A Comparison of Within- and Across- Session Progressive Time Delay Procedures for Teaching Sight Words to Individuals with Cognitive Delays

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Abstract

The effectiveness of within-session and across-session variations of a progressive time delay procedure for teaching sight words was evaluated for five participants with cognitive delays. Participants were exposed to five target stimuli using two variations of progressive time delay procedures in an alternating treatments design, followed by the most effective variation being applied to teach all target stimuli. Data indicated that the within-session time delay procedure was the most effective procedure for each participant. Implications for classroom instructional procedures using progressive time delay are discussed.

Keywords: Errorless learning, progressive time delay, sight words, stimulus control

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Time delay procedures have been used for teaching skills such as sight words (Gast, Wolery, Morris, Doyle, & Meyer, 1990), sign language (Browder, Morris, & Snell, 1981), social studies and health facts (Wolery, Cybriwsky, Gast, & Boyle-Gast, 1991), spelling (Coleman-Martin & Heller, 2004), instruction following (Striefel, Bryan, & Aikins, 1974), spontaneous speech (Charlop, Schreibman, & Thibodeau, 1985; Ingenmey & Van Houten, 1991; Taylor & Harris, 1995), vocational assembly tasks (Walls, Haught, & Dowler, 1982), gross motor skills (Zhang, Horvat, & Gast, 1994), word identification (Browder, Hines, McCarthy, & Fees, 1984; Lalli & Browder, 1993) and a variety of other skills (Walker, 2008, Wolery, Ault, & Doyle, 1992). Time delay procedures typically involve the presentation of a discriminative stimulus (e.g., a flashcard with the word "LAUNDRY" on it) followed by the delivery of an instructional cue (e.g., "What word is this?") followed by the provision of the controlling prompt (i.e., stating the correct response; e.g., "laundry"). In cases where the delays of 0 s (i.e., no delay) are employed the teaching method is often termed as "errorless learning" (Touchette, 1971, Touchette & Howard, 1984), whereas delays of longer than 0 s are termed as "time delay". In both procedures the controlling prompt cues the student to engage in the correct response (i.e., a prompted correct response). However, once a delay for providing the controlling prompt is introduced the student has the ability to respond to the salient features of the stimulus independent of the controlling prompt which is the goal of any instructional strategy (i.e., providing independent correct responses).

Two typically utilized time delay procedures are constant time delay and progressive time delay procedures (Walker, 2008). Both procedures are similar in implementation: the presentation of the discriminative stimulus, paired with the delivery of an instructional cue with a specified delay to the controlling prompt. The procedures differ on how the delay to when the provision of the controlling prompt is provided. In constant time delay, an arbitrary delay is often selected (e.g., 5 s; Coleman-Martin & Heller, 2004; Lalli, Casey, Goh, & Merlino, 1994), however in progressive time delay, the delay is typically faded in increments (e.g., 1-2 s) based on preset number or percentage of correct responding criteria (e.g., correct responses in 3 consecutive trials; Taylor & Harris, 1995). The effectiveness of both versions of these time delay procedures have been documented through literature reviews regarding time delay procedures (Handen & Zane, 1987; Walker, 2008). However, it has been reported that constant time delay procedures have been associated with slightly more errors and longer delays in the transfer of stimulus control (i.e., correct responding no longer being cued by the controlling prompt; Walker, 2008). Thus, progressive time delay procedures appear to have some advantages over constant time delay procedures.

Progressive time delay procedures typically proceed from 0 s to some delay contingent upon a set criterion of correct responding being met. For example, a 0 s delay will be faded to a 2 s delay, then to a 4 s delay and so on until some ceiling limit is reached (e.g., 10 s delay; Taylor & Harris, 1995). In most applications of progressive time delay, delays are typically increased across sessions based on correct responding. However, Touchette's (1971) original procedure consisted of within-session increases to the onset of the controlling prompt for the next trial by 0.5 s following a correct response, and reducing the delay on the next trial by 0.5 s following an incorrect response. Such changes can be burdensome in community based settings, especially when this criterion for increasing/decreasing the delay is applied to stimuli being trained concurrently. In such situations, it requires the teacher's careful attention to the appropriate delay for each trial because errors result in different stimuli requiring different delay times within a training session. A concern with any instructional procedure is its practicality when implemented in community-based settings. Therefore, time delay procedures using whole numbers may be more practical for teachers to utilize and is likely why it is more common in applied settings.

A second way to make progressive time delay procedures more practical would be to have a predetermined response independent schedule for advancing when the controlling prompt is delivered (e.g., based on the number of trials, or across sessions). Such a procedural variation would require less teacher attention to individual time delays because correct responding and errors would have no effect on the advancement criterion and could be applied to all stimuli. Examples of progressive time delay procedures using response independent criteria exist but are rare (e.g., Ingenmey & Van Houten, 1991). In this study, the authors increased the delay of the controlling prompt based on number of trials completed (i.e., every 8 trials the delay was increased by 2 s up to a maximum of 10 s). This procedural modification was successful in obtaining spontaneous speech in a child with autism. Replications of such procedures are difficult to locate and no studies have been able to be located that compared response independent and response dependent time delay procedures. If response independent time delay procedures are as effective as response dependent delay procedures, it would make intuitive sense to use the former variation due to its ease of implementation.

The purpose of this study was to evaluate two variations of progressive time delay procedures in terms of efficiency on the acquisition of reading sight words for young individuals with mental retardation. The first variation (i.e., within-session) consisted of altering the time of the delay to the controlling prompt contingent on responding as was originally implemented by Touchette (1971), but accommodated for practicality (i.e., correct and incorrect responding altered the time delay in seconds using whole numbers). The second variation (i.e., across-session) was based on a practical version of Ingenmey & Van Houten (1991) and consisted of increasing the time of the delay to the controlling prompt based on a predetermined number of training trials (i.e., changing the delay across sessions).

Method

Participants and Setting

Participant information and the type of instructional stimuli taught are listed in Table 1. Participants were primarily independent in personal care activities and used vocal language to interact. Words were initially selected from activities based on their written activity schedules (Helen, Arnold, and Teresa), from object labels found in the participants classroom (Marc) and staff names of the staff that would typically work with the person over the course of the week (Harry). Words were then initially assessed to ascertain if the participants could read these words using flashcards with a size 48 bold printed font. All words assessed were between 3 to 8 letters in length and approximately 10-30 words were initially assessed. Only two children were able to read any of the words during the initial assessment (Marc was able to read “snack” and Harry was able to read a preferred staff member’s name). Ten words that were read correctly on 0% of trials were randomly selected and then randomly assigned to the two experimental conditions to create equal word length lists of five words each. Sessions were conducted in a quiet area of the participants' classroom. The participant and one or two trained teaching assistants (for the purpose of interobserver agreement data collection) were present during sessions.

Table 1

Participant Information and Instructional Stimuli Taught

Participant	Age	Classification	Stimuli

Helen	18	Moderate MR	ADLs
Marc	8	Mild MR	Object Labels
Arnold	17	Mild MR	ADLs
Teresa	18	Moderate MR	ADLs
Harry	9	Mild MR	Staff Names

Note: MR = mental retardation, ADL = words depicting activities of daily living (e.g., lunch, shower, snack).

Dependent Variable and Data Collection

The assistant scored the participants' verbal responses to the written stimuli as either correct (+) (e.g., assistant showed the flashcard with the word 'bath' printed on it and stated "Look at the card, read the word. Bath." Child stated "Bath", or assistant showed the flashcard with the word 'bath' printed on it and stated "Look at the card, read the word." Child stated "Bath"), or incorrect (-) (e.g., assistant showed the flashcard with the word 'bath' printed on it and stated "Look at the card, read the word. Bath." Child stated "Barn", assistant showed the flashcard with the word 'bath' printed on it and stated "Look at the card, read the word." Child states "Barn", provides no response, or states "I don't know. Tell me.").

Interobserver Agreement and Treatment Integrity

A second observer independently recorded participants' responses during a mean of 31% of the sessions equally distributed across all participants and phases of the study. Interobserver agreement was calculated on a trial-by-trial basis by dividing the total number of agreements by the total number of agreements plus disagreements and multiplying by 100%. Interobserver agreement measures averaged 97% across participants (range 92% to 100%).

The author assessed the assistants' use of (a) the instructional cue (i.e., "Look at the card, read the word."), (b) the proper delay time for the controlling prompt for each procedure, and (c) the feedback procedures (descriptive praise, error correction). These integrity observations were conducted once during each phase of the study for each time delay procedure with each participant. The observer recorded the assistants' responses either as correct or incorrect and provided the assistants with performance-related feedback after each observation. Assistants responded correct on the average of 99% (range = 75% to 100%) for application of the discriminative stimulus, 100% for the correct controlling prompt delay with the across-session progressive time delay, 98% (range = 90% to 100%) for correct controlling prompt delay for the within-session progressive time delay, and 100% for the feedback procedures across participants.

Experimental Design

An alternating treatments design (Barlow & Hayes, 1979) was used to compare the effects of the training procedures on the participants' oral reading performance. The order of procedures (during training and probes) was randomly determined (every third day) and counterbalanced.

Procedures

Baseline, probe, and maintenance probes. Sessions consisted of 4 trials of each word (20 total trials per session) with flashcards shuffled after each of the five words was presented. One session of each procedure was conducted daily with sessions separated by a minimum of 4 hours (e.g., 10:00 am, 2:00 pm). The probe sessions were started after one training session for each procedure (on the following day) and followed an alternating schedule with training sessions (e.g., Day 1-train each procedure; Day 2-probe each procedure). On each trial, the assistant presented the participant with a flashcard and provided an instructional cue [e.g., "(Name), look at the card and read the word."]. The participant was allowed 5 s to say the word orally and the assistant scored the response as either correct or incorrect. If the response was inaudible, the participant was asked to repeat their response; if the response was again not interpretable the response was scored as incorrect. The assistant provided descriptive praise for correct responses, removed the flashcard, and waited the inter-trial interval (5 s) before presenting the next trial. No error correction procedures were used for incorrect responses during probes. For all sessions, the assistant provided edible rewards paired with descriptive praise at the start of each session and after every third trial for appropriate sitting. Maintenance probes were conducted for the most effective procedure's stimuli after a participant reached the training criterion. Maintenance probes consisted of presenting trials starting at the longest delay (i.e., 3 s) and followed the probe schedule described below.

Within-session time delay. During the within-session progressive time delay procedure, a correct response increased the delay of the controlling prompt for the next trial with that specific word by 1 s. The assistant provided a vocal model of the target word as the controlling prompt. An incorrect response reduced the delay of the controlling prompt for the next trial with that specific word by 1 s. For example, trial 1 = 0 s delay (correct response); trial 2 = 1 s delay (correct response); trial 3 = 2 s delay (incorrect response); and trial 4 = 1 s delay (correct response).

Across-session time delay. In the across-session progressive time delay procedure, the timing of the controlling prompt was increased 1 s after each training session. For example, session 1 = 0 s delay; session 2 = 1 s delay; session 3 = 2 s delay; and session 4 = 3 s delay. The delay interval for the controlling prompt during the across-session procedure was never decreased.

The treatment comparison phase continued until a participant responded with 100% accuracy (i.e., 20 of 20 correct) for three consecutive probe sessions with one set of words. (This also defined transfer of stimulus control for this study, defined as the child correctly and independently responding to the discriminative stimulus with or without the instructional cue to all words for 60 consecutive trials with the controlling prompt never being delivered). Once the most effective procedure (i.e., across- or within- session) was identified, this procedure was used to train the remaining stimuli and maintenance probes were conducted with the most effective procedure's words. The most effective procedure training phase continued until the participant responded at 100% accuracy (20 of 20 correct) for three consecutive probes.

Results

Words learned. Data presented in Figures 1, 2, and 3 and Table 2 show that the within-session progressive time delay procedure was the most effective technique for each participant. Across participants, the average number words correct per probe for the within- and across-session time delay procedures was 15.7 (range 13.8 to 19.5) and 5.0 (range 3.8 to 5.5) respectively. The number of sessions required for the participants to reach criterion for transfer of stimulus control (20 words read correctly for three consecutive probe sessions) without the controlling prompt using the within-session delay ranged from 4 (Marc) to 15 (Helen). No participant achieved the criterion using the across-session delay.

Data in Figures 1, 2, and 3 also show that the participants reached training criterion when the within-session progressive time delay procedure was applied to the second set of words. During the most effective treatment phase, the average number words correct per probe for words trained with the within-session procedures during maintenance and for words initially trained with the across-session delay procedures was 19.7 (range 19.3 to 20.0) and 15.6 (range 13.6 to 17.4) respectively. The number of sessions required for the participants to reach criterion for words initially trained with the across-session delay procedures ranged from 6 (Teresa) to 11 (Marc).

Training errors. Table 3 illustrates the percentage of trials with errors committed during training. The percentage of trials with errors also favored the within-session progressive time delay procedure for all participants with more errors committed during the across-session procedures. The average percentage of errors committed across participants during the alternating treatment phase for the within- and across-session procedures were 8.6% (range 4% to 18%) and 30.8% (range 22% to 42%), respectively.

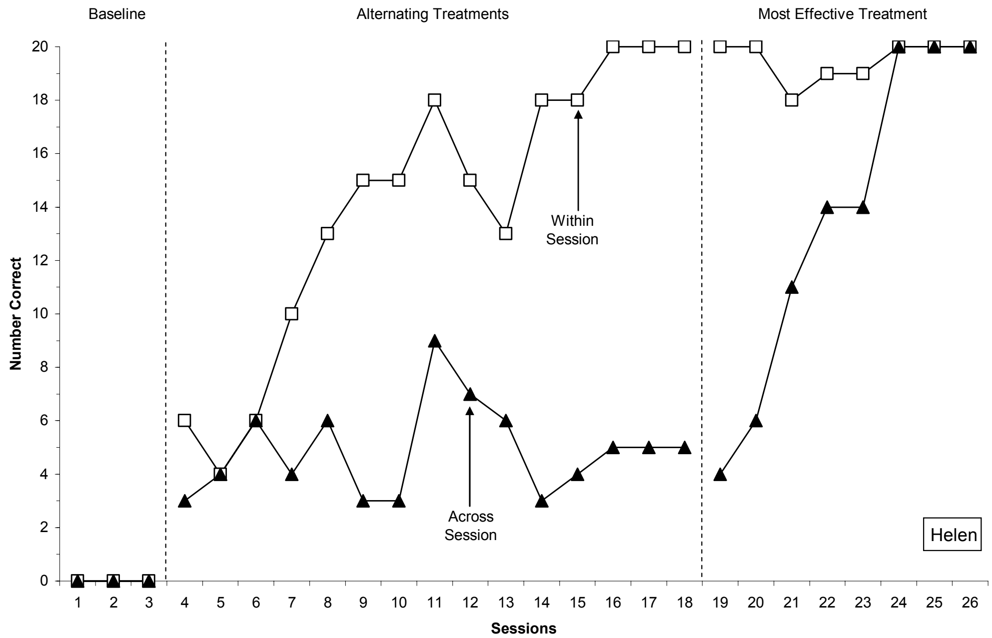

Figure 1. Number of words correct per probe during baseline, alternating treatments, and most effective treatment phases for Helen and Marc.

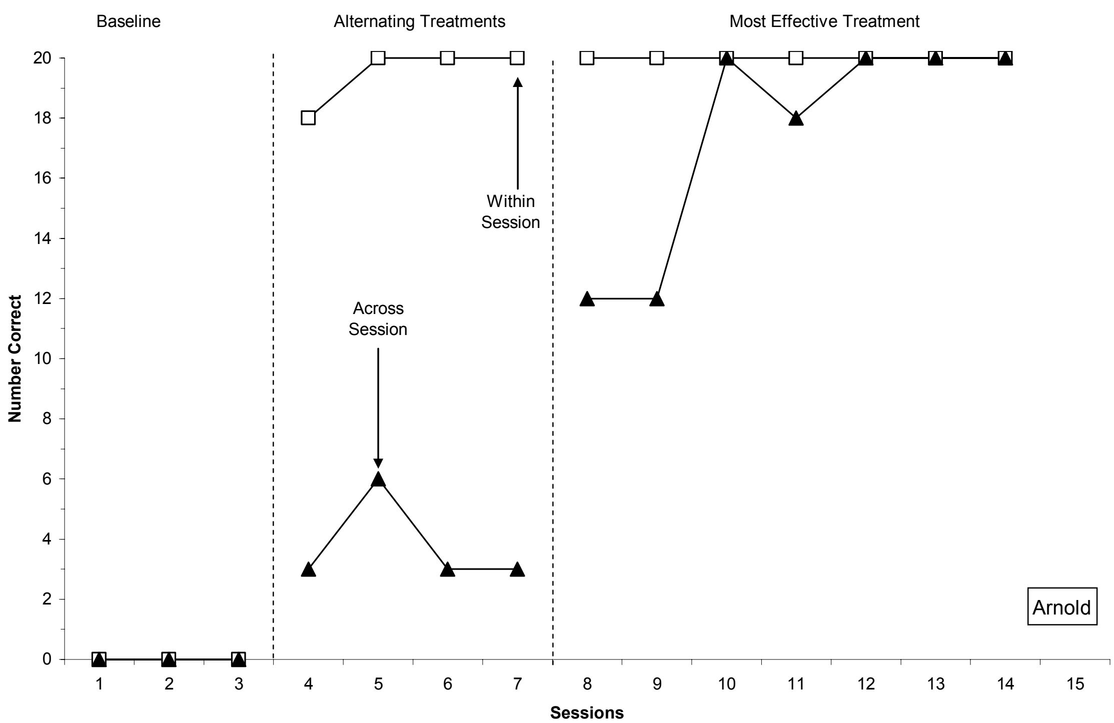

Figure 2. Number of words correct per probe during baseline, alternating treatments, and most effective treatment phases for Arnold and Teresa.

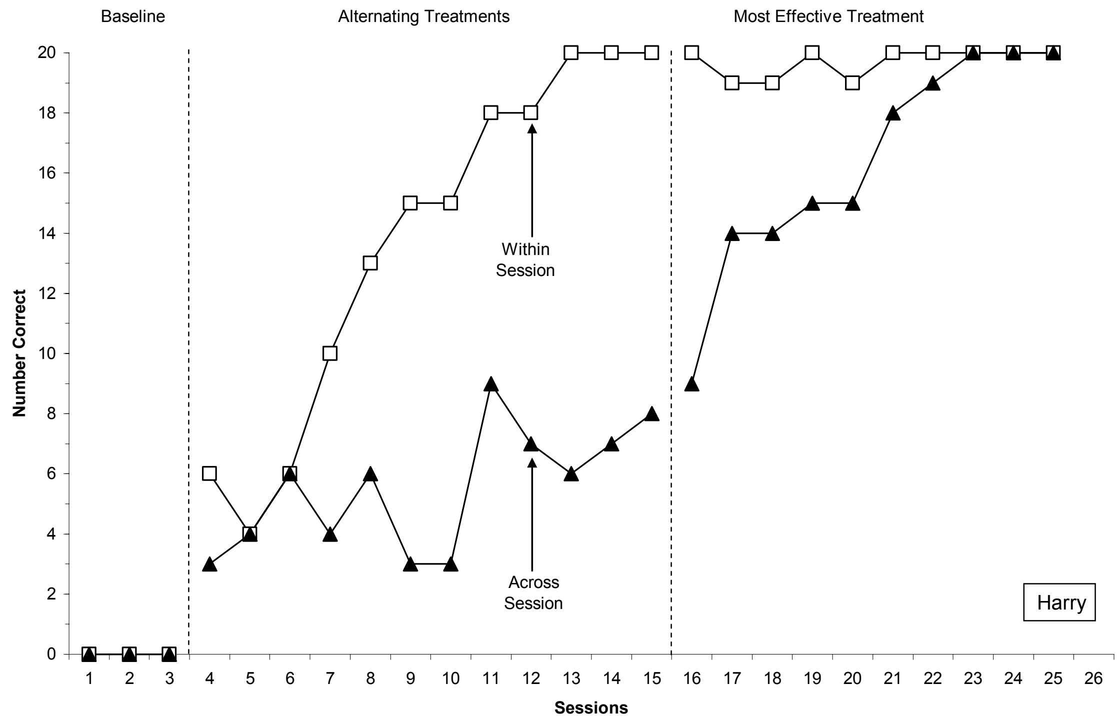

Figure 3. Number of words correct per probe during baseline, alternating treatments, and most effective treatment phases for Harry.

Table 2

Average Number of Correct Responses and Number of Sessions to Criterion per Probe for Within- and Across-Session Delay Procedures

	Alternating Treatments		Most Effective Treatment	
Participant	Within-Session	Across-Session	Within-Session	Across-Session
Helen	14.0 (15)	4.9	19.5	13.6 (8)
Marc	13.9 (13)	4.8	19.3	14.3 (11)
Arnold	19.5 (4)	5.5	20.0	17.4 (7)
Teresa	17.3 (7)	4.6	20.0	16.3 (6)
Harry	13.8	5.5	19.7	16.4

	(12)			(10)

Note: Numbers in parentheses depict sessions to criterion

Table 3

Average Number of Errors per Probe for Within- and Across- Session Delay Procedures during Alternating Treatments Analysis

Participant	Within-Session	Across-Session
Helen	4%	42%
Marc	18%	34%
Arnold	10%	31%
Teresa	5%	25%
Harry	6%	22%

Discussion

Two variations of a progressive time delay procedure, a within- and an across-session for teaching participants with cognitive delays oral reading of sight words were evaluated. Results showed that during the alternating treatments phase, the within-session time delay procedure was the more effective procedure for all participants in terms of number correct and errors committed. More importantly, all participants reached criterion when the within-session time delay procedures were used to teach the words initially associated with the across-session time delay procedures. Additionally, procedural integrity data showed little difference between the two procedures regarding the number of assistant errors.

These results advance the literature on the use of within-session progressive time delay procedures as an effective means to teach sight words to children with cognitive delays in several ways. First, while most implementations of progressive time delay procedures alter when the controlling prompt is delivered *across* sessions based on when advancement criterion are met, this investigation demonstrated success using a within-session progressive time delay procedure that was effective for all 5 children with two sets of word lists. A total of 4 to 15 sessions across participants were needed to achieve the stringent criteria for transfer of stimulus control (i.e., three consecutive sessions of 100% independent responding) with the initial set of words and 6 to 11 sessions for the other set of words initially exposed to the across-session progressive time delay procedures. Other researchers have defined transfer of stimulus control less stringently. Walker (2008, p. 270), for instance defines the transfer of stimulus control as “the point at which the percentage of unprompted correct responses exceeded the percentage of other responses”. Walker reported that in previous studies transfer of stimulus control was achieved in an average of 4.0 sessions (range 2 to 7 sessions) across four studies. The within-session procedures in the currently study met this threshold in an average of 2.6 sessions (range 1 to 4 sessions) and for the second set of words in an average of 1.8 sessions (range 1 to 3 sessions) across participants. Comparisons between the within-session progressive time delay procedures used herein with across-session progressive time delay procedures in other studies using similar procedures and stimuli were not conducted directed, so the positive results of the within-session progressive time delay procedures used herein must be tempered with that limitation. Future investigations are needed to further delineate such differences.

Second, the across-session progressive time delay procedure was ineffective altogether which fails to support the utility of response independent procedures demonstrated by Ingenmey and Van Houten (1991). It should be noted, however, that there were procedural differences used herein versus those in the Ingenmey and Van Houten investigation. In Ingenmy & Van Houten, the first session contained both 2 s delays and 4 s delays which occurred for the first and second set of eight trials. In the second session the 6 s and 8 s delays were distributed in a similar manner with 6 s delays occurring for the first eight trials and 8 s delays for the next eight trials, and in the third and subsequent sessions all trials were at a 10 s delay. For procedural simplicity, the same time delay parameter was used for the entire session and the delay was advanced progressively similarly to that of the within-session time delay procedure. That is, in the first session there was a 0 s delay, then in second session there was a 1 s delay, in third session a 2 s delay, and for all remaining sessions a 3 s delay was in place. Thus, shorter delay intervals were evaluated herein. There were also differences in the dependent measures evaluated in the Ingenmey and Van Houten study. In Ingenmey and Van Houten, the dependent variable was spontaneous speech, whereas, for the participants in the current investigation the dependent variable was sight words read correctly. Thus, it is possible that response independent progressive time delay procedures are successful for increasing the spontaneous speech (which may already be a behavior in the participant's repertoire) but are less effective with teaching correct responses to words on flashcards of words that are unknown by the participant. Despite these procedural differences the participants of the current study were unable to learn the list of words using progressive time delay procedures with a response independent advancement criterion. It is possible that the across-session time delay procedure may have eventually been effective if the phase was carried out longer (i.e., there were slight upward trends for Marc, Teresa, and Harry associated with these procedures). Still, the results of this investigation preclude the conclusion that response independent time delay procedures are ineffective altogether and future research is needed to assess potential differences using various discriminative stimuli, different dependent measures (e.g., reading, sign language, task completion, etc.), longer delay intervals, and various criteria for advancing the delay intervals to the delivery of the controlling prompt.

The results of the student response patterns bear noting. For Arnold and Teresa, once the within-session delay procedures were implemented, fairly quick learning curves were obtained. Notably, each child reached 100% correct in 2 and 3 sessions respectively, compared to the other 3 participants who reach the same percentage for the first time 10-13 sessions into the analysis. In both cases, it appeared that once the word was learned the participant was able to quickly discriminate what the word was during probes. In fact, one participant would often state the correct answer before the end of the instructional cue even at the 0 s delay. Meanwhile, for the across-session progressive time delay procedure some participants were regularly reading one word correctly, however despite receiving the correct word with 0 s delays, some participants would often, despite the controlling prompt, respond pre-maturely, state incorrect answers, use the same response for all stimuli, state they didn't know or ask again what the answer was (which was never repeated). The within-session time delay procedures may have some appeal for participants that impulsively respond to the discriminative stimuli as was the case for two participants in the current study (Arnold and Teresa), because all sessions started with a 0 s delay (until maintenance). Anecdotally, it did appear that the latency to respond was greater during the within-session time delay procedure relative to the across-session time delay procedure. Future research may evaluate errors and latency with greater detail which may be useful for prescribing specific time delay procedures to maximize success.

A plausible explanation for the substantial differences in the procedures' effectiveness is the establishment of stimulus control. When the intended discriminative stimulus fails to control a response, supplemental stimuli (i.e., controlling prompts) may be added to facilitate the development of stimulus control. Typically, these prompts are gradually faded to transfer stimulus control from the controlling prompt to the intended naturally occurring discriminative stimulus (with or without instructional cues). Prompts are gradually/progressively faded as reliable responding is observed at each respective delay in time between the delivery of the discriminative stimulus and the controlling prompt (i.e., after stimulus control is established at a particular prompt delay). In this study, the criterion for advancement in seconds for the within-session progressive time delay procedure was based on correct responding, that is, the development of stimulus control at a particular prompt delay (e.g., Taylor & Harris, 1995). In contrast, for the across-session progressive time delay procedure a predetermined number of trials at a particular prompt delay without regard to correct responding was used (e.g., Ingenmey & Van Houten, 1991). Therefore, stimulus control may not have been established using the across-session procedures (for a particular prompt delay) prior to advancing the prompt delay which is a plausible explanation for that specific procedures' failure.

The findings of the current study highlight the importance of selecting appropriate time delay procedures. Given the effectiveness of time delay, a teachers' natural inclination may be to adapt the procedures to their instructional situation and for ease of implementation. Thus, the across session time delay procedures were easier to implement, but were nonetheless ineffective. Interestingly, this was the teachers preferred method of implementing time delay which highlights the importance of the research to practice gap that is often evident in standard teaching practices. In adapting a procedure without regard to the underlying mechanism(s) that accounts for its effectiveness, teachers run the risk of implementing an ineffective procedures and losing precious teaching time. Though additional research is still needed however, the within-session time delay procedures appear to have promise in applied classroom settings.

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