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Effects of Active and Passive Error Correction on Matching Objects-to-Picture Tasks

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Effects of Active and Passive Error Correction on

Matching Objects-to-Picture Tasks

by

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Abstract

Error correction research has shown that active student response is more effective in enhancing performance for specific tasks compared to a passive student response. However, specific error correction procedures such as an error statement (e.g., saying "no"), modeling the correct response, and no feedback have shown inconsistent findings due to the idiosyncratic learning nature of individuals. This study compared the effectiveness of an error statement and modeling the correct response with an active and passive student response on a matching object-to-picture task. The results found that there were no differences in the number of sessions to mastery for the exemplars taught in either of the error correction procedures for two of the three participants. This study suggests that error-correction procedures may be individualized to the learner rather than applying the same error-correction method across all children with autism.

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Introduction

Individuals who have a combination of language and developmental disabilities often learn skills through repeated teachings of the relation over many sessions (Carr & Felce, 2008). Embedded in these teachings, are error correction procedures to teach the discrimination of correct and incorrect response(s). Groen et al. (2008) suggested that children with autism spectrum disorder may have a diminished processing of negative instructional feedback as a result of lower affective responsiveness to stimuli (i.e., decreased error awareness).

Various error correction procedures have been used to teach children with autism and other developmental disabilities across specific tasks, such as color discrimination (Williams, Perez-Gonzalez, & Queiroz, 2005), conditional discrimination (McGhan & Lerman, 2013), matching tasks (Carr & Felce, 2008; Rodgers & Iwata, 1991; Smith, Mruzek, Wheat, & Hughes, 2006), receptive tasks and tacting (Leaf et al., 2014; Turan, Moroz & Croteau, 2012), and academic tasks (Barbetta, Heron & Heward, 1993; Barbetta & Heward, 1993; Barbetta, Heward, Bradley, & Miller, 1994; Begeny, Daly & Valleley, 2006; Bennett & Cavanaugh, 1998; Drevno et al., 1994; Fabrizio & Pahl, 2007; Magee & Ellis, 2006; Marvin et al., 2010; Rapp et al., 2012; Worsdell, et al., 2005).

Instructional feedback typically includes error correction procedures alone and in combination such as blocking, repeated trials, antecedent and response prompting to teach discriminations. Error correction is performance-based information that a learner receives following a response that completes a three term learning trial (Heward, 1994 as cited in Bennett & Cavanaugh, 1998). Williams et al. (2005) taught a 14-year-old boy to discriminate

colors using a combined blocking procedure that consisted of praise and a small edible for correct responses. Following an incorrect response, the experimenter gently guided the boy's hand to the table top to the correct stimulus card for 3 s. Following 10 consecutive incorrect responses, the experimenter provided prompts for three trials and reinforced correct prompted responses. Carr and Felce (2008) compared the effects of error correction and error prevention procedures with two groups of children with autism and suggested incorporating a blocking procedure (i.e., blocking access to an incorrect response) to effectively teach conditional discriminations to children with autism. Since error correction procedures can vary in their application, it is important to extend and replicate research of the different procedures to provide more information about their effectiveness across different tasks and participants.

Error Correction

Word Supply versus Discrimination Error Correction

Fabrizio and Pahl (2007) compared the effectiveness of two procedures, a word supply and discrimination error correction procedure for teaching a child with autism to read segments of text from a book. Fabrizio and Pahl (2007) used an alternating treatment design followed by a reversal design to teach the participant to read texts that were segmented into blocks of words.

In the "word supply" error correction procedure, when the participant miscalled a word, the therapist would stop the participant and provide the correct word. The participant was asked to read the word correctly. If the participant responded correctly, she was redirected to read from the beginning of the sentence. If she responded incorrectly, the correction sequence was repeated. In the "discrimination" error correction procedure, when

the participant miscalled a word, the therapist would stop her and write on a piece of paper the word the way she said it and the word correctly (i.e., as it appeared in the text). The therapist modeled the correct response while pointing to the correct word and asked the participant to say the word correctly. Then the therapist pointed to the word written as she said it (incorrectly), modeled that response and asked the participant to say the word as she had read in the text (incorrectly).

Results indicated that word supply error corrections were more effective than discrimination corrections in producing accurate oral reading for the participant. Fabrizio and Pahl (2007) noted word supply corrections were superior in terms of overall number of corrections required and also took less time to conduct. Unfortunately, the number of corrections required for both error correction procedures did not decrease over the course of the study. One possible explanation provided by the authors that could remedy this problem is to closely match error correction procedures and the instructional history of the learner, because it may facilitate how efficient the procedure may be in improving the student's performance.

Active versus No-Response Error Correction

Directed rehearsal is a remediation strategy that requires students to emit the correct response several times following an error (Barbetta et al., 1993). Barbetta et al. (1993) used an alternating treatments design and found that active student response (ASR) error correction resulted in more responses (reading sight words) during instruction than no response (NR). In the ASR error correction, the experimenter modeled the word and prompted the student to repeat it. The NR error correction consisted of the experimenter modeling the word and the

student looking at the word card. After 2 to 3 s, the experimenter praised the student for attending but required no response effort from the participant. One-to-one instructional sessions were conducted with eight sets of 20 unknown words 4 days per week. Each session consisted of a next-day test, instruction with ASR and NR error correction, and same-day test. Whole-word error corrections were more effective when it required the student to emit the correct response following a teacher-provided model. Further, students learned, maintained, and generalized more words with the ASR than with the NR error correction.

Barbetta and Heward (1993) investigated the effectiveness of ASR and NR error correction in the learning of geography facts (e.g., capitals of states and countries). Using an alternating treatments design, the authors conducted sessions in a similar fashion as described in the Barbetta et al. (1993) study except for two aspects. First, this study consisted of students who were learning disabled and functioned academically at higher grade levels. Second, responses were in the form of factual information versus recognition-typed (sight word) responses. In the ASR error correction, the teacher immediately stated the capital and the student repeated it. In the NR condition, the teacher immediately stated the capital while the student looked to a geography card with the correct capital handwritten on it. That is, there was no response requirement expected of the student. The ASR error correction procedure resulted in more capitals learned for same-day, next-day, and maintenance tests. The authors noted it was unknown whether ASR and NR error correction procedures using less direct error correction strategies (e.g., providing students with prompts, rules, etc.) or academic tasks that require more than one-word responses are effective because ASR and NR error

correction procedures were compared with direct correction (i.e., the correct answer was provided by the teacher).

Drevno et al. (1994) used an alternating treatments design to compare the effects of ASR and NR error correction on seven dependent variables: (a) percentage of practice trials in which correct definitions were stated, (b) percentage of just-corrected definitions stated correctly on their next presentation, (c) number of definitions stated correctly on same-day tests, (d) number of definitions stated correctly on next-day tests, (e) percentage of learned definitions correctly stated on 1-week maintenance tests, (f) percentage of learned definitions written correctly on 1-week paper-and-pencil tests of maintenance and generality, and (g) percentage of learned definitions correctly stated on an end-of-the-study maintenance test.

Drevno et al. (1994) found ASR error correction was superior to NR during instruction and on post-instruction tests on all seven dependent variables. The authors noted one discrepancy in the percentage of learned definitions maintained was *not always* higher for terms taught with ASR error correction in the 1-week maintenance and paper and pencil tests. Results suggested students performed better during instruction and retained more of what they learned with ASR error correction.

Response Repetition

It is assumed that with practice, individuals can gain more competence in completing skills accurately. Rodgers and Iwata (1991) describe four error correction strategies that follow an incorrect response (i.e., error). The first is to provide no feedback, which can be thought of as an extinction component of differential reinforcement. Second, a delay is inserted prior to the next learning trial, and is typically brief (e.g., 10 s). The rationale is to

prevent reinforcement for an incorrect response. Third, the instructor presents discrete events following an incorrect response. This strategy does not require the student to emit a response (i.e., the student remains passive). Lastly, instructors present a remedial trial following an incorrect response. Rodgers and Iwata (1991) compared the effects of error correction procedures to a control condition where only correct responses received a consequence, with two conditions involving repetition of a trial contingent on errors on a match-to-sample task.

Baseline condition involved differential reinforcement. The experimenter presented the stimulus page with only the sample stimulus exposed and asked the participant to match comparison stimuli to the sample. Correct responses were followed by praise or food items. Incorrect responses were followed by a statement that an error was made. Then the next trial was presented. Procedures in the practice condition were identical to the baseline condition except for when an incorrect response occurred, the participant was required to repeat the error trial until a correct response was emitted. This condition was designed to examine the effects of stimulus control by practice and repeated exposure to the error trial. The practice condition also produced negative reinforcement of correct responses because during training, correct responses prevent remedial trials. In the avoidance condition, incorrect responses produced color-matching stimuli that were presented in a configuration identical to that used for presenting the learning stimuli. This condition was designed to separate the effects of negative reinforcement from stimulus control by repeated trials. Improved stimulus control could not account for learning because the repeated trials contained irrelevant stimuli (e.g., color-matching stimuli).

All participants made progress when no consequences were provided for incorrect responses (baseline condition). Therefore, Rodgers and Iwata (1991) suggested that differential reinforcement alone was sufficient to produce learning. For some participants, performance was better under one of the error correction conditions (practice or avoidance condition). The authors noted for some participants, trial repetition enhanced stimulus control over correct responding.

Worsdell et al. (2005) discussed how error correction increases correct responding in two ways. First, error correction may enhance stimulus control over correct responding on subsequent trials by providing added opportunities for the correct response to occur through repeated trials. Second, it can also function as punishment for incorrect responses, thereby producing correct responses to avoid correction trials (negative reinforcement).

Error Correction Repetition

The amount of repetition required to be effective following an error has been investigated. Worsdell et al. (2005) examined the extent of how much repetition influenced sight-word reading performance and the rates of sight-word acquisition when error correction consisted of a topographically similar (relevant) versus dissimilar (irrelevant) responses.

Pretests identified word lists that were selected one grade level above the participants' current reading level. Participants' were given 5 s to respond to each word and no consequences were delivered regardless of correct or incorrect responses. Only words read incorrectly were presented a second time, and any words read incorrectly in the second pretest were used for training. Study 1 used a multiple baseline across subjects design to investigate the number of repetitions required for the acquisition of sight-words. During baseline, eight

words were presented three times per session, and correct responses were followed by an edible item or ticket to exchange for preferred items after the session and incorrect responses were ignored. In the single-response (SR) repetition condition, the procedures were identical to baseline except following an incorrect response, the experimenter modeled the correct pronunciation of a word and the participant repeated it. In the multi-response (MR) repetition condition, when an incorrect response occurred, the experimenter modeled the correct pronunciation of a word and prompted the participant to repeat the word five times in the presence of the card. Results of study 1 suggested an increase in acquisition of sight-words when SR and MR procedures were used with more words learned in the MR condition. Although SR and MR conditions were similar in efficiency, more words were mastered and retained both short and long term in the MR condition.

In study 2, baseline and SR conditions were the same as study 1. Two MR conditions were utilized (continuous and intermittent). In the MR (continuous) condition, when an incorrect response occurred, the experimenter prompted the participant to repeat the word five times in the presence of the card regardless of the participant's correct or incorrect pronunciation of the word. After the fifth repetition, the next card was presented. In the MR (intermittent) condition, every third incorrect response was corrected with the MR procedure (i.e., VR 3 schedule of error correction). Errors that were not corrected were ignored. Results indicated that 5 of the 6 participants showed little or no improvement during baseline, but following the introduction of continuous MR and intermittent MR error correction, there were increases in all participants' word mastery with the most observable differences under the continuous MR condition. Although continuous MR sessions took longer to conduct, there

were inconsistent findings between training and short and long term tests. Worsdell et al. (2005) explained that a possible reason for this is participants mastered more words under the continuous MR schedule and therefore had to read more words from that condition on retention tests. The authors concluded that larger amounts of error correction enhanced performance and suggested that instructors should correct errors even occasionally when possible.

In study 3, contingent on each incorrect response, the experimenter implemented the MR error correction for the word that was misread, and following five repetitions regardless of the correct or incorrect pronunciation, the next card was presented. In the MR (irrelevant) condition, procedures were similar to the relevant condition except a nontraining word (i.e., unknown word that never appeared during training) was repeated during the MR error correction. The authors concluded that error-correction of any type enhanced sight-word repetition. Furthermore, they suggested that the irrelevant condition could be influenced by negative reinforcement because the only difference between baseline and irrelevant condition was repeating irrelevant words following errors. Worsdell et al. (2005) admit that nontraining words used in the irrelevant condition may not have been irrelevant in every possible respect because they may have shared similar properties (e.g., similar letters and phonemes). Although the results from study 3 showed mixed results, the authors conceded that relevant stimuli during error correction is recommended because small improvements, if maintained over time may have a significant advantage in the overall amount of learning, larger differences may be observed with other types of performances, and capitalizes on two learning processes. Overall, the most surprising finding was that there was an improvement in

sight-word performance during every error-correction condition over a baseline condition

consisting of positive reinforcement and future research should compare the effects of

positive and negative reinforcement for an analysis of how learning occurs. Limitations of this

study were differences may have been observed if two rather than five repetitions were

conducted and if error corrections were applied more consistently than a VR 3 schedule. In

addition, there was no data on responses that may interfere with performance such as duration

of error-correction sessions, which could influence problem behaviours.

Begeny et al. (2006) examined the nature of repeated readings (RR) and phase drill

(PD) error correction to improve oral reading fluency. Begeny et al. (2006) described the two

features that RR and PD have in common. First, the student practices the correct response in

the natural context for reading and not in isolation of other words. Second, they prompt the

student to repeatedly practice reading. A difference between the two error corrections is that

in RR, the student practices all the words in the passage and in PD, the student practices only

error words and the phrase(s) containing error words. In an alternating treatments design,

different passages were read each session using RR, PD, and reward (RE) conditions. In the

baseline condition, the participant read a passage in order to assess reading fluency of that

passage. In the RR condition, the participant read a passage two times before being evaluated

for oral reading fluency of that same text. During the PD condition the participant practiced

each word he read incorrectly by reading a three to five word phrase containing the

incorrectly read word. The participant read each phrase three times correctly before practicing

the next incorrectly read word. Then, the participant read the passage again to determine the

immediate effects of the PD error correction. In the RE condition, the participant received a

preferred reward if he read a passage faster with the same or fewer errors than his reading of a previously read passage. This condition was designed to determine whether or not manipulation of contingencies was as effective as or more effective than those in the other two conditions.

Results demonstrated that RR and PD produced improvements in oral reading fluency compared to baseline and RE conditions. Begeny et al. (2006) concluded in some instances, PD may be a more efficient strategy because it directly targets responses that are weakest or absent in the student's response repertoire. Further, consistent with Worsdell et al. (2005) study, repeated responding may also be effective as a function of a negative reinforcement contingency because the participants may respond correctly to future readings to escape the possible aversiveness of repeating phrases. There are some limitations to this study employed by Begeny et al. (2006). For example, generalization and maintenance effects were not examined, it is also unclear whether the same results would occur for other response opportunities such as number of passage readings, and the long term effects of PD remain unknown.

Marvin et al. (2010) extended the results of Worsdell et al. (2005) study by evaluating the multiple-response (MR) repetition procedure for error correction using a concurrent multiple baseline across sets of sight-word cards design with multiple participants to see if responses acquired using MR procedures generalized to untrained settings, responses, or both. A list of sight-words (that children should know upon the completion of first grade) were divided into three or four sets of 10 cards, and a sight-word that appeared in one set did not appear in any other set. A given set of cards was considered mastered when the participant

achieved 80% correct responding or higher for two or three consecutive sessions. Baseline

sessions varied across participants but in general, the experimenter held up a flashcard and

asked, "What is this?" and brief verbal praise was provided if the correct answer was given

orally within 5 s of the initial presentation. Self-correction was considered a correct response.

If the participant responded incorrectly or did not respond within 5 s of the card presentation,

the experimenter said "Okay." During the response repetition (RR) condition, correct

responses were followed by brief verbal praise and incorrect responses were followed by the

participant having to repeat the correct response five times, similar to procedures in Worsdell

et al. (2005) study. A generalized assessment was conducted with two of the four participants

which consisted of the classroom teacher conducting three standard reading assessments

during the course of one participant's training. The participant read aloud a list of 100 words

that contained a high percentage of words from instructional phases to the teacher. For the

other participant, baseline sets of words that he was not exposed to in the RR procedure were

used. Preferred items and praise or breaks were provided on a fixed ratio 30 schedule for

reading words aloud (correctly or incorrectly) to an experimenter.

Results demonstrated that error-correction with RR increased sight-word reading

performance for all four participants in the study. In addition, the correct responding

generalized to untrained words for two participants and untrained contexts for the other two

participants. This study's results were consistent with Worsdell et al. (2005) study by showing

that repeated practice of the correct response produced an increase in correct responding to

untrained words that were presented in the training setting and trained words that were

presented in a novel setting. It was suggested that the results of this study has useful

implications in the school setting because the procedure may promote stimulus generalization and response generalization and the procedure is consistent with technology that is often used in typical classroom settings where the learner must practice correct responses contingent on incorrect responses. Marvin et al. (2010) discussed that there are several limitations to the study. First, participants who had access to preferred items noncontingently and contingently for participating in training sessions may have increased motivation to respond correctly, decreased the aversiveness of the trainer's demands, or both. Second, the stability criterion (three consecutive sessions with less than 15% variability) to guide phases changes may have been too liberal to thoroughly evaluate the effects of RR. The third limitation was that they did not evaluate the differential effects of single-response error-correction and that may have yielded comparable results. Future avenues of research as suggested by Marvin et al. (2010) discussed evaluating participant's preference for RR versus baseline conditions or other interventions that consisted of positive reinforcement, the effects of RR as an error-correction procedure for other academic skills and separating the effects of the trainer modelling of correct responses (i.e., trainer repeating the correct response without imitation by learner) from the learner's practice of engaging in the correct response during RR.

Rapp et al. (2012) extended the results of Marvin et al. (2010) study by evaluating the effects or RR on acquisition of math facts and math computation, assessing the degree RR increased correct responding to math skills provided in an alternative format and the necessary materials and personnel resources required for an RR intervention. This study used math facts presented in a card format and problems (one participant) that consisted of only one type of mathematical operation (e.g., addition with carry-over). A correct response was

defined as a correct oral response within 5 s of the initial presentation of the respective card or

when the correct written response to the problem on the math sheet was provided within 15 s

of the presentation of the math sheet.

Rapp et al. (2012) used a combined design to investigate both between-subject and

within-subject effects of RR. The authors used a nonconcurrent multiple baseline across

participants design to evaluate the effects of RR on acquisition of math facts or math

computation. The study also used a concurrent multiple baseline design across sets of math

problems for each participant to evaluate the extent RR increased correct responding for

additional sets of math problems, produced generalized changes to untargeted sets of math

problems, or both. During the baseline phase, a trainer held up an index card and instructed

the participant to solve the problem. Correct responses were followed by brief verbal praise

and incorrect responses were followed by the experimenter saying, "Okay," removed the card

and presented the next card. For the participant who was solving math problems, a correct

response was followed by praise and incorrect responses were followed by the experimenter

saying, "Okay," removed the worksheet and then presented the next worksheet. During the

RR phase, the procedures were similar to baseline, except contingent on an incorrect

response, the participant was instructed to repeat the correct answer five times while the

participant looked at the respective card. Following an incorrect written answer, the trainer

verbally prompted the participant through the current problem so that he arrived at the correct

answer. Then, the participant was given two similar worksheets with the same math concept

to complete. For two of the four participants, an alternative format assessment was completed

to evaluate if the RR procedure, could increase correct responding from problems presented in

one format (e.g., left-to-right) to problems presented in another format (e.g., top-to-bottom).

Results showed that RR increased correct responding to math problems presented on flash

cards and worksheets involving a variety of mathematical operations. In addition, Rapp et al.

(2012) found that correct responding to problems presented in alternative formats also

increased for two participants whose teachers indicated that they exhibited problems applying

skills learned in one format to another format. The results from this study replicates those

produced from Marvin et al. (2010) study. This study also demonstrated the effectiveness of

RR procedures when applied to mathematical computations, RR procedures requires minimal

instructional guidance and materials for trainers and can be used for math and reading skills.

Rapp et al. (2012) noted that after being exposed to the RR phase, correct responding

could have been a result of being negatively reinforced by avoidance of RR for incorrect

responding. The authors also discussed that correct responding produced during training

sessions may have set the occasion for participants to seek out social positive reinforcement

from teachers and others for providing correct answers which may have contributed to the

maintenance of correct responding. The authors discussed several limitations of the study.

The first was that one participant had access to preferred items for participating in sessions

which may have increased his motivation to answer problems quickly and accurately. Second,

there were procedural differences in which RR phase was implemented. More specifically,

there was 5 problems per set using worksheets and 10 problems with flashcards. The

participant who was working on worksheets was required to complete three additional

worksheets for an error on a worksheet versus repeating the correct answer five times for an

error on a flashcard. Therefore, it is unclear if the amount of effort or number of tasks was

what made the RR procedure effective for increasing correct responding. Lastly, the authors note that it was not evaluated if the correct responding generalized to the classroom setting or to responses presented in other formats. The authors suggested that future research should explore the extent to which others (teachers, trainers, peers, or computer programs) could apply RR procedures, the effectiveness of RR when combined with other intervention components, and whether aberrant behaviour decreases as a result of newly acquired math skills.

Error Statement versus Modeling the Correct Response versus No Feedback

Smith et al. (2006) found idiosyncratic effects of error statement (e.g., saying "No"), modeling the correct response, and no feedback on discrete trial training (DTT) with six children with autism spectrum disorder. Smith et al. (2006) utilized an alternating treatments design to teach the participants to match words to pictures. In the error statement condition the instructor said 'no' in a neutral voice following an incorrect response. In the modeling condition, the instructor said 'This is matching' and modeled the correct response contingent on an incorrect response. In the no feedback condition, the instructor provided no feedback after an incorrect response and presented the next trial. Smith et al.(2006) showed that the type of error correction procedure affected skill acquisition for some individuals with developmental disabilities. The authors conceded that a potential limitation of this study is that training components such as prompting and reinforcement may have masked the effects of error correction. The authors suggested a future avenue or research would be to test differences within one child across behaviours. For instance, one participant would receive only error statement across all instructional programs.

Magee and Ellis (2006) conducted an A-B replication design with between-subject comparisons to examine the effects of prompt-all-errors, prompt-incorrect, prompt-no-response, and no-prompt conditions in study 1. This study was designed to teach students to match the Japanese phrase written on a word card to the English term requested by the trainer. The baseline condition involved presenting four stimulus sets to determine the level of correct responding. Following baseline, participants were grouped in a dyad and assigned to one of the four training conditions. The prompt-all-errors condition consisted of the trainer touching the correct stimulus card each time an error occurred and each time 10 s elapsed with no response. In the prompt-incorrect condition, trainers touched the correct card each time an error occurred but removed all cards and presented the next trial if 10 s elapsed with no response. In the prompt-no-response condition, trainers touched the correct card when 10 s had elapsed with no response, and removed all cards. In the no-prompt condition, the trainer did not touch the correct card regardless of the trainee's response. All correct responses received praise statements.

Results of study 1 demonstrated that when prompts were provided for incorrect responses, the trainees mastered the task sooner, however, the retention of the learned task was reduced in comparison to the no-prompt procedure in which trial-and-error procedures were in effect.

In study 2, Magee and Ellis (2006) attempted to strengthen retention if feedback was delivered at the trainee's request. The no-prompt procedure in study 1 was compared to a prompt-request (show me) condition. Procedures for correct responses and the no-prompt condition were similar to study 1. In the prompt-request condition, trainees could request

'show me' within a 10 s interval and the trainer would touch the correct card. In contrast to study 1, retention scores were higher in the prompt-request training, however, prompting incorrect responses resulted in higher number of errors. The authors concluded it was possible that prompts functioned as reinforcers. Despite this limitation, Magee and Ellis (2006) recommended teaching individuals to request prompts such as 'show me' to facilitate learning.

McGhan and Lerman (2013) evaluated an error-correction assessment to determine the least intrusive and most efficient procedure for teaching conditional discriminations to five children diagnosed with autism spectrum disorder. In phase 1, four error-correction methods were compared to determine the effectiveness by examining the total number of trials needed for the participant to reach the mastery criterion for the target in each condition. They also evaluated the intrusiveness on the amount of additional responding of the subject and therapist (i.e., considered error statement the least intrusive and directed rehearsal (DR) the most intrusive). Sessions consisted of five trials for each targeted sample and the mastery criterion for each condition was three consecutive sessions with correct responding on 100% of the trials. Procedures were the same across conditions with the exception of the type of error correction used when an error was made during each condition. On each trial, the therapist randomly placed the targeted sample in front of the learner along with two to four comparison stimuli that were never targeted. The therapist prompted the participant to attend to the stimuli and presented the discriminative stimulus (S^D), "Touch __." Correct responses were followed by verbal praise along with an edible item that they had chosen during the preference assessment. In the error statement (vocal feedback) condition, incorrect responses (emitted an

incorrect response or did not emit a response within 5 s) were followed by the therapist saying, "No, that is not ___" in a neutral tone and removed the stimuli and presented the next trial. In the model condition, incorrect responses were followed by the therapist representing the S^D, touched the correct card while saying "This is a ___" and then immediately removed all the stimuli until the next trial. In the active student response (ASR) condition, incorrect response was followed by the therapist saying, "This is ___ accompanied by a gesture prompt. Then the therapist immediately re-presented the S^D, "Touch___" and waited 5 s for a correct response. Correct responses following the prompt resulted in brief praise only. If the learner did not exhibit a correct response, the therapist physically prompted the learner to touch the correct card. In the directed rehearsal (DR) condition, incorrect response were followed by the therapist saying, "This is ___" accompanied by a gesture prompt, and then immediately re-presented the S^D "Touch ___." Correct responses following the gesture prompt resulted in the therapist delivering brief praise and immediately re-presented the S^D, "Touch___." The therapist repeated this procedure until the learner exhibited three consecutive correct unprompted responses. If the learner did not respond correctly on any trial during the error correction procedure, the therapist delivered a gestural prompt and restarted the error correction procedure.

In phase 2, McGhan and Lerman (2013) evaluated the reliability and utility of the assessment using a multielement design embedded within a multiple baseline across subjects design. The authors selected additional targets (three different stimuli: capital cities, flags, and American presidents) and compared the total number of trials needed for the subject to reach the mastery criterion under each of the error-correction conditions. During baseline, the

therapist presented the sample with comparison stimuli in the same manner as the assessment. Regardless of whether the learner responded correctly or incorrectly, the therapist delivered praise at the end of each trial. The therapist presented a new trial every 10 s. Results indicated that the model procedure was just as effective as, or more effective than the ASR and DR procedures for the majority of participant's. McGhan and Lerman (2013) suggest that their results lend support to the least intrusive, most efficient procedure varies across individual learners. The authors suggest that future avenues of research should explore if a single assessment would identify the most appropriate error-correction procedure for a variety of skills and if there is a learner's preference for the different error correction procedures.

Effects of Immediate versus Delayed Self-Correction

Bennett and Cavanaugh (1998) examined the timing of self-correction using an alternating treatments design for a fourth-grade girl on multiplication facts. In experiment 1, ten single-digit multiplication facts with a multiplier of 3 were taught using a no-correction and immediate self-correction condition. In the no-correction condition, there was no correction on errors. In the immediate self-correction condition, the participant corrected her work immediately using answer keys following the completion of each of the four five-item tests. Experiment 2 used multiplication facts with a multiplier of 6 and immediate self-correction was compared to delayed self-correction condition. In the delayed self-correction condition, the participant corrected her work using answer keys after all four five-item tests were completed.

The number of facts answered correctly were higher in the immediate self-correction condition. Bennett and Cavanaugh (1998) study demonstrated consistent findings with

previous research on active responding (self-correction) versus passive responding (Barbetta et al., 1993; Barbetta & Heward, 1993; Drevno et al., 1994).

Barbetta et al. (1994) extended Barbetta et al. (1993) study by comparing the effects of immediate ASR versus delayed error correction on the acquisition and maintenance of sight words in an alternating treatments design. The immediate ASR condition consisted of the teacher saying "No, this word is _____" contingent on an error. The student repeated the word and the teacher provided praise and presented the next word. In the delayed error correction, the teacher said "No, we'll try this word later" following an error, and after the training session was completed, the incorrect words were shuffled and presented again. When each incorrectly pronounced word was presented again, the teacher said "This word is _____. What word?"

The overall findings demonstrated that immediate error correction produced better performances on same-day and maintenance tests. The authors concluded that there were several possible reasons. First immediate error correction provides more opportunities for correct responses during instruction. Second, delayed error correction involved students repeating errors. Third, delayed error correction provided massed practice of incorrectly pronounced word. Finally, during massed practice, students may have imitated the teacher's model without looking at the word, and therefore, did not attend to the stimuli.

Effects of Delay Error Correction versus Independent Probe Error Correction

Turan et al. (2012) compared the effectiveness of a "Delay" and "Independent Probe" (IP) error correction across two studies. In study one, a within-session alternating treatments design was used with three children to evaluate the effectiveness of the two error correction

procedures on identifying concepts (e.g., streetcar). The delay condition consisted of a 5 s

delay following an error, with no feedback given, and then followed by a readministration of

the discriminative stimulus (Sd) and a prompt to respond correctly. This was then followed by

a new trial with a new stimulus. In the IP condition, a 3 s delay followed an error, with no

feedback given, then a readministration of the Sd with a prompt to respond correctly. Then,

the participant was asked to respond to a "distractor trial" which consisted of a request to

respond to a previously learned response. Following the distractor trial, the original Sd was

administered again to test for a learned response. Results of study one showed that two of the

three participants achieved quicker acquisition in the delay condition, but one participant

achieved quicker acquisition in the IP condition. Further suggesting that error-correction

procedures should be individualized.

Study 2 compared the effectiveness of the two error correction procedures (Delay and

IP) on tact training with two children. The purpose of this study was to evaluate whether the

more effective error correction procedure from study 1 generalized across tasks (i.e., tacts).

An alternating treatments design was used to evaluate the two error correction procedures that

were identical to study 1 except the Sd delivered was "What is it?" Results from study 2

showed that the children demonstrated individual effectiveness to a particular error correction

(i.e., one child achieved quicker acquisition in the IP condition, and the other in the delay

condition). The results were consistent with study 1 and suggests the error-correction

procedures can be applied across learning tasks. Turan, et al. (2012) noted that the IP

condition took twice the length of time to implement and a cost benefit analysis would need to

be considered when selecting the type of error correction to be used. The authors noted that

some limitations are that there were only two participants in the study that prevented external validity, the IP condition included several components (shortened delay, distractor trial) so it is difficult to determine which component was responsible for quicker acquisition, and the delay in the procedures makes it difficult to examine if punishment + stimulus control would be responsible for the results in the IP condition. Turan et al. suggest that future studies should examine exemplar data in studies involving discrete trial training, comparing punishment versus stimulus control relationships, efficiency of all early intervention studies and replicating these studies to determine if error correction procedures generalize across operants for individual learners.

Purpose

The purpose of this study was to compare the effects of ASR (active student response) error correction procedure to a NR (no response) error correction procedure in teaching object-to-picture matching task to children with autism. An alternating treatments design was used to evaluate the effects of the two different error correction procedures. The comparison of ASR and NR will extend the research of Smith et al. (2006); Barbetta et al. (1993); and Drevno et al. (1994).

Participants and Setting

Three children participated in the study. Kate was a 5-year-old girl diagnosed with Autism Spectrum Disorder (ASD) and participated in the Early Learning Autism program at St. Amant where she receives Intensive Behavior programming with a tutor for six and a half hours a day completing her individualized programming protocol. She was in the program for 1 year at the time of the study. Devin was a 3-year-old boy diagnosed with ASD and Liam was a 2-year-old boy diagnosed with ASD who were on the waitlist to participate in the Early Learning Autism program at St. Amant. One-to-one instruction sessions were conducted three days per week in the specified work room identified by their parents.

Preference Assessment

All participants were able to verbally respond to the question, "What do you want?" or would express their preferences prior to being asked by selecting from an array of mini edible's (e.g., mini chocolate chips) that were displayed on the table at the beginning of each session (similar to procedures used in Turan et al. (2012). Preference assessments were

conducted for all participants to ensure that motivation was high across all conditions (Turan et al.)

Assessment and Data Collection

Pre-assessment data was collected by administering all 20 (3D) objects and corresponding (2D) objects in an array of 3, two times in one session. For example, when given a dog (3D), the participant was asked to place the 3D object on the correct 2D object of a dog from an array consisting of a ball, dog and pig. Participants received no feedback for correct and incorrect responses but received praise for on-task behaviours such as sitting and looking after approximately one out of every three trials as described in Smith et al. (2006) study. Following each trial, the instructor scored the participant's responses as correct or incorrect on a pencil-and-paper form. If a participant responded correctly to one or both baseline trials of a particular object-to-picture pair, the pair was not used for that participant during the study.

The dependent variable was the number of sessions to mastery for each object-to-picture task. Mastery was defined as 5 out of 5 correct independent responses (i.e., 100%).

Interobserver Reliability

Interobserver agreement were assessed during 95% of all the sessions during the study. Interobserver agreement was recorded independently by a second observer and was calculated by the number of agreements divided by the total number of trials. The investigator collected trial-by-trial data and served as the primary observer. Interobserver agreement across sessions was 90%.

Experimental Design

   An alternating treatments design was used in the study. The design included ASR and NR conditions and follow-up. The order of conditions was similar to Smith et al. (2006), where each condition was rotated across sessions so it was counterbalanced over the course of the study (e.g., ASR, NR in session 1; NR and ASR in session 2, etc.). Each session consisted of 30 min of instructional time. During each session, there were 15 learning trials (three object-to-picture pairs were taught in the same set used in the array with the correct picture across trials) for each of the two conditions totaling 30 trials. Conditions within sessions were separated by 5 min breaks.

Procedural Integrity

   Training sessions were provided to each research assistant that assisted in conducting the study. Training consisted of a written copy of the procedures, role-playing, and feedback (Sarokoff & Stumey, 2004). The investigator demonstrated ASR and NR error corrections by modeling the procedures. During role-play, the investigator, playing the participant demonstrated each potential client response that may occur (error, no response) (Roscoe & Fisher, 2008) and provided corrective feedback (e.g., "You did this when the participant erred. You should have done this" and modeled the correct procedure) immediately to the therapists involved in the study. Table 1 illustrates the list of responses the participant could make and the correct action by the therapist. Role-play continued until the research assistant met the criteria of 3 consecutive correct trials for correct responses, ASR error correction and NR error correction (i.e., 100% correct).

Table 1

List of Participant's Response and Correct Therapist Response

Participant's response	Therapist's response
Correct response	Praise and mini-edible
Incorrect response	ASR or NR error correction
No response	ASR or NR error correction

General Procedure

Twenty unlearned objects and corresponding pictures were chosen to teach to all participants. Table 2 illustrates the 20 learned objects that were used for the participants. Objects were randomly assigned to one of two sets of 10 objects. Each session consisted of a next-day test (on object-picture pairs that were mastered in previous sessions) and instruction with ASR and NR error correction.

Procedures for presenting each trial, reinforcement system implemented, mastery criteria, and recording of dependent variables were similar to those used in the Smith et al. (2006) study and are described below.

Figure 1 illustrates each learning trial which consisted of: discriminative stimulus (SD), response from the participant, consequent event (either reinforcement for an accurate response or error correction immediately following an incorrect response or no response), and intertrial interval during which the instructor removed all materials and recorded data. After 3-5 s intertrial interval, instructor again placed all three 2D objects at the same time, side-by-

side in a random sequence on the participant's desk and started a new trial. The participant sat at his or her desk facing the instructor. In each trial, the instructor placed three pictures side-by-side in a random sequence on the participant's desk, handed an object to the participant, and gave the spoken discriminative stimulus, "Match." The instructor provided no prompts to assist the participant to give a correct response.

Three object-to-picture pairs were taught in the same set used in the array with the correct picture across trials. The instructor presented one of three teaching object-picture pairs in an array with two other pictures in the set. The instructor randomly rotated among presentations of each pair (Smith et al. (2006). Correct responses were followed by a brief praise statement (e.g., "Good!" "That's right!") and the mini-edible selected during the preference assessment. For incorrect responses, the experimenter said "No" and then provided either the ASR or NR error correction procedure.

Sessions continued until the participant mastered all pairs in both sets (i.e., all 20 objects and pictures). Changes were made for Devin on session 21 because there was no progress. These changes consisted of presenting three new object-to-pictures from each condition (ASR and NR). He was playing with the materials (e.g., looking at the features of the object such as the eyes of the fish) and we wanted to explore whether or not new materials would change his behavior by eliciting the target response (placing the object on top of the picture) instead of the materials he was used to playing with during the sessions. Since there was no progress after 10 sessions after the changes were made, we presented the original six object-to-picture pairs that were presented initially at the beginning of the study (three from ASR condition and three from NR condition), but prompted a correct response using most-to-

least prompting (MTL). MTL gradually fades the instructor's assistance from the most intrusive prompt (e.g., hand-over-hand prompt) to the least amount (e.g., gesture) so that the instruction alone elicits the response (Leaf et al., 2014). Following an erred response, an ASR or NR error correction was implemented.
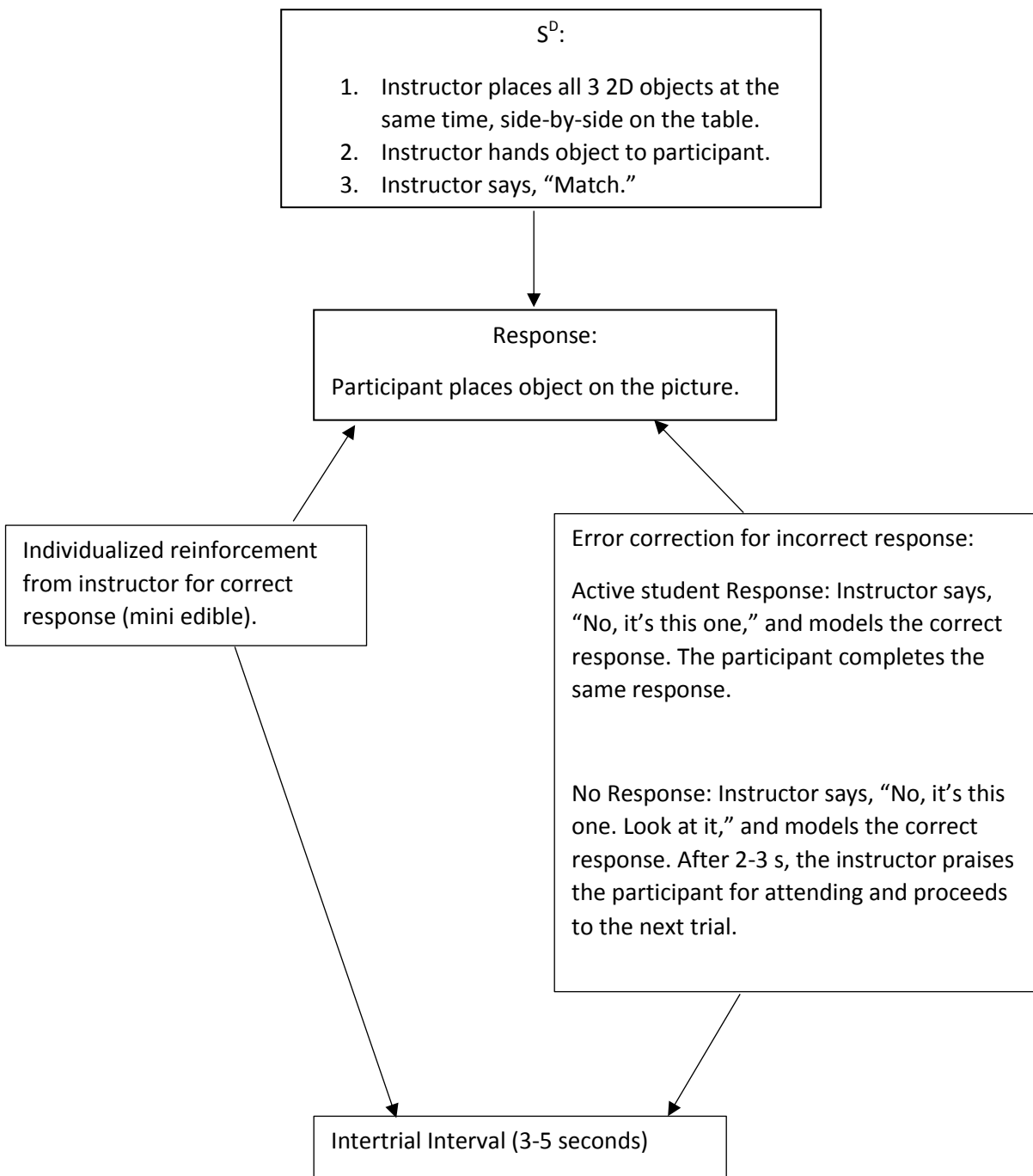
S^D:

1. Instructor places all 3 2D objects at the same time, side-by-side on the table.
2. Instructor hands object to participant.
3. Instructor says, "Match."

Response:

Participant places object on the picture.

Individualized reinforcement from instructor for correct response (mini edible).

Error correction for incorrect response:

Active student Response: Instructor says, "No, it's this one," and models the correct response. The participant completes the same response.

No Response: Instructor says, "No, it's this one. Look at it," and models the correct response. After 2-3 s, the instructor praises the participant for attending and proceeds to the next trial.

Intertrial Interval (3-5 seconds)

Figure 1. Components of a learning trial.

Error Correction

Active Student Response (ASR) Error Correction. ASR error correction consisted of the instructor modeling the correct response and having the participant complete the same modeled response. When a participant erred on a trial, the instructor immediately said, "No, it's this one." After the participant put the object on the correct picture, the instructor provided verbal praise ("that's it," "good") and started the next trial.

No Response (NR) Error Correction. NR error correction consisted of the instructor modeling the correct response while the participant looked at the experimenter modeling the correct response (participant did not model). When a participant erred in this condition, the instructor immediately said, "No, it's this one. Look at it." After 2 to 3 s (approximately the time used to make an active response in the ASR condition), the experimenter provided praise to the student for attending ("good looking") and started the next trial.

Follow-up. Follow-up data was taken one week after the intervention was completed to see if the object-to-picture pairs that were learned in sessions were maintained over time. Follow-up consisted of administering all 20 objects and corresponding pictures once in one session.

Results

Figures 2 to 4 illustrates the main findings. The numbers on the x-axis refer to the objects participants were taught to match to corresponding pictures. The y-axis displays the number of sessions that the participant required to achieve the criterion for mastery of the object-to-picture match. Figure 2 indicates that the first participant, Kate, showed little difference between the conditions for the object-to-picture tasks (except exemplars 3 and 5 where ASR was more effective). Liam showed no differences between the conditions except for the third object-to-picture task which, the NR condition was more effective. Thus, saying "No" and observing the experimenter model the correct response was more effective for teaching the third object-to-picture task (Figure 3). Figure 4 illustrates the number of trials to mastery for Devin. Devin was unable to learn the matching object-to-picture tasks therefore, on session 21, six new exemplars were introduced. Introducing the new materials yielded similar results as the first six exemplars (i.e., he was unable to reach the mastery criterion), therefore, after 10 sessions, a MTL prompting procedure was introduced for the original first six targets. It was thought that prompting Devin using MTL prompting to select the correct response would increase the percentage of correct responding. The prompting procedure was not effective in teaching Devin to learn the matching-to-object task. As a result, after 8 sessions, the study was discontinued for Devin due to no progress.

Discussion

In the current study, we evaluated the effectiveness of two error correction procedures on teaching object-to-picture task for three children with ASD. Results showed that there were no differences in the number of sessions to mastery for the exemplars taught in either of

the error correction procedures for two participants (Kate and Liam). Table 3 illustrates the number of trials to mastery for each participant. Kate and Liam were able to learn all 20 object-to-picture tasks and maintained the mastered object-to-picture tasks in the next day tests and the follow-up session. Kate was exposed to an error correction procedure that was similar to the ASR condition (without the error statement) in her individualized programming, however, she had never been exposed to the NR error correction. Therefore, it is interesting to note that she was able learn the object-to-picture tasks in the NR error correction condition at a similar rate of acquisition as the ASR condition. Liam took a few more sessions to learn the matching object-to-picture task at the beginning, however, once he learned what he was supposed to do, he quickly met the mastery criterion for the remainder of the exemplars taught in both the ASR and NR error correction conditions (met mastery criterion on average in 2 sessions for exemplar 6 to 10).

Devin was not able learn the matching object-to-picture task in either the ASR or NR error correction conditions. There are three possible explanations as to why Devin was not able to learn the task. First, he was not in the Early Learning program and did not have any exposure to one-on-one teaching. We had to start with some compliance training where reinforcement was provided for attending and listening to basic instructions such as sit down. It is possible that teaching him to match object-to-picture was too difficult. He often played with the objects or held on to the object. One possible strategy is to teach him to match identical objects or identical pictures first and then teach him to match object-to-pictures. Second, he was learning to make errors with the materials presented because no prompting strategies were introduced into later (session 32). Therefore, he had a learned history with the

materials that were presented and following either error correction procedure, only received brief verbal praise. Perhaps this was not as salient for him to learn what the desired response was. Third, it was difficult to determine reinforcers for him. Different edible reinforcers were used throughout the study and he often played with the edibles (squished them between his fingers or stuck them on his face). A potential strategy would be to use different preference assessments that included activities and not just edibles.

In the present study, there was no prompting strategies incorporated until later, (for Devin), which allowed us to test for the effects of the procedures. This study did not reproduce similar results as Barbetta et al. (1993), Barbetta and Heward (1993) and Drevno et al. (1994) and found that two participants in this study (Kate and Liam) were able to learn the matching object-to-picture task from both error correction procedures and there were no differences in the number of sessions to mastery for each exemplar taught. This study does extend Smith et al. (2006) study, in which results indicate idiosyncratic effects of error correction procedures. A potential limitation is that the current study only had three participants so it is unclear if similar results would be found if more participants were in the study. A second limitation is that in both error correction procedures, an error statement was used and there may have been potential interaction effects between the error statement and error correction procedure. For example, for Kate, she was familiar with the ASR procedure without the error statement, and when we started to say, "No, it's this one" she would stop and look at us or smile suggesting that this may have contributed to her progress because she received a different type of feedback than she typically would. A third limitation is that only one participant had a history of intervention that included modeling procedures, while the

other two participants had no intervention. This history may have been a variable that influenced participants' skill acquisition (Smith et al. (2006). Liam who did not have any previous intervention, did learn the matching object-to-picture skill and this may not have a role in his progress, whereas Devin who also did not have any previous intervention did not learn the skill.

This study does contribute to the current literature by investigating whether or not error correction procedures should be individualized rather than applying the same procedure to all children with Autism (Smith et al., 2006) and Iwata et al. (1991, as cited in Smith et al. (2006) study). By utilizing different error correction procedures, it may enhance the performance of the learner. Some learners may learn better if they are not required to complete the correct response after an error. Given that, in our procedure, two participants were able to learn from either error correction procedure, this lends itself to the implications of using different error correction methods in a group setting. In a group setting, it may be easier and quicker for teachers to model the correct response rather than having the learner perform the correct response. In a classroom, if the student made an error, the teacher could provide an error statement and model for everyone what the correct response is and move on to the next instruction. It would be advantageous for future research to examine how much quicker it is to implement the NR error correction than the ASR error correction. Perhaps another future avenue of research would be to use response repetition in addition to the ASR or NR error correction, that is, requiring the learner to emit the correct response more than once may be beneficial for learners such as Devin who may acquire skills more slowly (Begeny et al., 2006; Marvin et al., 2010; Rapp et al., 2012; Worsdell et al., 2005). This

would give him additional practice with the correct response. Worsdell et al. (2005) suggests that learners may do well in this condition because of negative reinforcement (i.e., learner emits correct responses to avoid correction trials). As an extension of this study, future research could see if there are differences within one child across different tasks and instructional programs (Smith et al., 2006). For example, would Kate benefit if error statement and modelling were used in all of her individualized programming? Another avenue for future research is to explore whether or not problem behaviors increase or decrease contingent on the type of error correction procedure used. Some learners may find that being prompted or just the mere fact that they erred aversive, and engage in problem behaviors. In this study, there was only mild problem behavior such as running away from the table for two of the participants, but they were easily redirected back to the table. Future research should investigate whether or not problem behaviors increase or decrease with the use of the ASR or NR error correction procedures.

This study contributes to the current literature on error correction methods by comparing two different error correction methods that have been used to teach a variety of skills to a matching object-to-picture task. Results suggest that although some learners do acquire skills quicker than others, there was not a difference in the type of error correction used in this study (which is not consistent with the literature in previous studies). A potential reason for why the results of this study are not consistent with previous literature is that the results from other studies may be attributed to differences in the subjects utilized. The subjects were older in age and the skills taught such as sight words, math facts, reading fluency meant that they had learned pre-requisite skills necessary to understand more difficult

tasks. Subjects in previous studies also had more of an ability to communicate using language. Future research may look to see if someone is not progressing with a skill; a different strategy may be more useful.

Table 2

List of Object-to-Picture Items for each Participant

	Kate		Liam		Devin	
	ASR	NR	ASR	NR	ASR	NR
Exemplar						
1	Toothbrush	Bag	Walkie Talkie	Chalk	Sock	Leaf
2	Pencil	Flower	Car	Ball	Skateboard	Harmonica
3	Spoon	Paintbrush	Cat	Soap	Shampoo	Fish
4	Leaf	Ball	Whistle	Crayon	Straw	Pumpkin
5	Marker	Pumpkin	Pig	Toothpaste	Bowl	Balloon
6	Balloon	Goose	Dog	Goose	Horse	Toothbrush
7	Trumpet	Harmonica	Cow	Block	Candle	Bandaid
8	Dog	Rooster	Flower	Remote	Goat	Paintbrush
9	Bandaid	Whistle	Marker	Sheep	Trumpet	Flower
10	Cow	Horse	Bull	Rooster	Bag	Pencil

Table 3

Number of Trials to Mastery for each Exemplar across Participants

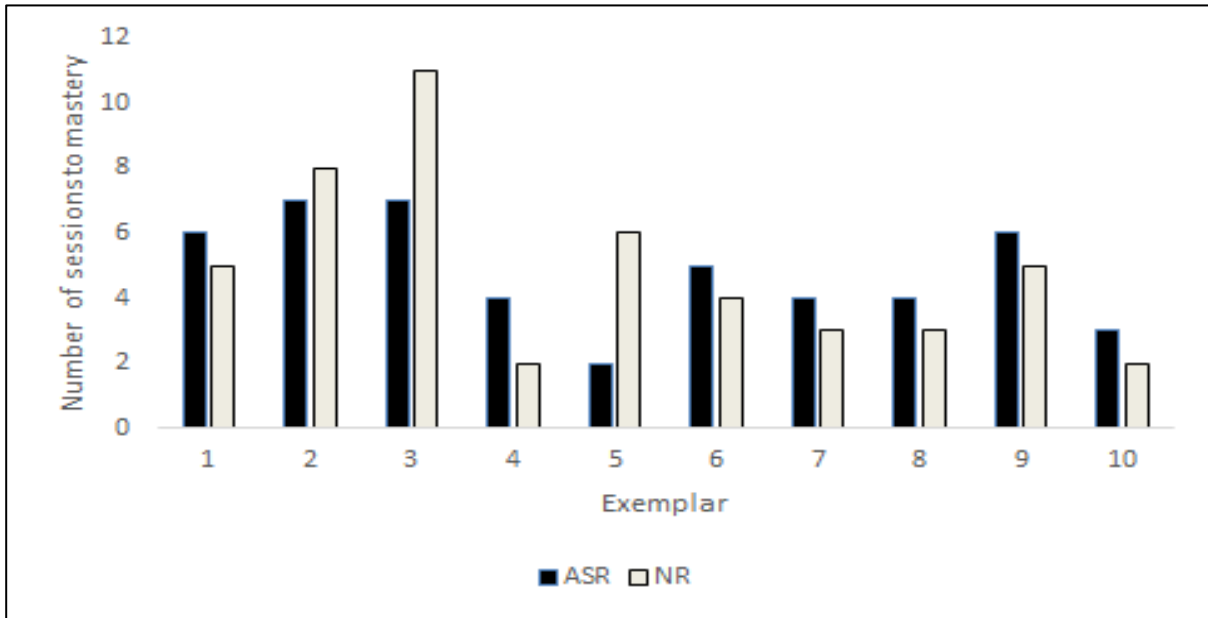|	Kate		Liam		Devin	
	ASR	NR	ASR	NR	ASR	NR
Exemplar						
1	6	5	3	3	0	0
2	7	8	3	4	0	0
3	7	11	7	2	0	0
4	4	2	5	7	0	0
5	2	6	3	4	0	0
6	5	4	2	2	0	0
7	4	3	2	2		
8	4	3	2	2		
9	6	5	2	3		
10	3	2	2	2		

Figure 2. Number of sessions to mastery for each object-to-picutre pair learned for Kate.
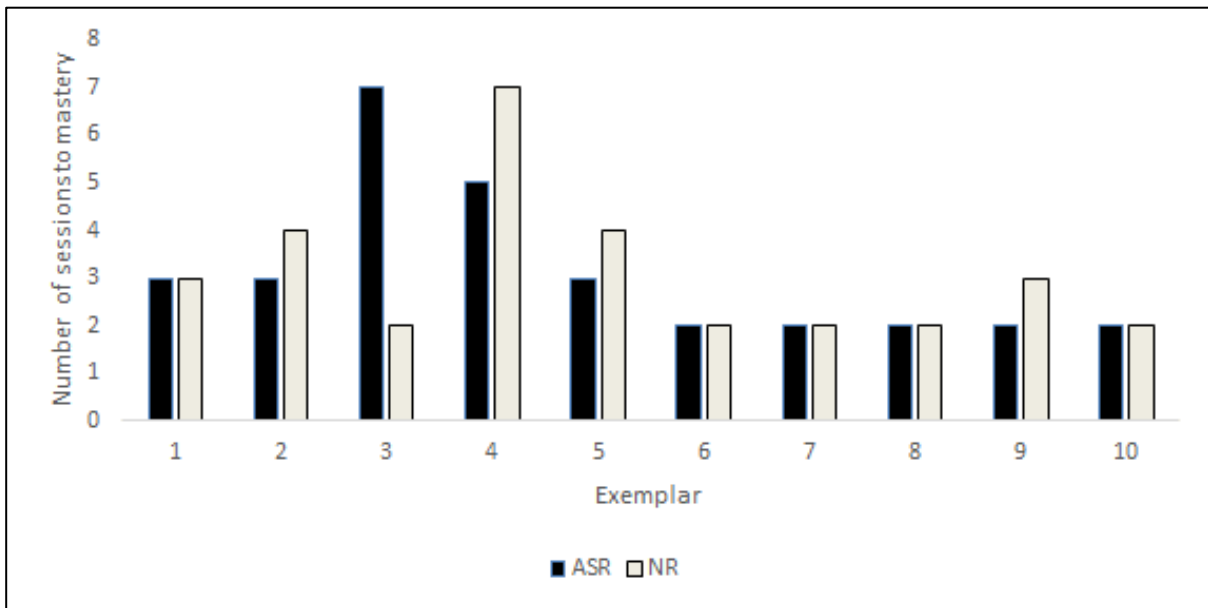

Figure 3. Number of sessions to mastery for each object-to-picture pair learned for Liam.
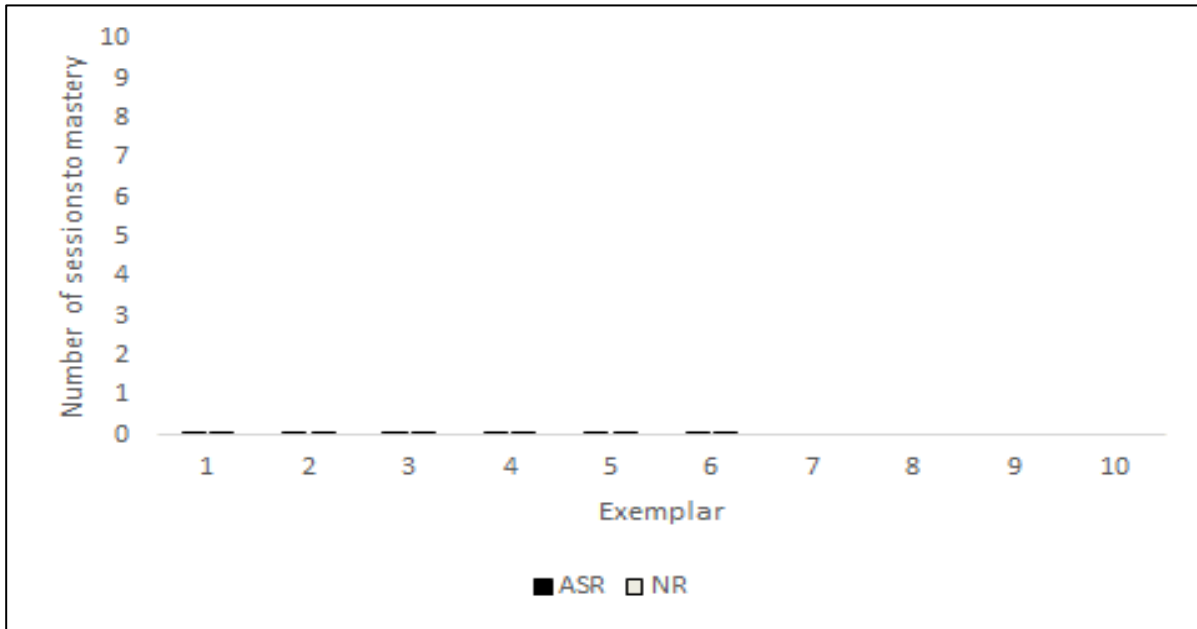
Figure 4. Number of sessions to mastery for each object-to-picture pair learned for Devin. Exemplars 7 to 10 were not introduced.

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