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Assessing the Differential Outcomes Procedure with Children Diagnosed with Autism

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ASSESSING THE DIFFERENTIAL OUTCOMES PROCEDURE WITH CHILDREN DIAGNOSED WITH AUTISM

by

Ivy M. Chong

A Dissertation
Submitted to the
Faculty of The Graduate College
in partial fulfillment of the
requirements for the
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Department of Psychology

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Ivy M. Chong
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INTRODUCTION

The *differential outcomes effect* (DOE) refers to the phenomenon whereby discrimination learning is enhanced when a correct response to a specific sample stimulus is followed by its own unique outcome (Savage, 2001). For example, Estevez, Fuentes, Overmier, and Gonzalez (2003) taught children and adults diagnosed with Down Syndrome a conditional discrimination task in which correct responding to stimulus A was consequated with red tokens (traded for edibles) and correct responding to stimulus B was consequated with green tokens (traded for brief access to toys). The authors found that all participants showed better terminal accuracy and maintenance of the conditional relations when unique outcomes were arranged for correct responding. This method of arranging unique outcomes for stimulus-specific correct responses is referred to as the differential outcomes procedure (DOP).

The DOE has been consistently demonstrated in the literature for over 30 years (see Goeters, Blakely, & Poling, 1992, for a review). Dozens of studies have been published on the DOE, which has been demonstrated with various consequences, such as edibles (Alling, Nickel, & Poling, 1991), water (Brodigan & Peterson, 1976), avoidance of shock (Overmier, Bull, & Trapold, 1971), and toys (Saunders & Sailor, 1979). The DOE has also been demonstrated with identical consequences delivered at different delays (Carlson & Wielkiewicz, 1972) and magnitudes (Carlson & Wielkiewicz, 1976). The DOE is remarkably general, having been demonstrated with several different species and human populations including chickens (Poling, Temple, & Foster, 1996), dogs (Carlson & Wielkiewicz, 1976), horses (Miyashita, Nakajima, & Imada, 2000), pigeons (Kelly & Grant, 2001; Peterson, Linwick, & Overmier, 1987; Peterson, Wheeler, &
In one of the earliest demonstrations of the DOE, Trapold (1970) presented a matching-to-sample discrimination task to rats, where the correct response in the presence of one stimulus produced food pellets and a correct response in the presence of a second stimulus produced a sucrose solution. Specific outcomes for stimulus-specific responses led to a quicker rate of acquisition and greater terminal accuracy compared to the same outcome for correct responses on both stimuli. This early demonstration of the DOE has led to further investigations and analyses of the phenomenon over the last several decades.

In a review of the empirical literature on the DOE, Goeters et al. (1992) identified 31 nonhuman studies examining whether stimulus-specific outcomes facilitated learning on discrimination tasks, such as matching-to-sample. A review of the database PsychInfo® shows that 22 additional studies have been added to the basic literature over the last decade, further demonstrating the robustness of the DOE.

Perhaps as a result of the numerous and reliable demonstrations of the phenomenon, a shift has occurred in the focus of research related to the DOE. Early
research served three objectives: 1) to test the reliability of the DOE; 2) to refine the DOP; and 3) to understand the underlying mechanism responsible for the DOE. More recently, researchers have investigated the clinical utility of the DOE. For example, Savage (2001) demonstrated that the DOE reduced and/or eliminated learning and remembering impairments associated with animal models of amnesia and dementia (Savage, 2001). In this particular study, the DOE was used with older rats to bridge gaps in learning times. Although the time required to acquire discriminations can be longer for older rats, the DOP increased acquisition rates to those of younger rats without the use of the DOP.

Despite the varying investigative purposes of previous studies, there are commonalities to each. First, all studies employed the discrete-trial (i.e., restricted operant) format as their primary teaching strategy. Second, the general procedures that were most commonly used were variations of matching-to-sample (MTS) tasks or two-choice conditional discriminations (see below for a description of each). Finally, the majority of studies incorporated the use of edibles as, at least, one of the consequences for correct responding to at least one of the controlling stimuli.

Before considering specific studies, the aforementioned general procedures used to examine the DOE will be described. The procedure most commonly applied in the study of the DOE has been the MTS task within a discrete-trial training procedure. The MTS procedure typically begins with the presentation of a single stimulus—the sample stimulus—(e.g., tone, flash of light, color or symbol), which is then followed by the presentation of at least two stimuli—the comparison stimuli. Additionally, each comparison stimulus has a designated response. One of the comparison stimuli may be
identical to the sample stimulus (identity matching) or physically dissimilar to the initial presentation stimulus (non-identity matching or symbolic matching). An example of the former might include presenting a green light, which is then followed by the presentation of comparison stimuli, such as the flash of green and a flash of red, each of which is paired with a specific response. The correct response to this task would involve pressing the lever that is associated with the flash of green light. In the latter procedure (non-identity matching), the initial presentation stimulus may again be a flash of a green light, but this time, the comparison stimuli may include textual comparisons, such as the word *GREEN* and the word *RED*. For this problem, the correct response would be to emit the response that was paired with the textual prompt *GREEN*. Finally, it should be noted that a common variation in the MTS task is the inclusion of a time-delay between the offset of the initial sample stimulus and the onset of the comparison stimuli (Goeters et al., 1992).

In two studies conducted by Overmier and colleagues (Linwick, Overmier, Peterson, & Mertens, 1988; Peterson, Linwick, & Overmier, 1987), 31 pigeons were exposed to two-choice conditional discrimination tasks in which the onset of the comparison stimuli began as long as 32 s after the offset of the initial sample stimulus. For both of these studies, a between-subjects design was employed in which half of the subjects were assigned to the differential outcomes group, where food was presented for correct responding on stimulus 1 and a hopper light (conditioned reinforcer) was presented for correct responding on stimulus 2. For the remaining subjects (nondifferential outcomes), correct responding on both stimuli was conseuated with food or a flash of a hopper light on a randomized schedule. Subjects with the differential outcomes group learned the two discriminations faster than the subjects in the
nondifferential outcomes group, as measured by percentage of correct trials. Interestingly, when the delay interval was increased to 32 s, terminal accuracy for the differential outcomes group was significantly higher than for the nondifferential outcomes group.

Another procedure commonly used to examine the DOE is the successive discrimination task. For this type of task, one of two stimuli is typically presented at the onset of a trial. Then, depending on the stimulus that is presented, one of two (or more) response classes may be reinforced. In an early study conducted by Overmier et al. (1971), three groups of mongrel dogs were exposed to a successive discrimination task in which correct responding led to the avoidance of an electric shock. The task involved the presentation of one of two tones (275 vs. 2,300 Hz) that was paired with either a right lever or left lever that was, in turn, correlated with either a pulsating or a constant shock. The subjects were taught to avoid the electric shock by emitting response 1 within 10 s of the offset of stimulus 1 and emitting response 2 within 10 s of the offset of stimulus 2. If the subject failed to press the lever correlated with the sample stimulus, the electric shock came on and was not terminated until the correct response was made (maximum shock duration = 30 s). Both experimental groups (differential outcomes) learned the discrimination task more rapidly than the control group (nondifferential outcomes; sample stimuli equally signaled pulsating or constant shock).

With the exception of one study (Santi & Savich, 1985), all studies using nonhuman subjects demonstrated that rate of acquisition and terminal accuracy were greater when differential outcomes were arranged for stimuli-specific responses. Nonetheless, it is important to note that some studies did not produce statistically
significant effects (on acquisition rates or terminal accuracy) of the DOE under certain situations (e.g., Peterson et al., 1980; Williams et al., 1990). For example, a control group (i.e., nondifferential outcomes group) may demonstrate high accuracy when a delayed-matching-to-sample [DMTS] procedure uses an extremely short or no delay. According to Goeters et al. (1992), undifferentiated results may indicate the presence of a ceiling effect. Increasing task difficulty should attenuate these ceiling effects. As a result, it is clear that when delay values are increased, the superiority of the differential outcome procedure becomes apparent and significant group differences are observed, thereby lending support to the DOE and its ability to withstand disruptions in the temporal contiguity between sample and comparison stimuli. A resistance to temporal disruption is quite valuable to applied work because most learning environments, such as classrooms, present logistical limitations that make delays in presentation or delivery of stimuli a common occurrence.

In an interesting variation of the DMTS task, Poling et al. (1996) used a titrating delayed-matching-to-sample (TDMTS) procedure to examine the DOE with 6 domestic chickens. With the TDMTS procedure, correct responding increased the delay between the offset of a sample stimulus and the onset of comparison stimuli. Incorrect responding decreased the delay between the offset of the sample stimulus and the presentation of the comparison stimuli and produced a 12.5-s intertrial interval. Illuminated keys (red and green) were used as sample and comparison stimuli, and correct responses were consequated with one of two durations of food delivery (1 or 4 s). The delay began at 0 s for all sessions of both DOP and NOP. The authors found that under the DOP condition, when 1- or 4-s grain delivery was correlated with a specific stimulus the maximum delay
(30.8 s vs. 22.4 & 25.6 s for the experimental group and control groups, respectively) reached by the chickens and their terminal accuracy (90% vs. 77.7% & 85.6%) was significantly higher than when the duration of the food deliveries was randomly arranged for correct responses during the NOP condition. According to the authors, the TDMTS procedure may be superior to the conventional DMTS task, because the aforementioned 'ceiling' effects are typically not observed with the procedure.

**Human Research on the DOE**

Although demonstrations of the DOE have been documented in the applied literature (e.g., Estevez et al., 2003; Joseph, Overmier, & Thompson, 1997; Maki, Overmier, Delos, & Gutmann, 1995), the use of the DOP as a learning tool has not been as extensively evaluated. A recent review of the PsycINFO® database revealed only 12 human studies using the descriptors “differential outcomes effect,” differential outcomes procedure,” “stimulus-specific outcomes,” and “stimulus-specific rewards”. With the exception of one study (i.e., Dube, Rocco, & McIvane, 1989), research with human participants has generally supported the DOE. However, it is important to note that the DOE varies considerably across conditions and participants and terminal accuracy is not always higher (e.g., Malanga & Poling, 1992) or more quickly achieved (e.g., Litt & Schreibmen, 1981) when the DOP is arranged.

As in the animal literature, research with human participants has primarily used the discrete-trial training format with conditional discrimination tasks. Two-choice conditional discrimination tasks have been the most commonly used procedure. In one of the earliest empirically sound studies, Saunders and Sailor (1979) compared three arrangements of reinforcement with three participants ($M = 10$ yrs) diagnosed with severe
mental retardation. The authors used a two-choice conditional discrimination task in which participants were asked to point to one of two toys when given its name. In the condition the authors described as 'specific reinforcement,' correct choices were consequtated with the opportunity to play with the toy to which the child pointed. In the 'nonspecific reinforcement' condition, the participant was offered a toy by the experimenter that was not a part of the training pair. Finally, in the variable reinforcement condition, the participant was offered one of two toys (from the training pair) on a random basis. The results showed higher correct responding under the specific reinforcement condition than under either of the other two conditions.

In a study conducted by Litt and Schreibman (1981), 6 children diagnosed with autism were taught 3 pairs of object labels successively across 3 separate training conditions. For half of the participants, condition 1 consisted of differential outcomes, condition 2 nondifferential outcomes, and condition 3 differential outcomes. For the remaining participants, condition 1 consisted of nondifferential outcomes, condition 2 differential outcomes, and condition 3 nondifferential outcomes. Data were presented for 5 participants because one failed to acquire the first pair of object labels after 500 trials. For 3 of the 5 children, the average number of trials required to reach criterion was lower when the reinforcer-specific condition was in place. However, for the remaining participants, the average number of trials to reach criterion was equal across reinforcer-specific and varied conditions. The authors attribute the latter findings to a ceiling effect. Based on the results of the three children who acquired the labels more quickly under the reinforcer-specific condition, it was concluded that the rate of acquisition increases as the correlation between the discriminative stimulus and reinforcer increases.
To extend DOE research to adults with mental retardation, Malanga and Poling (1992) examined the effect of the DOP on letter recognition. Four participants were taught to identify American Sign Language (ASL) letters in successive pairs across two conditions (i.e., DOP, NOP). Under the DOP, a correct response to one letter produced food and a correct response to the other produced verbal praise. Under the NOP, a correct response to either letter in the pair produced food or verbal praise equally and randomly across both letters. Overall, the terminal accuracy was greater under the DOP. However, upon closer examination, the accuracy of individual participants varied across conditions and was not always higher when the DOP was arranged.

More recently, investigations on the DOE have focused on extending previous findings to other populations. For example, Joseph et al. (1997) examined the use of the DOP on the acquisition of arbitrary conditional discriminations with adults diagnosed with Prader-Willi syndrome. Specifically, the participants were taught to match arbitrary geometric symbols presented on a computer screen. Under the DOP, correct matches were followed by one of two distinctive visual displays, one of two distinctive musical phrases, and a token. Under the NOP, correct matches were followed equally by one of two different visual displays, musical phrases, and tokens. The authors reported that the use of the DOP enhanced equivalence class formation. Nonetheless, it is important to note that the effect was not seen for one participant. In similar study, Estevez et al. (2003) examined the effect of the DOP on the acquisition of a delayed symbolic matching-to-sample task with 24 children and adults diagnosed with Down syndrome. Under the DOP, correct matches were followed by a red or green token. Under the NOP, participants received quasi-random rewards of either red or green tokens. Statistical
analysis indicated that participants showed better overall accuracy and learned the conditional discrimination task faster when the DOP was in effect.

Additionally, several studies have attempted to investigate the underlying mechanisms of the DOE using typically developing children as participants. For example, Maki et al. (1995) conducted three experiments with 45 children ranging in age between 4 to 6 years. The three experiments had two aims: to replicate previous findings of the DOE and to assess participants’ ‘expectancies’ for the specific rewards and whether this served any functional significance. As expected, the DOE was observed and participants receiving differential outcomes for correct responding performed significantly better following training than participants who received nondifferential outcomes (they typically scored at chance level after training). Additionally, those participants receiving differential outcomes were able to tact the pre-established stimulus-specific consequence relation after training. Although the authors stated that this did not demonstrate a causal relation between expectancy and the DOE, they suggested that more direct evidence was provided during their second and third experiments. During experiments 2 and 3, the authors implemented a ‘transfer of control’ procedure, which, according to the authors, substantiated previous claims that expectancy did, in fact, lead to correct responding on sample stimuli associated with the DOP.

Specifically, Maki et al. (1995) observed participants (who were initially exposed to differential outcomes) to continue to perform better on tests with new sample stimuli, where correct responding had not been previously rewarded. The transfer of control procedure involved two training phases: (1) a phase in which stimuli were paired with particular rewards (conditioning phase), and (2) a phase in which correct responding to a
sample stimulus for a discrimination task was correlated with a specific reward (learning phase). In the transfer of control ‘test’, a sample stimulus that was initially paired with a specific reward (but not used in the second phase of the training procedure) served as the sample stimulus during a second discrimination test. The same two response options were used for this transfer test as in the original discrimination task. According to the authors, the pairing of the stimulus with a specific reward in the initial phase leads to an ‘expectancy’ for the particular consequence with which it was paired, and that this expectancy ‘guided’ the selection of the response. Results were interpreted as evidence that participants’ expectancies guide choice making, thereby gaining control of the correct response (i.e., expectancy theory). It is noteworthy to mention that Estevez et al. (2003) who used a similar procedure with typically developing children reported similar results. However, Estevez et al. (2003) reported that expectancy theory did not appear to be a sufficient account for increased accuracy of responding (see below).

It is important to note the inconsistencies in the demonstration of the DOE with human participants. As previously mentioned, the DOE has not been consistently evident across participants (e.g., Malanga & Poling, 1992). For example, in a study conducted by Dube et al. (1989), four adults diagnosed with mental retardation were exposed to a DTMS procedure. The DTMS procedure used in this study was similar to those used in studies with nonhuman subjects and included delays between 0 to 7 s. For three of the participants, correct responding was similar for both differential and nondifferential outcomes. For the final participant, correct responding increased across sessions, irrespective of outcome condition. Since generalized matching-to-sample was an entry skill required for all participants, it may be argued that a “ceiling effect” may have
occurred. However, this is not the case, as elevated responding in the nondifferential outcomes condition was not observed. The authors cited the absence of a prearranged motivational variable as a possible methodological flaw. In previous studies using nonhuman organisms as subjects and employing similar MTS procedures, the subjects were food deprived. However, in the current study, the human participants were not. As such, Dube et al. argued that perhaps food deprivation is a variable that may contribute to the emergence of the DOE. However, the DOE has been demonstrated in some studies with non-deprived human participants (e.g., Litt & Schreibman, 1981). Finally, Dube et al. speculated that perhaps, “human and nonhuman organisms may perform the identity matching-to-sample task in a qualitatively different way” (p. 489), since humans are able to acquire generalized matching-to-sample (Holth, 2003), while pigeons are not.

Theoretical Analysis of the DOE

It is important to note that both theoretical accounts described next are quite similar. However, although it might appear that they differ only at a semantic level, the latter account is more parsimonious and less mentalistic and, thus, more compatible with a behavior-analytic paradigm.

Expectancy Theory. According to Peterson and colleagues (1980), learned expectancy is the basis of the DOE. A learned expectancy is assumed to result from the stimulus-stimulus pairings, thereby providing an additional discriminative stimulus (cue). That is, when a response ($S_A$) is predictably followed by a specific reward ($S_B$), $S_A$ will come to elicit a learned response or an expectancy of the specific reward that it has been correlated with (i.e., $E_B$; Peterson & Trapold, 1980). It should be noted here that an
organism’s behavior often can serve as a discriminative stimulus for other behavior, as in *behavioral chains* (Martin & Pear, 2003).

According to Brodigan and Peterson (1976), response topography can differ depending on the specific reward that is correlated with a sample stimulus. For example, when water is produced for correct responding on a specific stimulus, pigeons’ key pecks can more closely approximate that of a drinking response (slow, sustained key contacts). However, when food is associated with a specific sample-stimulus, the key pecks may be sharp and open, which more closely approximates a response topography associated with food. According to Brodigan and Peterson, these differential response forms support the expectancy theory account of the DOE.

Peterson et al. (1980) state that *expectancies* may include overt behaviors and private events. As such, they help to enhance the distinctiveness of test stimuli. For example in the aforementioned study conducted by Maki et al. (1995), correct responses on a conditional discrimination task were consequated with red or green tokens. Across successive experiments, the authors claimed to demonstrate that learned expectancies were used “to guide choice responding in [a] novel conditional discrimination” (p. 66). The authors attributed the increased rate of acquisition across experiments to a learned expectancy that had been developed initially during experiment 1. The authors stated “the pairing stimulus assume[s] immediate control over the selection of the choice stimulus by virtue (a) of the paired stimulus and the discriminative stimulus’s shared association with the same reinforcer and (b) their shared capacity to evoke an expectation of that reinforcer” (p. 68). Through this process, termed *inter-problem transfer of control*, participants were ‘guided’ in making correct choices for the novel conditional
discrimination tasks. Although this was the first study to employ the use of a transfer of control procedure with human participants, these authors are not alone in suggesting that expectancy mediates the DOE (e.g., Maki et al., 1995; Overmier & Linwick, 2001; Savage, 2001). However, the term “expectancy” is problematic because it is a construct; it internalizes sources of control and it may lead to circular explanations. Furthermore, with any mediational account of behavior, the mediating agent (in this case, expectancy) must still be explained.

Behavioral Theory. From the radical behavioral perspective of B.F. Skinner, the common practice of looking inside the organism to locate the cause of behavior tends to obscure the independent variables that are readily available for analysis (Skinner, 1974). Goeters et al. (1992) provided a concise summary of what has been empirically observed in studies on the DOE. Given the absence of direct experimental demonstrations of expectancy as a necessary component in the account of the DOE, to explain the phenomenon by appealing to such a mentalistic description would add nothing to the explanation except a postulated process that itself requires an explanation.

According to Goeters et al. (1992), expectancy is not a necessary component in describing the DOE. Instead, the authors stated that it is plausible that “an organism’s own behavior can serve a discriminative stimulus function” (p. 400). For example, discriminative stimuli that are correlated with food may produce private events such as salivation that have much different stimulus properties than those correlated with water (Goeters et al.). Though it may not be possible to detect private events experimentally, they are nonetheless present and may play a respondent role in the mediation of a response established with the DOP. Although there does not appear to be a consensus as
to how the DOE is best explained, the analysis of Goeters et al. suggests that respondent
and operant relations appear to be sufficient in mediating the DOE. However, to date, no
behavioral account has been provided to address the fact that the DOE has been
demonstrated with secondary reinforcers, which should not differentially elicit private
stimuli.

Irrespective of differences in the explanations of the DOE, results of previous
studies suggest the DOP as a reasonable method to facilitate acquisition and maintenance
of conditional discriminations. However, given the limited findings with human
participants, especially those with developmental disabilities, further investigation is
warranted to identify participant and task characteristics for which the DOP is most
efficacious. In particular, the DOP may be a useful method to improve the discriminative
learning of children diagnosed with autism who typically, have difficulty acquiring these
discriminations.

The Behavioral Treatment of Autism

According to the Diagnostic and Statistical Manual of Mental Disorders (4th ed.;
American Psychiatric Association, 1994), pervasive developmental disorders, including
autistic disorder and pervasive developmental disorder – not otherwise specified (PDD-
NOS), are typically characterized by marked impairments in multiple areas of
development. These areas of impaired development include: a) reciprocal social
interaction, b) communicative skills, c) the presence of stereotypical or repetitive
behaviors, and d) a limited range of interests. These pervasive developmental disorders
are first diagnosed in early childhood and their prevalence is approximately 5-15 per
10,000 children (Howlin, 1997).
Although the specific etiologies of the pervasive developmental disorders are still largely unknown, from a behavioral perspective, autism is "a syndrome of behavioral deficits and excesses that have a neurological basis," but is subject to change with highly specific, structured, and intensive training (Green, 1996, p. 29). To date, the most dramatic changes occur when children receive early and intensive behavioral intervention. Early behavioral intervention is based on a fundamental tenet of operant conditioning; namely, behavior is primarily governed by its consequences (Skinner, 1953). In early behavioral intervention, procedures based on basic behavioral principles (e.g., reinforcement, stimulus control, extinction) are used to increase appropriate behaviors and reduce aberrant behaviors within various areas.

In the absence of treatment, most children diagnosed with autism fail to learn how to communicate vocally; they may only produce nonsensical speech or may be completely mute. Several behavioral programs that aim at teaching children diagnosed with autism have emphasized strategies to improve vocal language, given the desirability of such a form of communication. Children who do not receive specialized treatment, and fail to learn vocal language, run the risk of living in more restricted residential placements during their adult lives. According to Howlin (1997), treatment and education are essential in minimizing behavioral problems and ensuring the development of existing skills. Nonetheless, only a small percentage of children diagnosed with autism will go on to lead typical adult lives (Howlin). This small percentage is disconcerting in the light of seminal studies in the field of autism suggesting that early intensive behavioral intervention may result in significant gains in overall level of functioning (e.g., Lovaas, 1987; McEachin, Smith, & Lovaas, 1993; Smith, 1999).
Further, early intensive behavioral intervention has been demonstrated to be successful in integrating children into general education classrooms and research suggests that approximately one third of all cases will achieve some level of independence (Green, 1999; Maurice, Green, & Luce, 1996).

Early behavioral intervention typically involves a structured curriculum that is developmentally sequenced. As such, easier skills are taught first and may include proper sitting, proper attending, non-vocal imitation, matching-to-sample, following instructions, vocal imitation, play/social skills, and object identification (e.g., Leaf & McEachin, 1999; Lovaas, 1981, Maurice et al., 1996). It has been hypothesized that the combination of a hierarchical curriculum, an increased number of learning opportunities, the use of discrete-trial training, and the deliberate programming of consequences has led to the success of children diagnosed with autism who receive this type of therapy (Maurice et al.).

In one of the first investigations in the behavioral intervention literature, Ferster and DeMyer (1962) conducted a series of studies in which three children diagnosed with autism received reinforcement for engaging in simple behaviors, such as matching-to-sample. The authors found that training in an experimental setting led to significant positive changes in the children's repertoires. According to Lovaas, Schreibman, and Koegel (1974), "these early studies were the first to show that the behavior of autistic children could be related in a lawful manner to certain explicit environmental changes" (p. 113).

Other studies have suggested that early intensive behavioral intervention can result in significant improvement to overall level of functioning such as improved
intellectual abilities as measured by standardized tests or developmental scales (Lovaas, 1987; Lovaas et al., 1974; McEachin et al., 1993). In a seminal study conducted by Lovaas (1987), 19 children diagnosed with autism received 40 or more hours per week of one-to-one behavioral treatment from trained undergraduate students. A control group of 19 comparable children received 10 or fewer hours of similar treatment, while a second control group of 21 children were treated in other programs. It was reported that 90% of the experimental group made improvements on measures of intellectual ability. Moreover, 47% of the experimental group of children was found to achieve IQs in the "normal" intellectual functioning range after treatment. In a follow-up study conducted by Lovaas and colleagues, 42% of the children from the original treatment group were found to maintain significant, long-lasting gains, which led to less restrictive educational placements (McEachin et al.).

For all behavioral models, the intervention appears to be most beneficial when it starts early, between the ages of 2 and 4 years (e.g., Fenske, Zalenski, Krantz, & McClannahan, 1985), and when the intervention is intensive. The most commonly used training format is discrete-trial training (Lovaas, 1987), which can be presented in various ways (e.g., massed task, task interspersal). Some professionals (e.g., Maurice et al., 1996; Smith, 2001) have found that the presentation of new tasks in a massed- or continuous-trial format to be most effective, whereas others (e.g., Dunlap, 1984) have advocated interspersed-trial training (i.e., maintenance tasks are distributed with nonacquired tasks). Additionally, there is some controversy regarding the number of hours of intervention, which often varies from 15 (e.g., Hoyson, Jamieson, & Strain, 1984) to 40 hours per week (e.g., Lovaas, 1987). Nonetheless, the goal of the intervention...
is to present learning material in a repetitive and systematic format such that a child is able to practice the skill. Accordingly, early intervention programs are largely based on the presentation of numerous trials. It is not uncommon for 1000s of trials to be taught across a number of task areas within a day.

Despite the demonstrated effectiveness of early intervention, many of the children who receive behavioral treatment do not make significant gains (e.g., only 53% of participants from Lovaas, 1987). Thus, it is important to keep evaluating procedures to improve learning within such programs, even though they are superior to other types of interventions (e.g., sensory integration). Thus, the rationale for the current investigation is straightforward. Because the DOP has been shown to increase rate of acquisition and terminal accuracy in other populations, it may be an effective method to enhance early intervention programs for children diagnosed with autism, which typically employ the use of discrete trials to teach numerous discriminations. Thus, the purpose of the current study was to evaluate the DOP when teaching conditional discriminations to children diagnosed with autism.

EXPERIMENT 1

Method

Participants. Four participants who had a prior diagnosis of autism according to DSM-IV criteria (American Psychiatric Association, 1994) were included in the study. Brady was 5 years of age, Lake and Ava were 4 years of age, and Noah was 3 years old of age. Participants were assessed for the following prerequisite learning skills before admission into the study: responds to own name and instructor-delivered reinforcers, generalized non-vocal imitation, vocal imitation, and follows simple instructions, using
the Behavior Language Assessment\(^1\). These criteria were chosen to ensure that participants were able to work well for at least 5 min without disruptive behavior and could be taught using standard prompting procedures (e.g., prompting, modeling). Additionally, the *Scales of Independent Behavior-Revised (SIB-R) – Problem Behavior Scale*\(^\text{\textsuperscript{ii}}\) (Bruininks, Woodcock, Weatherman, & Hill, 1996) was also administered to ensure that the participants exhibited minimal problem behavior.

**Setting.** Sessions were conducted in a quiet area of each participant’s home. The therapist was seated either across from (Brady, Ava, & Noah) or adjacent to (Lake) the participant at a table, where all training trials took place. Most sessions were videotaped for subsequent data scoring purposes. The video camera was positioned in the room in the most unobtrusive manner possible. A trained observer, in addition to the therapist, was present for some of the sessions to collect data interobserver agreement (IOA) and treatment integrity data.

**Stimulus Preference Assessment.** Each participant began the experiment with a preference assessment. First, parents were asked to complete the Reinforcer Assessment for Individuals with Severe Disabilities (RAISD; Fisher, Piazza, Bowman, & Amari, 1996) to identify 8 to 10 preferred items (e.g., candy, chips, books). The RAISD is an interview designed to assess via caregiver report the preferences of nonverbal individuals with developmental disabilities. A paired-stimulus preference assessment (Fisher et al., 1992) was then conducted to identify a hierarchy of preferred items.

During the paired-stimulus preference assessment, a pair of items was placed in front of the participant. The participant was instructed to “Pick one.” When the participant chose one of the stimuli, he or she was allowed to consume the item (i.e., food
assessment) or given brief access to the item (i.e., toy assessment); the remaining item
was then removed. Another pair of items was then presented. This procedure was
repeated until all possible stimulus comparisons had been presented (and counterbalanced
for possible side bias) and a hierarchy of preferred items was determined.

To control for changing preferences throughout the study, a brief multiple-
stimulus (without replacement) preference assessment (MSWO; DeLeon & Iwata, 1996)
was conducted prior to the first session of the day for each participant. During the brief
MSWO assessment, the top 4-6 items identified from the paired-stimulus preference
assessment were placed in a row in front of the participant. The participant was then
prompted to select one item, after which brief access was provided before the item was
removed from the array. Following selection of the first item, the remaining items were
re-ordered and re-presented. These trials were conducted until all of the stimuli had been
selected and then the entire process was repeated two more times. At the conclusion of
each training session, participants were allowed to use their tokens to purchase the top
food or toy items identified by the preference assessment that day. Parents were also
instructed to restrict, as much as possible, delivering to their child food and toy items that
were used during the study.

Response Definition and Measurement. In this study, a task was defined as a
class of behavior consisting of several training exemplars. For example, for the task of
object labeling (i.e., tact training) exemplars might include the vocal responses of “car”
or “doll” in the presence of those respective items. Specific response definitions for each
exemplar depended on the tasks taught to each participant (see Table 1 for description of
examples of tasks). Responses were measured within a discrete-trial teaching format in
which the target exemplars were presented within blocks of 32 trials. One to two sessions were conducted each day, with a 5-10 min break provided between sessions. Each trial was scored as correct or incorrect. A trial was scored as correct when the response specified by the therapist’s request was independently emitted by the participant (i.e., not prompted by the therapist) within 3-5 s of the instruction. A trial was scored as incorrect when the participant did not respond, or the response was not the one specified by the therapist’s request. The percentage of correct responses during each session constituted the study’s primary dependent measure. The mastery criterion employed in the study was a score of 90% or greater across three consecutive sessions with the first trial of each session also scored as correct.

Tasks were selected with the consultation of the participant’s parent and program consultant. For the purpose of this study, tasks that have been identified in the research literature as generalized operants, such as matching and imitation, were not used (see Holth, 2003). Motor tasks were defined as tasks that required an observable motor (i.e., non-vocal) response only. The general procedure to teaching motor tasks involved presenting the target exemplar (e.g., ‘red’ color patch) along with one or more comparisons (e.g., ‘blue’ and ‘yellow’) while requesting the child to “Touch red.” The correct response (i.e., touching the ‘red’ color patch) was consequated with praise and a token. The motor tasks for this experiment included pointing to an object that did not belong in a group of objects (Brady) and identification of color patches (Ava & Noah). Vocal tasks were defined as tasks that required an audible vocal response such as beginner conversational skills (i.e., intraverbal training). The general approach to intraverbal training involved presenting an instruction (e.g., “Tell me some foods.”) to the
child. The target response would then consist of spoken words and, for this example, could include "apple and banana." For this experiment, the vocal task was naming items from a category. Correct responses were consequtated with praise and a token. See Table 1 for a description of examples of tasks and responses.

**Training Sets.** Exemplars within a condition were introduced successively in pairs. Specifically, four exemplars were taught concurrently in which correct responding to one pair was rewarded with differential outcomes (i.e., DOP) and correct responding to the second pair was rewarded with nondifferential outcomes (i.e., NOP). This arrangement was referred to as a training set. During the first training set for each task type, cooperation tasks (e.g., hands down, clap hands) were used for task interspersal. However, during the remaining training sets, exemplar pairs that were mastered during the previous sets were used for interspersal. Parents were instructed not to practice these specific tasks with their children at any time during the course of the study.

**Procedures**

**Pre-intervention Assessment.** Prior to each training set of the study, performance on exemplars to be taught was assessed. Three baseline trials were presented for each of the four target exemplars during one session (12 trials). Verbal affirmation (i.e., "That's right") was provided for correct responses and no programmed consequence followed incorrect responding. Only exemplars in which participants performed at 33% correct or less were subsequently taught, to ensure that novel exemplars were chosen.

**General Teaching Format.** The framework for each trial was as follows. First, the therapist presented the instruction (discriminative stimulus [SD]) to the participant, who was given 3-5 s to respond. If the participant responded correctly, he or she received
immediate enthusiastic praise from the therapist and a token. If the participant did not respond or responded incorrectly, the therapist immediately provided verbal feedback (e.g., “no”) and began the error correction procedure. During the error correction procedure, the therapist re-presented the SD and provided a prompt using the least intrusive method possible (verbal, gestural, or mild physical prompts, depending on participant and skill). Following the prompted response, the participant received verbal affirmation (e.g., “That’s right.”). The participant was then provided with an independent opportunity to respond. The participant received enthusiastic praise and a token for a correct response during this second independent trial. If again, the participant responded incorrectly, a 2-3 s intertrial interval was initiated and the therapist began the next trial. Correct responses during the error correction procedure were not counted towards the mastery criterion.

When responding for each of the two pairs of exemplars reached mastery criterion during the first training set (i.e., training set A), participants proceeded into the next training set (i.e., training set B) in which the former pairs of exemplars were used as interspersal items. During training set B, two additional pairs of exemplars (i.e., nonacquired exemplars) were taught to each participant and quasi-randomly interspersed with the just-mastered exemplars. When the second set of training exemplars had been mastered, all four exemplars were interspersed quasi-randomly with a third pair of exemplars (i.e., training set C). This procedure of introducing novel exemplars in pairs and then interspersing newly trained exemplars with previously learned exemplars continued until all exemplars in a training set had been learned. See Figure 2 for an illustration.
Independent Variables. The present study examined the DOP on rate of acquisition of motor and vocal tasks. Participants were taught either a motor or vocal task. For Brady, Ava, and Nicholas, a motor task was taught. A vocal task was taught to Lake. Only tasks that included multiple exemplars (i.e., sub-tasks) were included, since training for early intervention programs typically involves teaching numerous exemplars within the same task. Within each task area, the experimenter taught the participant up to 12 exemplars, across 3 training sets. During each training set, 4 exemplars were taught concurrently in pairs. Following a correct response, participants received either a red or blue token, which the experimenter then placed on a corresponding token board. A token board (top panel included the text “I am working for candy” in red font; bottom panel included the text “I am working for toys” in blue font) was located to the right side of the participant. The participants used tokens to purchase rewards (red tokens purchased foods; blue tokens purchased toys) at the conclusion of a session. Figure 1 shows an example of the DOP and NOP procedures. Candy and toys consisted of items identified during the stimulus preference assessments. The toys and candy were located behind the experimenter and out of the participants’ sight.

Correct responding on two of the exemplars were consequated with differential outcomes (DOP; condition 1) and correct responding on the other 2 exemplars were consequated with mixed outcomes/nondifferential outcomes (NOP; condition 2). During the DOP, a correct response to exemplar 1 produced consequence 1 (i.e., red token, traded in for food) whereas correct responding on exemplar 2 produced consequence 2 (i.e., blue token, traded in for toys). For the NOP, correct responses to exemplars 3 and 4 produced consequences 1 or 2 (i.e., 50% of correct responses produced red tokens; 50%
of correct responses produced blue tokens for each exemplar). When the mastery criterion was met for all 4 exemplars, training for set B began. The mastery criterion was defined as at least 90% correct responding across 3 sessions, with the first trial of each session being correct. A total of 12 exemplars were taught to each participant (see Figure 2).

Tokens were provided on a continuous reinforcement schedule (CRF) for correct responding for nonacquired exemplars. Edibles were provided on a variable ratio (VR) 3 schedule for mastered items. Praise was provided on a CRF schedule for both previously mastered (i.e., acquired) and nonacquired tasks.

Training. Trials were presented when the participant was not engaged in aberrant or off-task behaviors. Sessions consisted of 32 trials each and continued until the mastery criterion was reached. Following training set A, participants began training on set B. During each of training sets B through C, 4 new exemplars were taught (one pair of exemplars for each condition). All teaching strategies remained the same as for training set A, except cooperation tasks were no longer used for interspersal. For these training sets, exemplars mastered during previous set(s) were used for interspersal. Thus, for each session during training sets B and C, 8 trials of each nonacquired exemplar were presented and interspersed with 16 trials of the previously mastered exemplars. Data for both nonacquired and mastered items from each trial block were graphed for each exemplar within a training set.

Experimental Design. An alternating treatments design was used to evaluate the effects of the DOP and NOP. Exemplars for each condition were taught in separate sessions. If mastery criterion was met for one pair of exemplars, training continued for
the second pair until mastery was achieved. The order of presentation of each set of exemplars (i.e., set A vs. set B) was counterbalanced across sessions to control for potential order effects.

Interobserver Agreement

Interobserver agreement (IOA) was calculated using the overall agreement formula by dividing the number of agreements by the number of trials and multiplying by 100% (Poling, Methot, & LeSage, 1995). IOA was assessed by having a second observer collect data in vivo during sessions or from videotape. An agreement was scored when the responses of the second observer matched those of the primary observer. For Brady, IOA data were collected for 37% of motor-task sessions. Mean IOA was 100%. For Lake, IOA data were collected for 28% of vocal-task sessions. Mean IOA was 97% (range, 91-100%). For Ava, IOA data were collected for 28% of motor-task sessions. Mean IOA was 97% (range, 88-100%). For Noah, IOA data were collected for 25% of motor-task sessions. Mean IOA was 96% (range, 91-100%).

Treatment Integrity

Treatment integrity was assessed for at least 25% (range, 25-27%) of sessions distributed across phases for each participant. Sessions were quasi-randomly selected across conditions throughout the study. A treatment integrity score was computed by dividing the number of correctly implemented trials by the total number of trials conducted by the experimenter multiplied by 100%. A trial was scored as correct when the experimenter engaged in all of the following behaviors (all categories must have been scored as accurate for each trial to be scored as correct): The correct S was provided for the predetermined target exemplar by the experimenter at the beginning of each trial; the
participant was given 3 to 5 s to respond; if the participant responded correctly, the predetermined reward was immediately delivered; if the participant responded incorrectly or did not respond, the experimenter properly implemented the error correction procedure; and the onset of the subsequent trial was delayed by approximately 3 s in which there was no interaction between the experimenter and the participant. Overall treatment integrity for all participants was 99% (range, 97-100%). IOA on experimenter behavior was assessed for at least 20% of the sessions in which treatment integrity was assessed. Overall IOA for therapist behaviors was 100% for each participant.

Results and Discussion

Figures 3 through 5 display the results of Experiment 1 for each participant. The top panels of Figures 3 and 4 display the session-by-session performance for each exemplar. The bottom panels of Figures 3 and 4 show the number of sessions to reach mastery for each exemplar. The top panel of Figure 5 shows session-by-session performance for exemplars for Noah and the bottom panel shows results for Ava. Each participant’s data are described in detail below.

All participants’ performance on exemplars was similar across DOP and NOP conditions. As can be seen by the line graphs displayed on Figures 3 through 5, patterns of responding across exemplars are similar across conditions and phases. As can be seen in the bottom panels of Figures 3 and 4, the number of sessions to mastery was not always less for the DOP. For Brady, exemplars were acquired in 4 sessions under the DOP condition and 3 sessions for NOP during phase 1. For phase 2, exemplars were acquired at the same rate (4 sessions each). However, during phase 3 exemplars were acquired in 6 sessions under the DOP condition and 9 sessions for the NOP. For Lake,
exemplars under the DOP condition were acquired in 9, 5, and 6 sessions across the three phases, and exemplars under the NOP condition were acquired in 20, 8, and 5 sessions across the three phases.

As can be seen on Figure 5 (Noah, top panel; Ava, bottom panel), correct responding for both the DOP and NOP was low and variable for more than 20 sessions. In addition, both participants began to engage in problem behavior and general noncompliance (e.g., pushing task materials away, crying). Thus, a decision was made to change the presentation of the task. Initially, the conditional discrimination was presented with 3 comparisons. After session 28 (for Noah) and 23 (for Ava), the conditional discrimination task was presented with 2 comparisons. Nonetheless, both participants continued to become increasingly agitated during sessions. Because of increasing problem behavior and an inability to learn the presented tasks, Noah and Ava did not meet criterion on any of the exemplars and were excused from the study.

In summary, performance on exemplars was similar across conditions during initial sessions. That is, a review of terminal accuracy scores on initial training sessions did not reveal differences across the DOE and NOE conditions. Across two participants, exemplars were acquired considerably more quickly under the DOP during three phases; slightly more quickly under the NOP during two phases, and equally during one phase. It is not readily apparent why the DOE was not more salient in the present experiment. One difference might be the use of secondary reinforcers (i.e., tokens). In the previous literature, reinforcers (i.e., food & toys) were typically presented immediately following the correct response. Since all of the participants received at least 6 hours of intensive training per day, an effort was made to limit amount of food and access to toys received.
by each participant. As such, backup reinforcers in the present study were presented at the end of the session. Had the backup reinforcers been presented immediately contingent upon each response during training, it is possible that DOP effects may have been more robust. Another source of variability may have included the use of nonspecific food and toy items. That is, previous research has typically incorporated the use of specific items for each response (e.g., salted peanut vs. m&m). However, in the current experiment, a category of items (i.e., various foods or toys) was used. It is possible that using both conditioned reinforcers (i.e., tokens) and classes of back-up reinforcers hindered the opportunity to demonstrate the DOE. Finally, it is also important to note that for one participant (Lake), the task was not a conditional discrimination (i.e., intraverbal training). Since previous research has focused on the effect of the DOP on conditional discrimination tasks, Experiment 2 only included such tasks.

**EXPERIMENT 2**

Due to a failure to detect a substantial DOE in Experiment 1, a second experiment was conducted. Many of the features from Experiment 1 (e.g., participants, settings, session structure, baseline and treatment, experimental design) remained unchanged, with the exception of the addition of two participants and the termination of one (Noah, due to increasing problem behavior and inability to identify preferred food items). The new participants, Malcolm and Nicholas, both had a previous diagnosis of autism and were 4 years of age.

In Experiment 2, only motor tasks were used. Because previous research has only examined the DOP with conditional discrimination tasks, all of the target tasks were changed to conditional discriminations. Additionally, three-choice successive conditional
discrimination tasks were used, since research indicates such a procedure to be most efficacious when teaching conditional discriminations (e.g., Green, 2001). See Table 1 for sample instructions and responses for each task.

Training Sets

Exemplars within a condition were introduced successively in triplets. Specifically, 6 exemplars were taught concurrently; in which correct responding to 3 exemplars was rewarded with differential outcomes (i.e., DOP) and correct responding to the second set of three exemplars was rewarded with nondifferential outcomes (i.e., NOP).

Independent Variables

Independent variables remained unchanged from Experiment 1, except that correct responding resulted in immediate presentation of a food reinforcer. During the DOP, correct responses to exemplars resulted in specific food reinforcers. For the NOP, correct responses to exemplars produced one of three food reinforcers equally. That is, each correct response was followed, quasi-randomly and equally by one of three food reinforcers. Table 2 summarizes the food reinforcers used for each participant. Praise was also provided for correct responses across both conditions.

Interobserver Agreement

Interobserver agreement was calculated as described for Experiment 1. For Lake, IOA data were collected for 35% of sessions. Mean IOA was 99% (range, 92-100%). For Malcolm, IOA data were collected for 72% of sessions. Mean IOA was 99% (range, 97-100%). For Nicholas, IOA data were collected for 25% of sessions. Mean IOA was
Treatment Integrity

Treatment integrity was assessed as described for Experiment 1. Treatment integrity was assessed during at least 25% (range, 25-35%) of sessions distributed across phases for each participant. Treatment integrity was 99% for Ava and 100% for all other participants for sampled sessions. IOA on experimenter behavior was assessed for at least 20% of the sessions in which treatment integrity was assessed. Overall IOA was 100% for each participant.

Results and Discussion

Figures 6 through 9 display the results for each participant. The top panel displays session-by-session performance for each exemplar and the bottom panel displays number of sessions to mastery for each training set. All participants’ performance on exemplars was similar for DOP and NOP conditions. Each participant’s findings are described in detail below.

Lake’s data are shown in Figure 6. As seen in the upper panel, his performance on exemplars was similar under both DOP and NOP for both phases. As seen on the lower panel, average number of sessions to mastery were the same for phase 1 (9 sessions) and slightly less under the DOP condition for phase 2 (5 & 7 sessions for DOP & NOP, respectively).

Figure 7 shows Malcolm’s session-by-session responding for each exemplar (upper panel) and average number of sessions to mastery (lower panel). As can be seen in the line graph, performance for all exemplars was similar. Malcolm reached mastery for all exemplars in 6 sessions or less. For phases 1 and 2, the exemplars were acquired
in 4 sessions under the DOP and 5 sessions under the NOP. For phase 3, exemplars under both conditions were acquired in 6 sessions.

Figure 8 shows Nicholas’ session-by-session performance for exemplars (upper panel) and average number of sessions to mastery (lower panel). As can be seen on the upper panel, responding across all exemplars remained low and variable after 28 sessions. In addition, Nicholas began to engage in increasing levels of noncompliance as sessions progressed. Thus, a decision was made to modify the task instruction (i.e., from identifying an item by its category to identifying the named item). An increase in responding was subsequently observed and exemplars were acquired in 18 and 17 sessions (DOP & NOP, respectively).

Figure 9 shows Ava’s session-by-session performance for exemplars (upper panel) and average number of sessions to mastery (lower panel). As can be seen on the upper panel, responding on exemplars was highly variable across all exemplars under both DOP and NOP. The first exemplar under the DOP was acquired in 4 sessions. The second and third exemplars were acquired in 9 sessions. The exemplars under the NOP condition were acquired in 15, 12, and 9 sessions. Due to increasing demands on Ava’s guardian, Ava exited the study prior to its completion (i.e., one phase was completed).

In summary, across participants, exemplars were acquired more quickly under the DOP during four phases (Lake, Malcolm, Ava); more quickly under the NOP during two phases (Nicholas); and equally during two phases (Lake, Malcolm). Nonetheless, a review of performance on initial training sessions did not reveal differences in performance across conditions.
GENERAL DISCUSSION

Two experiments were completed that examined the DOP with children diagnosed with autism. Based on mean sessions to mastery per phase, in 7 out of 14 phases (3 in Experiment 1, 4 in Experiment 2), exemplars were acquired more quickly under the DOP. When data are combined across participants and exemplars, exemplars were acquired more quickly under the DOP across all phases for Experiment 1 and during phase 1 for Experiment 2 (see figure 10). Exemplars were acquired in the same number of sessions during the remaining two phases of Experiment 2. Although the aggregate data appear to be somewhat consistent with previous findings on the DOE, the question remains whether the current findings serve any practical value in the treatment of children with autism.

According to some researchers, the DOE is a consistent and powerful effect that enhances the acquisition and retention of conditional discriminations (e.g., Urcuioli, 1990). Although several authors have offered accounts and possible explanations of the DOE, currently there is no consensus as to how it is best explained. Consequently, it is even more difficult to decipher when the effect is minimal or does not occur. Although the DOE was observed for 4 of 5 participants (Brady & Lake, Experiment 1; Lake, Malcolm, Ava, Experiment 2), the effect was not consistent across exemplars or phases within participants. In addition, exemplars were acquired slightly more quickly under the NOP condition for one participant (Nicholas, one session; Experiment 2). Thus, it cannot be said that results indicate enhanced performance with outcome specific procedures, which might be predicted from results with studies with nonhumans. These results are

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noteworthy, since previous research with human participants has generally supported the DOE (with a few exceptions).

One seemingly important difference between the two experiments described here and earlier studies is the research design employed. Previous studies employed an ABAB design (i.e., withdrawal design) in which the DOP and NOP conditions were introduced during separate phases. In an ABAB design, the effects of an intervention are observed by exposing participants to conditions in successive phases (Kazdin, 1982). When the pattern of change indicates improved performance as a function of alteration of phases, the evidence for the intervention effect is strong. Although withdrawal designs can provide important information pertaining to the effectiveness of an intervention, the specific variables that influence responding under each condition cannot be isolated. This is particularly relevant to the study of the DOE because researchers have posited that the DOE occurs because stimulus-specific ‘expectancies’ exert control over choice behavior (e.g., Peterson & Trapold, 1980). In the current experiments, the DOP and NOP were compared to determine their separate effects on the acquisition of conditional discrimination tasks. Although multiple-treatment designs provide a unique method by which to compare conditions, they are only useful to the extent that responding across conditions is differentiated. Finally, there remains a possibility that multiple-treatment interference may have contributed to the results (Kazdin), which may have been the case in the experiments presented in this paper.

Another critical difference that might account for the current findings and the previous literature related to the type of dependent variable. The current experiments examined the effect of the DOP on the acquisition of conditional discriminations.
However, several of the previous studies (e.g., Dube & McIlvane, 1995; Dube, Rocco et al., 1989; Joseph et al., 1997) examined the role of the DOP in enhancing the emergence of a derived relation (i.e., stimulus class formation) during stimulus equivalence training. For example, Dube, Rocco et al. (1989) examined the role of the stimulus-specific reinforcers (i.e., DOP) on stimulus classes. Two participants diagnosed with moderate mental retardation showed quicker emergence of stimulus class formations when stimulus-specific reinforcers were in effect than when there were not. For the aforementioned studies, data were not presented for the rate of acquisition on the training exemplars. It is possible that acquisition rates on the initial training exemplars were similar to those of the current experiments. Although, the DOE has been "demonstrated" in tests of conditional discrimination acquisition (e.g., Litt & Shreibman, 1981; Malanga & Poling, 1992) the results of those studies are congruent with the current findings. For example, Litt and Schreibman assessed the DOP with 5 children diagnosed with autism. Three of five participants acquired the conditional discrimination more quickly under the DOP. However, for two of the participants, the rate of acquisition did not differ between the DOP and NOP. In a study by Malanga and Poling, terminal accuracy was higher under the DOP (84%) than the NOP (57%). However, the authors mention that the accuracy of individual participants varied and was not always higher the under the DOP. Indeed, visual inspection of their individual results indicated that two participants did not consistently show higher terminal accuracy under the DOP. Although, for the remaining two participants, terminal accuracy was consistently and significantly higher under the DOP.
It is also important to examine the differences in participant characteristics in the current experiments. Although efforts were made to recruit participants who engaged in minimal problem behavior, such characteristics are common of children with autism (e.g., Lovaas, 1987). All of the participants in the current experiments engaged in some form of stereotypy and noncompliance. In addition, two participants (Ava, Noah) engaged in aggression and property destruction. Research has found that problem behavior (including stereotypy) restricts learning opportunities because much time must be devoted to minimizing those problem behaviors (Dunlap, 1984; Lovaas, 1987). It is possible that the presence of problem behavior (including noncompliance), perhaps in combination with some other unknown variables, contributed to our findings.

A second difference with respect to participant characteristics is that all of the children in our study had received at least one year intensive early intervention by trained therapists in which pre-academic and academic skills (namely conditional discriminations in a discrete-trial format) were taught for at least 40 hours per week. Thus, all of the participants in the present study had extensive experience with the teaching format used and receiving nonspecific reinforcers for correct responding. The DOE has been shown to enhance performance on a conditional discrimination task presented in a discrete-trial format. As noted previously, our participants entered the present study with extensive experience with discrete trials. This may have been the critical difference. It is possible that those individuals with a history of intensive intervention may already learn more readily in such teaching situations, and that arranging stimulus-specific reinforcers does not result in additional learning enhancement.
A third difference between the previous research and the current experiments is the task presentation. In the previous literature, the DOP was examined using a two-choice conditional discrimination task (i.e., two comparisons). Such discrimination tasks (aka, simple discrimination task) are less complex and are consequently more easily acquired (Green, 2001). However, in an effort to keep task presentation similar to those typically used in intensive behavioral intervention programs for children with autism, we presented 3 comparisons for each trial. Typically, 3 comparisons are presented in order to increase the difficulty of the task and to minimize false positives in acquisition (e.g., chance responding). For Experiment 1, the third comparison served as a ‘distracter’ and varied across trials and conditions and was never used as the sample stimulus. It is possible that the addition of this third comparison stimulus somehow interfered with the reinforcer-specific arrangement. However, in Experiment 2 the third comparison was part of the set of exemplars being taught. It is not clear whether simultaneously teaching 6 exemplars (3 per condition) in conjunction with some other variables, perhaps treatment interference, masked the DOE.

In summary, when evaluating the outcomes of the current experiments, at least three limitations are worth noting. First, an alternating treatments design was used in the experiments. It is possible that multiple-treatment interference (Kazdin, 1982) masked the appearance of the DOE. Second, all participants had extensive experience with the teaching format used. It is possible that the DOP enhances acquisition for individuals who have not had such an extensive history with discrete trials in teaching novel discriminations. Third, our method of task presentation differed from that of previous studies. All the reviewed studies examined the DOP with two-choice conditional
discrimination tasks. Complex conditional discrimination tasks (e.g., those used in the current experiments) require more advanced skills to acquire and it is possible that the DOP was not sufficient to enhance acquisition.

Future Research

Although we failed to consistently identify the DOE, the effect clearly exists under certain conditions. When using a rather liberal estimate (aggregate performance across exemplars and participants, but within phases), 7 of the 14 phases showed quicker acquisition under the DOP. Nonetheless, the effects were minimal and are of little practical value when considering the additional effort required in arranging stimulus-reinforcer pairs. The contribution of the current experiments is the knowledge that the DOE is not a guaranteed finding with children diagnosed with autism. The question remains, however, under which conditions the DOE can be observed. It is the task of future researchers to determine under what conditions the DOE can be reproduced. The most likely topics of such research would be to replicate the procedures with children who are first entering early intervention programs to determine whether the DOE is specific to participants with minimal exposure to the discrete-trial teaching format. Additionally, it is important to examine the DOP on three-choice successive conditional discrimination tasks, since this is the most efficacious format for teaching conditional discriminations to children diagnosed with autism.
Endnotes

1 The Behavior Language Assessment is an informant rating scale, which is administered as an interview to an individual that is familiar with the child’s abilities. The scale contains 12 different sections that provide an overview of basic learning and language skills based on Skinner’s (1957) analysis of verbal behavior. Each section is subdivided into 5 levels, in which level 1 represents no skills in an area, and 5 represents strong skills (representative of a typically developing 2- to 3-year old). Information obtained from the assessment is typically used to guide a professional in making initial curriculum decisions in an early intervention program.

2 The Problem Behavior Scale provides a general summary of eight problem behavior areas.
Appendix A
This letter will serve as confirmation that your research project entitled “Assessing the Differential Outcomes Procedure with Children Diagnosed with Autism” has been approved under the full category of review by the Human Subjects Institutional Review Board. The conditions and duration of this approval are specified in the Policies of Western Michigan University. You may now begin to implement the research as described in the application.

Please note that you may only conduct this research exactly in the form it was approved. You must seek specific board approval for any changes in this project. You must also seek reapproval if the project extends beyond the termination date noted below. In addition if there are any unanticipated adverse reactions or unanticipated events associated with the conduct of this research, you should immediately suspend the project and contact the Chair of the HSIRB for consultation.

The Board wishes you success in the pursuit of your research goals.

Approval Termination: August 20, 2004
Appendix B
Permission of Parent or Guardian

Principal Investigator: James E. Carr, Ph.D.
Student Investigator: Ivy M. Chong, M.A.

My child has been invited to participate in a research project (i.e., Ivy Chong's dissertation) entitled “Assessing Differential Outcomes Procedure with Children Diagnosed with Autism.” The purpose of this study is to assess whether providing each behavior with its own reward during discrete-trial training leads to faster learning.

My permission for my child to participate in this project means that my child will receive in-home, individualized treatment in the preacademic/academic areas of vocal and motor behavior. After a brief interview with me and an initial assessment with my child, the treatment study will be divided into four phases. During each phase, my child will be taught 4 motor and 4 vocal skills, for a total of 16 motor skills and 16 vocal skills. Correct responses to half of the skill programs will result in specific food and toy rewards. Correct responses to the other half of the programs will result in nonspecific food and toy rewards such that rewards will be shared between programs.

My child will be asked to participate for approximately 3-4 months, with approximately 3-5, 1-hour sessions being conducted per week. During each visit, the experimenter will teach my child using discrete-trial training. In a typical session, my child will be seated at a small table, with the experimenter seated either next to or across from my child. My child will be presented with various pictures and objects and will be asked to say or point to the correct one. If my child is correct, he or she will be given praise and a food or toy reward. If my child is incorrect, he or she will be told to “try again” and, if necessary, will be prompted to perform correctly.

The benefits my child may receive in this study are (a) learning up to 32 skills in two educational areas and (b) frequent adult attention and preferred rewards. However, in the event that the study is unsuccessful, there may be no benefits resulting from participation in the study.

The primary risk associated with participation in this study is that my child may experience some frustration at being presented with academic tasks. To counter this risk, all correct responses will be rewarded and sessions will be kept brief. In addition, if my child shows signs of distress (e.g., crying), sessions will be terminated. If 5 sessions in a row are terminated due to my child’s distress, the experimenter will discuss with me my child’s continued participation in the research. If my child is excused from the study it will be without penalty. As in all research, there may be unforeseen risks to my child; however, these risks should be no different from those associated with the typical school environment. If an accidental injury occurs, appropriate emergency measures will be taken; however, no compensation or treatment will be made available to me or my child except as otherwise specified in this permission form.
All of the information collected in this study will remain confidential. That means that my child’s name will be omitted from all data collection forms and a code number will be used instead. The principal investigator will keep a separate master list with the names of the children and the corresponding code numbers. No names will be used if the results are published or reported at a professional meeting. During the study, the staff will videotape all the sessions with my child. These videotapes are to be used only for the purposes of data collection and training (e.g., Ivy Chong’s research assistants) and will be kept confidential. All information and videotapes will be stored for at least 3 years in locked file cabinets in the Clinical Behavior Research Laboratory (Wood Hall – 1526) or Dr. Carr’s office (Wood Hall – 3758) at WMU. Only research staff involved with this project will have access to these videotapes.

I may refuse to have my child participate or I may withdraw my child from this study at any time. Not participating or withdrawing from this study will not negatively affect my child or any other services they are being provided. If I have any questions or concerns about this study, I may contact either of the investigators, Dr. James Carr (269-387-4925) or Ivy Chong (269-387-4926, 204-269-4296). I may also contact the Human Subjects Institutional Review Board (269-387-8293) or the Vice President for Research (269-387-8298).

As an alternative to participating in this study, early intervention services are available to your child in the community (e.g., Speech and Language Therapy, Occupational Therapy, Physical Therapy). You could also check with your pediatrician or family service worker for recommendations for other appropriate services.

This permission document has been approved for use for one year by the Human Subjects Institutional Review Board as indicated by the stamped date and signature of the board chair in the upper right corner. I will not participate in this project if the corner does not have a stamped date and signature.

My signature below indicates that I, as parent or guardian, can and do give my permission for _______________ (child’s name) to participate in the previously described experimental intervention.

[Signature]
Date: 01/25/04

Permission Obtained By

[Signature]
Date: 01/25/04
Sample Script for Child Assent

Research staff to child

1. Make direct eye contact with child and smile.
2. Prompt the child to look at you (say “look at me”) and listen.
3. Say “Would you like to work with us?”

The parent will help the experimenters define assent behaviors for the child and will be present to determine if the child assents to participate in the research study.

Potential Indicators of Assent
1. Absence of dissenting behaviors such as crying, pulling away, or hitting.
2. Smiling, nodding, touching the experimenter, or other physical actions that the parent or teacher indicates as affirmative.
3. Saying “yes,” “uh-huh” or a phrase or sound that the parent or teacher indicates as affirmative.

☐ Child indicated yes.
☐ Child indicated no.

Parent Signature ___________________________ Date ________
REFERENCES


Savage, L. M. (2001). In search of the neurobiological underpinnings of the Differential
Outcomes Effect. *Integrative Physiological and Behavioral Science, 36, 182-195.*

impairments on matching-to-position following pyrithiamine-induced deficiency


Shepp, B. E. (1962). Some cure properties of anticipated rewards in discrimination
learning of retardates. *Journal of Comparative and Physiological Psychology, 63, 856-859.*


Table 1. Descriptions of tasks, participant responses, and sample instructions ($S^D$s).

<table>
<thead>
<tr>
<th>Task Type/Participant</th>
<th>Task</th>
<th>Sample $S^D$</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experiment 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Motor</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brady</td>
<td>conditional discrimination</td>
<td>“which doesn’t belong”</td>
<td>child identifies the item that doesn’t belong</td>
</tr>
<tr>
<td>Noah</td>
<td>conditional discrimination</td>
<td>“touch red”</td>
<td>child identifies correct color patch</td>
</tr>
<tr>
<td>Ava</td>
<td>conditional discrimination</td>
<td>“touch red”</td>
<td>child identifies correct color patch</td>
</tr>
<tr>
<td><strong>Vocal</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lake</td>
<td>Intraverbal behavior</td>
<td>“tell me two tools”</td>
<td>vocal response “hammer &amp; nail”</td>
</tr>
<tr>
<td>Experiment 2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Motor</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lake</td>
<td>Math equations</td>
<td>“which one equals &lt;number&gt;”</td>
<td>child points to corresponding equation</td>
</tr>
<tr>
<td>Ava</td>
<td>Associative matching</td>
<td>“which one goes with this”</td>
<td>child points to corresponding association</td>
</tr>
<tr>
<td>Malcolm</td>
<td>Sight word reading</td>
<td>“show me the one you eat”</td>
<td>child points to the correct item (text)</td>
</tr>
<tr>
<td>Nicholas</td>
<td>Sight word reading</td>
<td>“show me the one you eat”</td>
<td>child points to the correct item (text)</td>
</tr>
</tbody>
</table>
Table 2. The backup (delayed) reinforcers used for each participant in Experiment 1 and immediately delivered reinforcers used for each participant in Experiment 2.

<table>
<thead>
<tr>
<th>Participant</th>
<th>Food</th>
<th>Toys (Experiment 1 only)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Experiment 1</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brady</td>
<td>M&amp;M’s, Peanuts, Chips</td>
<td>Crossword puzzles, Board games</td>
</tr>
<tr>
<td>Lake</td>
<td>Smarties, Pretzels, Pringles</td>
<td>Arts &amp; Crafts, Books, Board games</td>
</tr>
<tr>
<td>Noah</td>
<td>Milk, popcorn, icing, olives</td>
<td>Blues Clues &amp; Teletubby Videos</td>
</tr>
<tr>
<td>Ava</td>
<td>Aero® chocolate bar, Shreddies®, Goldfish crackers</td>
<td>Photos, flyers, Elmo Videos</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Experiment 2</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lake</td>
<td>Smarties, Pretzels, Cheezies</td>
<td></td>
</tr>
<tr>
<td>Malcolm</td>
<td>Lucky Charms®, Marshmallows, Fruit snack</td>
<td></td>
</tr>
<tr>
<td>Nicholas</td>
<td>Pretzels, Marshmallows, Apple juice</td>
<td></td>
</tr>
<tr>
<td>Ava</td>
<td>Smarties, Goldfish crackers, Shreddies®</td>
<td></td>
</tr>
</tbody>
</table>
Figure 1. A visual representation of the procedures used in Experiment 1. DOP = differential outcomes procedure, NOP = nondifferential outcomes procedure.
Figure 2. A depiction of the condition structure for Experiments 1 and 2.

Experiment 1

<table>
<thead>
<tr>
<th>Training Set A</th>
<th>Training Set B</th>
<th>Training Set C</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Vocal Task</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exemplars</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 &amp; 2 (differential)</td>
<td>Exemplars 5 &amp; 6 (differential)</td>
<td>Exemplars 9 &amp; 10 (differential)</td>
</tr>
<tr>
<td>3 &amp; 4 (non-differential)</td>
<td>Exemplars 7 &amp; 8 (non-differential)</td>
<td>Exemplars 11 &amp; 12 (non-differential)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Training Set A</th>
<th>Training Set B</th>
<th>Training Set C</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Motor Task</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exemplars</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 &amp; 2 (differential)</td>
<td>Exemplars 5 &amp; 6 (differential)</td>
<td>Exemplars 9 &amp; 10 (differential)</td>
</tr>
<tr>
<td>3 &amp; 4 (non-differential)</td>
<td>Exemplars 7 &amp; 8 (non-differential)</td>
<td>Exemplars 11 &amp; 12 (non-differential)</td>
</tr>
</tbody>
</table>

Experiment 2

<table>
<thead>
<tr>
<th>Training Set A</th>
<th>Training Set B</th>
<th>Training Set C</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Motor Task</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exemplars</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 - 3 (differential)</td>
<td>Exemplars 7 - 9 (differential)</td>
<td>Exemplars 13 - 15 (differential)</td>
</tr>
<tr>
<td>4 - 6 (non-differential)</td>
<td>Exemplars 10 - 12 (non-differential)</td>
<td>Exemplars 16 - 18 (non-differential)</td>
</tr>
</tbody>
</table>

---

1 Lake
2 Condition 1.
3 Condition 2.
4 Brady, Noah, Ava

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Figure 3. Brady’s results from Experiment 1. Top Panel: Percentage of correct responses per exemplar across phases and conditions. Bottom Panel: Average number of sessions to mastery per condition for each phase.
Figure 4. Lake's results from Experiment 1. Top Panel: Percent correct per exemplar across tasks and conditions. Bottom Panel: Average number of sessions to mastery per condition for each phase.
Figure 5. Noah’s results from Experiment 1. Top Panel: Percent correct per exemplar across tasks and conditions. Ava’s results from Experiment 1. Bottom Panel: Percent correct per exemplar across tasks and conditions.
Figure 6. Lake’s results from Experiment 2. Top Panel: Percent correct per exemplar across tasks and conditions. Bottom Panel: Average number of sessions to mastery per condition for each phase.
Figure 7. Malcolm’s results from Experiment 2. Top Panel: Percent correct per exemplar across tasks and conditions. Bottom Panel: Average number of sessions to mastery per condition for each phase.
Figure 8. Nicholas’ results from Experiment 2. Top Panel: Percent correct per exemplar across tasks and conditions. Bottom Panel: Average number of sessions to mastery per condition for each phase.
Figure 9. Ava’s results from Experiment 2. Top Panel: Percent correct per exemplar across tasks and conditions. Bottom Panel: Average number of sessions to mastery per condition for each phase.
Figure 10. Group data: Average number of sessions to mastery.

**Experiment 1**

![Bar chart for Experiment 1 showing sessions to mastery for DOE and NOE groups across Exemplars 1-4, 5-8, and 9-12.]

**Experiment 2**

![Bar chart for Experiment 2 showing sessions to mastery for DOE and NOE groups across Exemplars 1-6, 7-12, and 13-18.]

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