the PowerPoint procedure. As in Experiment 1, only two participants showed improvements across procedures such that their final performance was their best. As in Experiment 1 there was a lack of carryover in each of the procedures.

General Discussion

The results from both experiments offer promising guidelines for effective ways to teach parents of children with ASD how to implement DTTs. Previous research has shown that video modelling can be used to teach implementation of DTT sessions whilst still maintaining treatment integrity (Severtson & Carr, 2012). Video modelling involves showing a novice, behaviours that they should “imitate and demonstrate in an appropriate context” (Vladescu, Carroll, Paden, & Kodak, 2012, p. 419). An animation could, based on technological advancements, be considered another form of video modelling. The animation within this study was very explicit on how a DTT procedure should be implemented and was able to animate angles of the DTT that would perhaps be hard to film using a traditional video camera or via verbal description. Subtle behaviours that may not be apparent in traditional video models or via instruction, such as exaggerated eye contact, or angles from above showing session preparation, where a part of this procedure. The animation was, therefore, able to incorporate these nuances whilst ensuring that procedural explanations were clear and concise. For all participants within both experiments there was a lack of carryover from procedure to procedure. This would suggest, based on the overall results of the ten participants, that regardless of presentation the animation was superior at helping with error identification faster due to the very nature of the design of it that the other procedures could not provide. Also, behavioural terminology for DTT sessions can be difficult to grasp for a novice. The use of an animation to teach the DTT lesson could reduce the probability of complex behavioural language being misunderstood, potentially reducing the efficacy of the procedure. Further research could build on these findings comparing the Animation procedure with an in-vivo demonstration to determine which is more effective at helping non-trained parents identify errors within a DTT session. Additionally, these experiments could be expanded upon by teaching participants to identify a generalised pool of errors within a DTT session to determine whether the findings are similar to these reported here.

A limitation of this study was that, due to limited time resources, the different pairs of videos could not be tested across all procedures. Future research may wish to allocate the Video Pairs to all of the procedures to establish whether the same findings occur, this would also augment the overall experimental control of the research. Also, while all of the conditions were randomised in how they were presented to the participants, for true randomisation to have occurred it would have been beneficial to have additional participants included so that all permutations of the procedures could be assessed to support generality of the results. However, as the findings were consistent across the two experiments it would suggest that results were because of the procedure, not the Video Pair that was allocated to that particular procedure. Furthermore, the fact that all participants did not improve across procedures in both experiments suggests that the experimental design was not compromised either by sequence effects or history effects.

Due to ethical restrictions data were prohibited from being recorded on how the effects of this training transferred to an applied setting or how DTTs were implemented with a child. This is a major limitation that should be addressed in subsequent studies. Ultimately the findings from these studies raise a lot of questions about traditional teaching methods that rely on PowerPoint presentations or lecture notes with a required text for supplementary information.

DTT has always been a staple procedure in an early intensive behavioural intervention programme. It has been shown to be an efficacious procedure in helping establish appropriate learning behaviours for young children and, through systematic instruction, new targets can be introduced which are gradually increased to more complex learning materials. These results have raised potential research questions about the validity of how we teach. It has been demonstrated that adults learn differently from children, however, the teaching methods used in the classroom often do not reflect this difference (Zemke & Zemke, 1995). Keenan (2003) enlarged upon this issue in relation to the teaching of behaviour analysis. When criticising the reliance on the printing press that is common in academic circles, he said that

“the design of our training/ communication materialis overly reliant on the printing press. In fact, I would go so far as to suggest that unlesswe explore the limitations of the traditional printing press we will find ourselves limited in the creativity we use to enlist other technologies that could facilitate better the dissemination of important practical skills” (p. 72).

With recent developments in modern technology to create multimedia teaching material, new opportunities exist for addressing the shortcomings of the printing press.

“The promise of multimedia as a tool for enhancing learning is indeed intoxicating. The prospect of actively engaging learners through multiple communication channels is, intuitively, very compelling as a means of facilitating learning for a larger percentage of our students. ...The results of this experiment do in fact lend support to the value of multimedia-enhanced educational products as a method of facilitating greater depth of learning" (Ellis, 2001, p. 107).

The findings from these studies offer tentative support for the value of using multimedia for teaching complex concepts to adults. Teaching these complex concepts in an effective way is crucial for the success of any education programme, particularly those that are challenging to explain in traditional teaching methods. For behavioural concepts and technologies, which can be difficult for non-behaviourally trained individuals to grasp, using multimedia developments can ensure that the principles are disseminated whilst ensuring that the integrity of the Science is retained.

References

Asmus, J.M., Wacker, D.P., Harding, J., Berg, W.K., Derby, K.M., & Kocis, E. (1999). Evaluation of antecedent stimulus parameters for the treatment of escape-maintained aberrant behavior. *Journal of Applied Behaviour Analysis, 32*(4), 495–513.

Belfiore, P. J., Fritts, K. M., & Herman, B. C. (2008). The role of procedural fidelity: Using self-monitoring to enhance discrete trial instruction (DTI). *Focus on Autism and Other Developmental Disabilities*, *23*, 95–102.

Bolton, J., & Mayer, M.D. (2008). Promoting the generalization of paraprofessional discrete trial teaching skills. *Focus on Autism and Other Developmental Disabilities,* 1–9.

Carroll, R.A., Owsiany, J., & Cheatham J.M. (2018). Using an abbreviated assessment to identify effective error-correction procedures for individual learners during discrete-trial instruction. *Journal of Applied Behavior Analysis, 51*(3), 482–501.

Carroll, R.A., Joachim, B.T., St.Peter, C.C., & Robinson, N. (2015). A comparison of error-correction procedures on skill acquisition during discrete-trial instruction. *Journal of Applied Behavior Analysis*, *48*(2), 257–273.

Catania, C.N., Almeida, D., Liu-Constant, B., & DiGennaro Reed, F.D. (2009). Video modelling to train staff to implement discrete-trial instruction. *Journal of Applied Behavior Analysis, 42*(2),387–392.

Crockett, J.L., Fleming, R.K., Doepke, K.J., & Stevens, J.S. (2007). Parent training: acquisition and generalization of discrete trials teaching skills with parents of children with autism. *Research in Developmental Disabilities, 28*(1),23–36.

Cooper, J.O., Heron, T.E., & Heward, W.L. (2007). *Applied behavior analysis (2nd ed.)*. Upper Saddle River, NJ: Prentice Hall.

Dogan, R.K., King, M.L., Fischetti, A.T., Lake, C.M., Mathews, T.L. & Warzak, W.J. (2017). Parent-implemented behavioral skills training of social skills. *Journal of Applied Behavior Analysis, 50*(4), 805–818.

Downs, A., & Downs, R.C. (2012). Training new instructors to implement discrete trial teaching strategies with children with autism in a community-based intervention program. *Focus on Autism and Other Developmental Disabilities*, 1–10.

Eldevik, S., Ondire, I., Hughes, J., Grindle, C., Randell, T., & Remington, B. (2013). Effects of Computer Simulation Training on *In Vivo* Discrete Trial Teaching. *Journal of Autism and Developmental Disorders, 43*(3), 569–578.

Ellis, T.J. (2001). Multimedia Enhanced Educational Products as a Tool to Promote Critical Thinking in Adults Students. *Journal of Educational Multimedia and Hypermedia, 10*(2),107–124.

Fazzio D. & Martin G. L. (2006). *Discrete-trials teaching with children with autism: A self-instructional manual.* Unpublished manuscript.

Fazzio, D., Martin, G.L., Amal, 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.

Fodstad, J.C., Kirsch, A., Faidley, M., & Bauer, M. (2018). Demonstration of Parent Training to Address Early Self-Injury in Young Children with Intellectual and Developmental Delays. *Autism and Developmental Disorders*, 1–12.

Ghezzi, P.M. (2007). Discrete trials teaching. *Psychology in the Schools, 44*(7),667–679.

Green, G. (1996). *Evaluating Claims about Treatments for Autism*. Retrieved from: http://www.feathouston.org/wp-content/uploads/2009/11/evaulating_claims.pdf

Hamad, C.D., Serna, R.W., Morrison, L., & Fleming, R. (2010). Extending the Reach of Early Intervention

Training for Practitioners: A Preliminary Investigation of an Online Curriculum for Teaching Behavioral Intervention Knowledge in Autism to Families and Service Providers. I*nfants and young children, 23*(3), 195–208.

Heflin, J.L., & Alaimo, D. (2007). *Students with autism spectrum disorder: Effective instructional practices.* Upper Saddle River, NJ: Pearson.

Higbee, T.S., Aporta, A.P., Resende, A., Nogueira, M., Goyos C., & Pollard, J.S. (2016). Interactive computer training to teach discrete-trial instruction to undergraduates and special educators in Brazil: A replication and extension. *Journal of Applied Behavior Analysis, 49*(4), 780–793.

Johnson, E., & Hastings, R. P. (2002). Facilitating factors and barriers to the implementation of intensive home-based behavioural intervention for young children with autism. *Child: Care, Health and Development, 28*, 123–129.

Johnson, C.R., Brown, K., Hyman, S.L., Brooks, M.M., Aponte, C., Levato, L., …, Smith, T. (2018). Parent Training for Feeding Problems in Children With Autism Spectrum Disorder: Initial Randomized Trial. *Journal of Pediatric Psychology,* 1–12.

Joyce, B., & Showers, B. (2002). *Student Achievement Through Staff Development (3rd ed.)*. Alexandria, VA: Association for Supervision and Curriculum Development.

Kazemi, E. & Stedman-Falls, L.M. (2016). Can humanoid robots serve as patient simulators in behavior analytic research and practice? *Behavior Analysis: Research and Practice, 16*(3), 135–146.

Keenan, M. (2003). (Printed) words alone! *European Journal of Behaviour Analysis, 4*, 70–75.

Koegel, R.L., Russo, D.C., & Rincover, A. (1977). Assessing and training teachers in the generalized use of behaviour modification with autistic children. *Journal of Applied Behavior Analysis, 10*(2),197–205.

Lafasakis, M. &, Sturmey, P. (2007). Training parent implementation of discrete-trial teaching: effects on generalization of parent teaching and child correct responding. *Journal of Applied Behavior Analysis, 40*, 685–689.

LeBlanc, M.P., Ricciardi, J.N., & Luiselli, J.K. (2005). Improving discrete trial instruction by paraprofessional staff through and abbreviated performance feedback intervention. *Education & Treatment of Children, 2*8, 76–82.

Lerman, D. C., Tetreault, A., Hovanetz, A., Strobel, M., & Garro, J. (2008). Further evaluation of a brief, intensive teacher-training model. *Journal of Applied Behavior Analysis, 41*, 243–248.

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

Lovaas, O.I., (2003). *Teaching individuals with developmental delays: Basic intervention techniques*. Austin, TX: Pro-Ed.

Malott, R. &, Trojan-Suarez, E. (2004) *Principles of Behaviour.* New Jersey, NJ: Pearson Prentice Hall.

McClannahan, L., Krantz, P., & McGee, G. (1982). Parents as therapists for autistic children: A model for effective parent training. *Analysis and Intervention in Developmental Disabilities, 2*, 223–252.

McClannahan L.E, & Krantz P.J. (1993) On systems analysis in autism intervention programs. *Journal of Applied Behavior Analysis, 26*, 589–596.

McEachin, J.J., Smith, T., & Lovaas, O.I. (1993). Long-term outcome for children with autism who received early intensive behavioral treatment. *American Journal of Mental Retardation, 97*, 359–372.

Pennefather, J., Hieneman, M., Raulston, T,.J., & Caraway, N. (2018). Evaluation of an online training program to improve family routines, parental well-being, and the behavior of children with autism. *Research in Autism Spectrum Disorders, 54*, 21–26.

Ryan, C.S., & 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*, 1–136.

Sarokoff, R.A., & Sturmey, P. (2008). The effects of behavioral skills training on staff implementation of discrete-trial teaching. *Journal of Applied Behavior Analysis, 37*(4),535–538.

Serna, R.W., Lobo, H.E., Fleming, C.K., Fleming, R.K., Curtin, C., Foran, M.M., & Hamad C.D. (2015). Innovations in Behavioral Intervention Preparation for Paraprofessionals Working with Children with Autism Spectrum Disorder. *Journal of Special Education Technology, 30*(1), 1–12.

Serna, R.W., Foran, M.M., Cooke, C., Hurd, K.E., Tello, A.J., Vangapalli. R., & Hamad, C.D. (2016). Teaching Discrete Trial Training: The effects of asynchronous computer-based instruction on live implementation. *Journal of Special Education Technology,31*(1), 39–49.

Severtson, J.M. & Carr, J.E. (2012). Training novice instructors to implement errorless discrete-trial teaching: a sequential analysis. *Behavior Analysis in Practice, 5*(2),13–23.

Simple Steps (2015). *The Online Teaching Platform for the treatment of Autism.* Retrieved from: http://www.simplestepsautism.com/

Simpson, R.L. (2005). Evidence-based practices and students with autism spectrum disorders. *Focus on Autism and Other Developmental Disabilities, 20*(3),140–149.

Skinner, B.F. (1945). The operational analysis of psychological terms. *The Psychological Review, 52*, 270–277.

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

Sturmey, P., & Fitzer, A. (2007). *Autism spectrum disorders: Applied behavior analysis, evidence and practice*. Austin, TX: Pro-Ed.

Symes, M. D., Remington, B., Brown, T., & Hastings, R. P. (2006). Early intensive behavioral intervention for children with autism: Therapists' perspectives on achieving procedural fidelity. *Research in Developmental Disabilities, 27*, 30–42.

Thompson, K., 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.

Vladescu, J.C., Carroll, R., Paden, A., & Kodak, T.M. (2012). The effects of video modeling with voiceover instruction on accurate implementation of discrete-trial instruction. *Journal of Applied Behavior Analysis, 45*(2), 419–423.

Ward-Horner, J., & Sturmey, P. (2008). The effects of general-case training and behavioral skills training on the generalization of parents' use of discrete-trial teaching, child correct responses, and child maladaptive behavior. *Behavioral Interventions, 23*, 271–284.

Zemke, R., & Zembe, S. (1995). Adult learning: What do we know for sure?. *Training, 32*(6),31–38.