

AN EXAMINATION OF THE DIFFERENTIAL OUTCOMES EFFECT WHEN TEACHING  
DISCRIMINATIONS TO CHILDREN WITH  
AUTISM AND OTHER DEVELOPMENTAL DISABILITIES

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## ABSTRACT

The differential outcomes effect (DOE) refers to the finding that performance in discrimination training improves when different behaviors produce different reinforcers. In the current study, the effects of two DOE procedures on the acquisition of receptive language skills were compared. Participants were four children with autism and/or developmental delay/speech and language impairment. The children were presented with two toy or food items and asked to give the experimenter the item named. The names consisted of three-letter nonsense syllables. Correct responses were followed by one of the following consequences: (a) The opportunity to manipulate or consume the item to which the child correctly responded; (b) the opportunity to manipulate or consume a third item that was unique to that label but was not one of the two test items in the pair; or (c) randomized access to one of two various third items (non-differential outcomes condition). Results showed similar patterns of response acquisition in all three of the conditions (DOE-Matched, DOE-Unmatched, and No DOE). This is consistent with several previous applied investigations on the DOE. Suggestions are provided for future research on alternative techniques for teaching discriminations to children with developmental disabilities.

## INTRODUCTION

A growing number of children are diagnosed with autism each year. Educational interventions based on the principles of applied behavior analysis have been found to be highly effective for teaching social, communicative, self-care, and academic skills to individuals with autism and other developmental disabilities. A common procedure used in behavioral interventions is discrimination training. A well-established phenomenon found in research on discrimination training is called the "differential outcomes effect" (DOE). The current study evaluated one factor that may influence this phenomenon. The purpose of the following review is to discuss the current literature on the DOE. The introduction will begin with a brief overview of autism and its associated deficits, as well as a discussion of interventions for children with autism. Next, discrimination training and its relevance to teaching children with autism will be discussed. Relevant basic and applied literature on the DOE will be presented. Finally, the conceptual development of the DOE will be discussed briefly, followed by a description of the purpose of this research.

### Autism

The rate with which individuals are diagnosed with autism is known to be rapidly increasing. The American Psychiatric Association has reported that autism is diagnosed in every 2 to 5 cases per 10,000 individuals (APA, 1994). Consistent with these findings, Harris (1995) found that autism is diagnosed in 4 or 5 out of every 10,000 persons. More recently, Fombonne (1999) compared the rates found in 11 different studies conducted since 1989 and found that the median rate of individuals diagnosed with autism was 7.2 out of every 10,000 people. However, prevalence rates vary depending on the definition of autism employed (Vicker & Monahan, 1988).

Autism is diagnosed four to five times more often in boys than in girls (APA, 1994). The most frequent co-morbid diagnosis for autism is mental retardation, with approximately 75% of individuals falling into the moderately to severely retarded categories (Wenar, 1994). Females diagnosed with autism are more likely to be diagnosed with severe mental retardation than males diagnosed with the same disorder (APA, 1994).

Although the prevalence of autism is on the rise, autism was first identified in the 1940's when American psychiatrist Leo Kanner described three features he found to be central to this disorder (Kanner, 1943). These three features are extreme isolation, the need for sameness in the environment and behavior, and mutism or non-communicative speech. The current diagnostic criteria specified in the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV; APA, 1994) is based on these three features. A more detailed discussion of these features is presented in the next section.

#### Associated Deficits of Autism

According to the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV; APA, 1994), autistic disorder is a subtype of the classification of Pervasive Developmental Disorder characterized by the presence of repetitive activities, behaviors, and interests, as well as impairments in social interaction and communication. Although individuals with autism usually have similar deficits, the ways in which the deficits are presented vary across individuals and over time (Tsai, 1992).

The presence of repetitive activities, behaviors, and interests in some individuals with autism can be seen in their need for sameness and resistance to change (Mauk, Reber, & Batshaw, 1997). These individuals become inflexible about particular rituals and insist on following specific schedules. In addition, these individuals might exhibit repetitive behaviors

(e.g., arm flapping or toe walking) or limited interests (e.g., preoccupation with one part of a toy).

Most individuals with autism interact less with others than do typically developing children. Wing (1988) suggested that individuals with autism have three types of social deficits. The first, impaired social recognition, refers to the individual's indifference to others and lack of eye contact with others. Second, impaired social communication, refers to a lack of interest in communicating with other individuals. Lastly, the author referred to a lack of interest in imitating others' behavior or engaging in pretend play.

A common impairment in individuals with autism is in the area of communication. These individuals typically have delayed receptive and expressive communication skills (Mauk et al., 1997). About half of children with autism do not ever develop speech (Prizant, 1996). In individuals who do develop speech, it is often stereotyped and echolalic rather than spontaneous. Many individuals with autism are unable to understand long receptive instructions and respond better to short, direct phrases (Mauk et al., 1997). Nonverbal forms of communication (e.g., eye contact) usually remain problematic for these individuals without behavioral interventions (Frea, 1995).

A variety of interventions have been developed as a result of extensive research on the deficits associated with autism. However, the interventions with the most empirical support are behavioral interventions based on the principles of applied behavior analysis (e.g., prompting, reinforcement, shaping, chaining). The characteristics of behavioral interventions based on the principles of applied behavior analysis will be discussed in the next section.

## Behavioral Interventions

Reports of progress in children with autism who are enrolled in early intervention programs have led to an emphasis on systematic intervention (Rogers, 1998). Most researchers agree that early and effective intervention results in improved outcomes for children with autism (Simpson, 1999); however, some disagreement still exists as to the particular type of treatment that should be implemented. This is evident in the wide variety of treatment procedures reported for these children (Schopler, Mesibov, & Baker, 1982). Some common treatments for autism include behavioral interventions, psychotherapy, sensory-integration therapy, speech and language therapy, parent training, community integration, and medication. Many of these therapies have no empirical evidence supporting their use, while others have some support in the literature.

Although no treatment has been found to cure autism, numerous studies have shown that intensive behavioral intervention using the principles of applied behavioral analysis can result in large improvements for children with autism (Green, 1996). No other intervention for autism offers comparable effectiveness (Rogers, 1998). These behavioral interventions share some common components, which include: (a) breaking skills into smaller, more teachable responses, (b) prompting correct responses during structured teaching situations, (c) delivering reinforcers for accurate responding, (d) providing the child with frequent opportunities to respond, (e) emphasizing parental involvement, (f) using a functional approach to problem behavior, and (g) incorporating strategies for generalization.

A wide variety of social, communication, self-help, and academic skills have been taught with behavioral interventions. Most early intervention programs for children with autism focus on basic attending, nonverbal imitation, and receptive and expressive language skills.

Procedures used to teach many of these skills (e.g., receptive and expressive language) involve discrimination training, which will be discussed in the next section.

### Discrimination Training

For children with language delays, such as those with autism, many hours of intervention time are spent on improving both receptive and expressive language skills. Although the specific procedures can vary greatly, a central technique to most receptive language training programs is discrimination training. Discrimination training is a procedure in which reinforcement is delivered when a correct response occurs in the presence of one stimulus, but not when the response occurs in the absence of the stimulus or in the presence of a different stimulus. As a result of this training, the correct response is more likely to occur in the presence of the stimulus than in its absence. This outcome is typically referred to as "discrimination". The effect that this stimulus has on responding is typically referred to as "stimulus control." For example, in teaching a child to learn the difference between an apple and a ball, a teacher might present the two items simultaneously and say, "Touch the apple." If the child correctly touches the apple, the behavior is reinforced. If the child touches the ball, the behavior is not reinforced. Discriminations are important in learning a number of skills ranging from self-help to reading. Individuals must acquire discriminations (e.g., between shapes, sizes, letters, verbal instructions) to successfully perform many common skills.

Cooper, Heron, and Heward (1987) described five factors important in achieving stimulus control through discrimination training. These factors include: (a) pre-attending skills, (b) differential reinforcement, (c) stimulus presentation, (d) salience of the stimuli, and (e) masking and overshadowing. Certain prerequisite behaviors such as pre-attending skills (e.g., sitting and attending) must be in the individual's repertoire prior to discrimination training.

Differential reinforcement should be implemented by providing reinforcement for the correct response more frequently in the presence of the discriminative stimulus than in its absence.

Three aspects of stimulus presentation are important to achieving stimulus control: (a) The instructions should be directly related to the discrimination taught, (b) the stimulus should be followed by frequent opportunities to respond, and (c) a quick pace of instruction should be used.

The stimuli included in training also must be highly salient, or noticeable, to the learner. The individual's sensory capabilities, past history of reinforcement, and the context are relevant in determining the saliency of a stimulus. Additionally, the phenomena of masking and overshadowing influence the saliency of a stimulus. Masking is evident when a stimulus that has control of a behavior is blocked when presented with another stimulus. Overshadowing is evident when one stimulus interferes with another stimulus acquiring stimulus control.

Due to the extensive amount of time educators invest in teaching children discrimination skills, a pivotal goal of researchers is to develop techniques that result in more efficient learning. In the following section, one such technique will be discussed in greater detail.

#### Differential Outcomes Effect

One phenomenon that has been the subject of numerous studies on discrimination training is the Differential Outcomes Effect (DOE). The DOE refers to the finding that discrimination training occurs more quickly when different outcomes occur for different responses (Peterson & Trapold, 1980). The two basic procedures that have been used in studying the DOE are the match-to-sample (MTS) or delayed match-to-sample (DMTS) task and two-choice discrimination tasks (Goeters, Blakely, & Poling, 1992).

A typical MTS task involves the presentation of a sample stimulus followed by the simultaneous presentation of two comparison stimuli. Reinforcement occurs if the participant

selects the comparison stimulus that matches the sample stimulus. For example, a sample stimulus (e.g., circle) might be followed by two comparison stimuli (e.g., circle and square). The individual must choose the symbol that matches the sample stimulus (e.g., circle). With DMTS tasks, a brief delay is inserted between the offset of the sample stimulus and the presentation of the comparison stimuli (Goeters et al., 1992). As noted by Perez-Gonzalez and Williams (2002), teaching individuals auditory-visual discriminations involves match-to-sample procedures wherein the verbal instruction (e.g., “Hand me \_\_\_”) is the sample stimulus and the two objects are the comparison stimuli. Alternatively, a two-choice discrimination task may begin with the presentation of two stimuli, and choosing one of the stimuli results in reinforcement while choosing the other does not. In contrast to the MTS procedures, the two-choice discrimination procedure does not involve learning a relation between two antecedent stimuli. For example, a child may learn to discriminate between two cards: A card with a picture of a snack and a card with a picture of some other object. During training, choosing the card with the picture of a snack results in the child receiving food reinforcement and choosing the other card results in no reinforcement.

The DOE has been considered a consistent and robust phenomenon in discrimination training (Urcuioli, 1990a). This phenomenon has been investigated with a variety of organisms using a number of different tasks and outcomes. In the following sections, basic and applied research on the DOE will be described.

#### Basic Research with Nonhumans

In a review of basic research on the DOE, Goeters et al. (1992) concluded that every study with nonhumans has supported the DOE phenomenon with the exception of one study (i.e., Santi & Savich, 1985). Most investigations of the DOE with nonhumans were conducted with

rats and pigeons, used primary reinforcers such as food and water, and employed group designs. Various factors that may influence the DOE (e.g., the delay or magnitude of the reinforcer) have been evaluated. However, most basic research on the DOE was conducted to either support or refute particular theories about the phenomenon.

The DOE received extensive attention in the basic literature following an initial investigation with rats (Trapold, 1970). In this study, rats were taught to respond differentially in the presence of two stimuli (i.e., a tone and clicker). For the DOE group, rats received food reinforcement for pressing the right lever in the presence of one stimulus and sucrose solution for pressing the left lever in the presence of the other stimulus. For the non-differential outcomes group, half of the rats received food as a reinforcer for correct responding whereas the other half received sucrose solution for correct responding. Rats in the DOE group had quicker rates of acquisition.

The DOE has been replicated with pigeons (e.g., Edwards, Jagielo, Zentall, & Hogan, 1982; Jones, 2003; Jones & White, 1994; Kelly & Grant, 2001; Peterson & Trapold, 1980; Sherburne & Zentall, 1995; Sherburne & Zentall, 1998; Urcuioli, 1990a; Urcuioli, 1990b; Urcuioli, DeMarse, & Lionello-DeNolf, 2001; Urcuioli & Zentall, 1990; Zentall & Sherburne, 1994), rats (Carlson, 1974; Carlson & Wielkiewicz, 1972; Carlson & Wielkiewicz, 1976; Fedorchak & Bolles, 1986; Friedman & Carlson, 1973; Kruse & Overmier, 1982; Papini & Silingardi, 1989; Ramos & Savage, 2003; Savage, Pitkin, & Careri, 1999), and dogs (e.g., Overmier, Bull, & Trapold, 1971). While most investigations of the DOE have involved primary reinforcers (e.g., food and water), some studies have included conditioned reinforcers, such as a flash of light (e.g., Fedorchak & Bolles, 1986; Friedman & Carlson, 1973; Kelly & Grant, 2001).

The potential clinical utility of the DOE has been discussed by numerous authors (e.g., Overmier, Savage, & Sweeney, 1999; Savage et al., 1999). A first step in investigating the clinical implications of this phenomenon has been to replicate these findings with the human population. In the next section, basic studies with humans will be described.

### Basic Research with Humans

With the exception of one study (i.e., Dube, Rocco, & McIlvane, 1989), all published laboratory studies on the DOE with humans have demonstrated the phenomenon. Participants included typically developing children and adults, as well as individuals with developmental disabilities. Many of the investigations were designed to evaluate particular theories about the (primarily cognitive) mechanisms underlying the DOE. In most of these studies, a group design was used, and participants were taught arbitrary stimulus relations (i.e., those not found in the participants' daily environment). Other procedures varied widely across the investigations, including the manner in which the stimuli were presented and the types of reinforcers used.

In Maki, Overmier, Delos, and Gutman (1995), for example, the DOE was evaluated with 45 typically developing children (aged 4 years to 5 years 9 months) using DMTS tasks. The sample stimulus (e.g., a light or dark shaded square) was presented on one page of a three-ring binder, followed by a blank page (to insert a 2-s delay) and then a page with two comparison stimuli (e.g., heart and circle figures). The children in the DOE group received verbal praise ("That is very good!") for pointing to the heart following the presentation of the lightly shaded square and fruit for pointing to the circle following the presentation of the dark shaded square. Children in the non-differential outcomes group received either food or verbal praise randomly for correct responses. Each child received a total of 32 trials (presented in blocks of 8) randomized across the two sample stimuli. Children in the differential outcomes group had

significantly higher levels of accurate responding than those in the non-differential outcomes group.

Attempting to extend these results to older children, Estevez, Fuentes, Mari-Beffa, Gonzalez, and Alvarez (2001) used a DMTS task with 70 typically developing children ages 4 years to 8 years. The procedures were similar to those described in Maki et al., (1995). However, children in the DOE group received a green token for pointing to the correct comparison stimulus (i.e., nonsense symbols) following the presentation of one sample stimulus (i.e., nonsense symbol) and a red token for pointing to the correct comparison stimulus following the presentation of the other sample stimulus. Upon completion of the experiment, children exchanged the red tokens for food and the green tokens for toys. Children in the non-differential outcomes group received either red or green tokens randomly for correct responses. Two experiments were conducted using these procedures. In the first experiment, children in the DOE group learned the discrimination faster and with greater accuracy than those in the control group, with the exception of the older children (ages 7 years 6 months to 8 years 6 months). This finding led the authors to test (in the second experiment) whether the DOE was not replicated because the task was too easy for the older children. Thus, children were presented with four comparison stimuli rather than two. Results indicated that the older children in the DOE group performed better than those in the non-differential outcomes group when a more difficult discrimination task was used.

Miller, Waugh, and Chambers (2002) studied the DOE with typically developing adults. In this investigation, 63 college students were taught to discriminate between 15 abstract kanji characters (i.e., a Japanese writing system based on modified Chinese characters) using a MTS task. Sample stimuli (Kanji characters) were presented on a computer screen for 5 s followed by

a screen with 9 comparison stimuli (possible meanings of the Kanji characters). Each of the 15 characters was presented 3 times in each block of trials and a total of 3 blocks were presented to each participant. The reinforcers for selecting the correct comparison stimulus included a photograph of a picture on the screen (e.g., pond, waterfall, traffic) and an entry into one of 15 different lotteries for various items (e.g., cash, movie tickets, chocolates). For the DOE group, selecting the correct comparison stimuli resulted in a specific picture and entry into a specific prize lottery. For the partial DOE group, selecting the correct comparison stimulus resulted in a specific picture and an entry into any prize lottery (not one specific lottery). For the non-differential outcomes group, selecting the correct comparison stimulus resulted in the random presentation of a picture and random entry into one of the prize lotteries. The adults in the DOE group learned the matching task more rapidly than those in the non-differential outcomes group and the partial DOE group.

In contrast to these findings, a study investigating the DOE with four adults with mental retardation found no difference in accuracy scores for any of the participants on a task taught via differential outcomes and a task taught via a non-differential outcomes procedure (Dube et al., 1989). A DMTS task using nonsense symbols for the sample and comparison stimuli was presented on a touch-screen computer for all participants. In the DOE condition, the participant received one reinforcer (e.g., candy, penny) for touching the correct comparison stimulus following the presentation of one sample stimulus and a different reinforcer (e.g., different type of food) for touching the correct comparison stimulus following the presentation of the other sample stimulus. Correct responses resulted in randomized access to either reinforcer in the non-differential outcomes condition. No differences in the accuracy scores associated with the two conditions were obtained. The authors hypothesized that methodological differences between

this study and those conducted with nonhumans (e.g., degree of food deprivation) and species-specific behavioral differences in pigeons and humans (e.g., differences in ability to exhibit generalized identity matching) might explain the failure to replicate previous research on the DOE. However, it was unclear how the specific reinforcers were chosen for each participant. Furthermore, results may have been confounded by differential reinforcer effectiveness if the reinforcers associated with each stimulus were not similarly preferred.

Another step in establishing the clinical relevance of the DOE has been to extend this research to clinical populations and stimuli that are encountered in everyday life. The following section summarizes research conducted with individuals with developmental disabilities using tasks and stimuli that are commonly found in applied settings.

#### Applied Research with Individuals with Developmental Disabilities

A limited amount of applied research on the DOE has been conducted. The main findings of three applied studies will be described below. These studies were selected for inclusion in this review because they were the only applied investigations that employed a controlled experimental design (i.e., not case studies). In all of these studies, children with disabilities were taught receptive language skills with three-dimensional objects using a single-subject design. Generally, the authors concluded that stimulus-specific reinforcement (DOE) resulted in quicker acquisition than non-differential outcomes or arbitrary reinforcers alone.

In Janssen and Guess (1978), four children with mental retardation were taught to discriminate between three items presented simultaneously under two conditions: (a) A label-only condition in which the participant received an arbitrary reinforcer (e.g., praise or edibles) contingent on a correct response, and (b) a function-plus-label condition in which the participant received an arbitrary reinforcer, was shown how to use the item (e.g., stapler), and was permitted

to manipulate it contingent on a correct response (differential outcomes). In each condition, three stimulus items were presented to the individual and the experimenter instructed the individual to “Point to \_\_\_”. The authors concluded that the participants learned the object names more quickly in the function-plus-label condition than in the label-only condition.

Visual inspection of the graphed data did not show clear differences in responding across conditions (i.e., many of the data points overlap across conditions). In addition, this study contained several important limitations. First, the authors assumed that manipulating the object (e.g., cutting with scissors) was a reinforcer for the child. However, data on engagement with the objects were not recorded, and no other information was provided to suggest that the opportunity to manipulate the objects was a reinforcer for these individuals. Moreover, it was unclear how the arbitrary reinforcers (e.g., praise, food items) were identified for each participant and whether the arbitrary reinforcers were held constant across conditions and training items. Finally, the DOE was evaluated via a sequence of AB comparisons across tasks for each child rather than a more rigorous experimental design.

Saunders and Sailor (1979) investigated the effects of three types of reinforcement procedures on the acquisition of receptive language skills in three children with mental retardation. In each reinforcement condition, the experimenter presented two toys and instructed the child to “Point to the \_\_\_”. Nonsense syllables were used instead of the actual names of the toys to control for exposure to the correct item names outside of experimental sessions. Contingent on the correct response, the participant received: (a) Access to the correct toy (differential outcomes), (b) access to a third toy not included in the training pair (non-differential outcomes), or (c) random access to the correct toy or to the other toy in the training pair (non-differential outcomes). The order of the conditions varied across the participants. Two of the

participants were exposed to the first and second conditions twice (each time with different stimuli) and the third condition once. The third participant dropped out of the study before the sequence was completed. Each session consisted of 30 training trials, and each condition was implemented for 15 sessions.

Although the authors concluded that the participants had a higher percentage of correct responding in the DOE condition than in the other two conditions, visual inspection of the graphed data indicates that similar levels of responding occurred across most of the comparison conditions. Furthermore, the child's preference for the reinforcers was not held constant across conditions because different toys were used. Finally, a sequence of AB comparisons across tasks was implemented for each child rather than a more rigorous within-subject design.

Litt and Schreibman (1981) extended previous research by exploring some potential confounds of previous research (e.g., Janssen & Guess, 1978; Saunders & Sailor, 1979). More specifically, the investigators attempted to hold preference for the reinforcers constant across conditions by empirically identifying reinforcers that were of similar preference prior to the study. The purpose of the investigation was to compare the effects of stimulus-specific reinforcement (i.e., the DOE; a specific reinforcer paired with a specific stimulus) versus salient, non-differential reinforcement (i.e., one predetermined highly reinforcing consequence regardless of the stimuli presented). Participants were five boys diagnosed with autism. In each reinforcement condition, the experimenter presented two objects and instructed the child to “Give me \_\_\_” (e.g., nail, barrette, hinge). Each of the participants was exposed to three conditions in which contingent on a correct response the participant received: (a) One of two equally preferred reinforcers that was specific to that item, neither of which were the most preferred item from the preference assessment (i.e., differential outcomes), (b) a third item (the

most preferred reinforcer) (i.e., salient reinforcement or non-differential outcomes), or (c) one or the other of the equally preferred reinforcers regardless of the item requested (i.e., varied non-differential outcomes). The authors concluded that the DOE condition resulted in faster acquisition of the receptive labels than the other conditions, although visual inspection revealed no difference between the DOE and the varied non-differential outcomes condition for one of the children. The salient reinforcement condition resulted in the slowest acquisition for all children. However, this study was limited in several respects. First, procedures used to determine if the child knew the names of the objects prior to the study may have underestimated the baseline levels of correct responses. The child was required to respond correctly to the object name when all eight objects were presented simultaneously. Second, the investigators did not use a true experimental design but instead implemented a sequence of AB comparisons across tasks for each child.

As evident from this limited section, more applied research is needed on the DOE. Although the literature on the DOE is extensive, the vast majority of research has been conducted with nonhumans. Further research with clinical populations is needed to expand our understanding of the DOE, its theoretical underpinnings, and applied relevance. In the following section, the main theory about the basic process underlying the DOE is briefly discussed.

### Conceptual Development

The above research findings suggest that more rapid acquisition occurs in discrimination training when different responses result in different consequences. In behavior theory, the underlying process implicated in the DOE is that of stimulus control. As a result of discrimination training, a particular response will come under the control of a certain stimulus and, thus, will occur more often in the presence of this discriminative stimulus than in its

absence. With the DOE, the differential outcomes provided contingent on the different responses act as an additional source of control over the organism's behavior (Peterson, 1984). That is, the presentation of the stimulus being learned and the specific reinforcer both provide a source of stimulus control for that response. Acquisition occurs more rapidly because the response is under the control of two discriminative stimuli during DOE training rather than just one. Some authors have suggested that this underlying process is based on Pavlovian trace conditioning (Savage, 2001). That is, the discriminative stimulus acts as a conditioned stimulus due to pairing with an unconditioned stimulus (i.e., the outcome).

Although many basic studies have been conducted to evaluate various theories about the processes involved in the differential outcomes procedure (e.g., Ramos & Savage, 2003; Sherburne & Zentall, 1995; Sherburne & Zentall, 1998; Urcuioli & Zentall, 1990; Zentall & Sherburne, 1994), a more pressing concern for applied researchers involves the aspects of stimulus control that result in more efficient learning. As mentioned previously, Cooper et al. (1987) discussed five factors important to developing stimulus control (i.e., pre-attending skills, differential reinforcement, characteristics of the stimulus and its presentation, and the phenomena of masking and overshadowing). The authors suggested that some stimuli might be more salient than others, depending on the individual's past history of reinforcement, sensory capabilities, and the stimulus context. Furthermore, the stimulus control theory of the DOE suggests that stimulus-reinforcement pairings can exert control over responding.

One unexplored area of research with the DOE involves the relation between the stimulus and the outcome. It is possible that the degree of similarity or association between these two stimuli will influence the saliency of the stimuli and, thus, the amount of control over responding. More specifically, would a reinforcer that is highly similar to the stimulus being

learned (e.g., using the same item as both the discriminative stimulus and the reinforcer) result in that stimulus becoming more salient to the individual -- and thereby lead to faster acquisition of the discrimination -- than a reinforcer that is specific to the stimulus being learned but not similar? If so, this outcome would be important to the design of instructional strategies and might also provide additional support for the stimulus control interpretation of the DOE.

In the differential outcomes condition of previous studies, the reinforcer was either identical to the stimulus taught (e.g., Janssen and Guess, 1978; Saunders and Sailor, 1979) or different but stimulus-specific (e.g., Dube et al., 1989; Estevez et al., 2001; Litt and Schreibman, 1981; Maki et al., 1995; Miller, Waugh, and Chambers, 2002). However, these two differential outcomes conditions have been compared in just one previous study (Shepp, 1963).

In Shepp (1963), 41 children with mental retardation were taught a simultaneous two-choice discrimination task with two types of candies (marshmallows and M&M's™) as the discriminative stimuli. The participants were divided into three groups. For all groups, the candies were placed on food containers (i.e., a marshmallow on one container and an M&M™ on the other container) and covered with plastic. The participant was required to open the correct food container to obtain the reinforcer that was placed inside the container. The candy reinforcer inside the container was identical to the candy on the outside of the food container for one group (matched differential outcomes). Conversely, the candy reinforcer inside the container was identical to the candy on the outside of the opposing food container (i.e., on the incorrect food container) for the second group (unmatched differential outcomes). Lastly, the candy reinforcer was different from both of the candies on the containers (i.e., chocolate kisses) for the third group (nondifferential outcomes). Relative to participants in the nondifferential outcomes group, overall accuracy was highest for the participants in the matched differential

outcomes group and lowest for the participants in the unmatched differential outcomes group. The author concluded that strong stimulus control was established by using the reinforcers as a part of the comparison stimuli.

Nevertheless, this study had a number of limitations. First, for the unmatched differential outcomes condition, correct responses produced access to a reinforcer that was identical to the discriminative stimulus associated with the incorrect response. A better comparison would have been to use a reinforcer that was not identical to the incorrect stimulus. In fact, participants who received the same reinforcer for all correct responses (nondifferential outcomes group) acquired the discrimination more quickly than participants in the unmatched differential outcomes group. Second, the task instructions delivered to the participants were not described, making it difficult to evaluate and replicate the findings. Third, a preference assessment was not conducted to control for the possibility that one of the items acquired discriminative control over the participants' behavior more quickly because a response produced access to a more highly preferred reinforcer. Finally, the results were limited to food as stimuli and reinforcers.

## PURPOSE

The DOE refers to the finding that discriminations are acquired more quickly when different outcomes occur for different responses (Peterson & Trapold, 1980). A vast majority of the research on the DOE has been conducted with nonhuman participants. With the exception of one study (Santi & Savich, 1985), every study with nonhumans has supported the DOE phenomenon. Most of these investigations were conducted using a group design and primary reinforcers such as food and water. Various factors that may influence the DOE (e.g., the delay or magnitude of the reinforcer) have been evaluated, as well as particular theories about the phenomenon.

Less research on the DOE has been conducted with humans, and most of these studies contained various methodological weaknesses as described above. Clear differences in acquisition between the DOE and non-differential outcomes conditions were not found in two of the three applied studies although the authors concluded otherwise (e.g., Janssen & Guess, 1978; Saunders & Sailor, 1979). Nevertheless, the DOE has been replicated with humans in a number of published studies (with the exception of Dube et al., 1998). Furthermore, the DOE has some important implications for teaching discrimination skills effectively and efficiently to individuals with disabilities. That is, although using a matched DOE situation might only apply to discriminations in which the discriminative stimulus is also the reinforcer; there are several situations in teaching these children in which this might be the case. One such situation is seen in early intervention. For example, when teaching receptive language skills to children, educators can first teach the names of reinforcing items and allow the child to manipulate this item contingent on correct responses. Once the child has successfully learned these discriminations, the educator can begin to teach other items in which the reinforcer and stimuli

being learned might differ in physical qualities. In addition, this might help the child to become less frustrated with the task, increasing compliance and the acquisition of new discriminations. This would make learning more efficient in the future because the child would have a history of reinforcement for learning and might be more compliant to the task. Furthermore, one possibility is that educators use a matched DOE situation when teaching discriminations through exclusions. That is, educators could present one learned item (e.g., a ball) and one new item (e.g., a brush) which would help the child to learn the new item more efficiently. Alternatively, additional applied investigations that do not support the DOE would also be important to educators because educators could provide the child with a third item that is not specific to the stimulus being taught and not compromise the efficiency of the training.

Thus, further research on the DOE with clinical populations is needed to expand our understanding of this phenomenon, as well as its theoretical underpinnings and applied relevance. Investigations that correct for the methodological weaknesses of previous applied research with clinical populations would contribute significantly to the current literature. In addition, factors that may enhance the DOE should be evaluated.

According to behavior theory, the underlying process responsible for the DOE is that of stimulus control. An unexplored area of research with the DOE is the degree of similarity or association between the stimulus and reinforcer, a factor that may influence the amount of control over responding. More specifically, would using the same item as both the discriminative stimulus and the reinforcer lead to faster acquisition of the discrimination than a reinforcer that is specific to the stimulus being learned but not similar?

The purpose of the current study was to replicate and extend the results of Shepp (1963) by using a single-subjects design and a variety of food and toys. A preference assessment was

also conducted to decrease the likelihood that one of the stimuli might acquire discriminative control over the participant's behavior more quickly because a response produced access to a more highly preferred reinforcer. This control has not been included in a number of studies on the DOE (e.g., Estevez et al., 2001; Maki et al., 1995; Miller et al., 2002; Saunders & Sailor, 1979; Shepp, 1963). Furthermore, the effectiveness of the reinforcers was held constant by using the same reinforcers in all conditions.

Specifically, in the current investigation, four children diagnosed with autism and/or developmental delay/speech and language impairment were taught receptive language skills using a match-to-sample procedure. Three different reinforcement procedures were implemented using a combined multielement and non-concurrent multiple baseline design. In the DOE-Matched reinforcement condition, the reinforcer for a correct response was the same as the stimulus being taught. In the DOE-Unmatched reinforcement condition, the reinforcement for correct responses was one of two items that was specific to the stimulus being taught but was not either of the stimuli being taught. In the No-DOE condition, the reinforcement for correct responses was one of two items that were not specific to (or the same as) either of the stimuli being taught.

## METHOD

### Participants and Settings

Participants were four children, aged 3 years to 6 years. Three of the participants (Tyler, Johnny, and Jacob) had a diagnosis of autism, while Kyle had a diagnosis of developmental delay/speech and language impairment. None of the students had any physical or sensory impairment. The participants were not receiving any medications during this investigation.

Participants for the study were recruited from a group of children who had been referred for the assessment and treatment of various behavior problems, including noncompliance, disruption, and aggression. The participants' assessments and treatment evaluations were concluded prior to their entry into this study. To be included in the study, participants had to demonstrate some auditory-visual discrimination skills, as determined by performance on an initial discrimination test (see description below). The first four children who passed the pretest were included in the study.

Tyler was a 6 year-old boy who attended a self-contained preschool classroom for children with autism. His teacher reported that Tyler had some receptive language skills and used speech spontaneously. Johnny, a 5 year-old boy, attended a self-contained preschool classroom for children with autism. His teacher reported that he had some receptive language skills and limited spontaneous speech, often engaging in delayed echolalia. Jacob was a 3 year-old boy who attended a preschool classroom for children with developmental delays. His teacher reported that he had limited receptive and expressive language skills, and typically engaged in echolalia. Kyle, a 4 year-old boy, attended a preschool classroom for children with developmental delays. His teacher reported that he had some receptive language skills and limited expressive language skills and frequently engaged in delayed echolalia.

For Johnny and Jacob, all sessions were conducted in a small room of a building that housed a university-based early intervention summer program. For Tyler and Kyle, some or all sessions were conducted in a separate classroom at the child's school. The rooms each contained a table, chairs, and materials needed to conduct the sessions.

#### Response Measurement and Reliability

During the preference assessments, a choice response was recorded when the participant pointed to or reached for one of two items within 5 s of the experimenter's instruction (i.e., "Pick one"). Observers recorded the item selected on each trial using a specially designed data sheet and a pencil. Data for each item were summarized by totaling the number of times that it was chosen (see further description below). A second observer independently collected data during at least 34% of the preference assessments using an identical data sheet and a pencil.

Interobserver agreement was calculated for each participant by dividing the total number of trial agreements by the total number of presentation trials. Interobserver agreement was 99% (range, 98.3% to 100%) for Tyler, 100% for Johnny, 99.7% (range, 98.9% to 100%) for Jacob, and 98.4% (range, 98.4% to 98.4%) for Kyle.

Correct responses during baseline and training were defined as the participant picking up the requested item and placing it in the experimenter's open hand within 10 s of the instruction. Observers collected frequency data on correct responses using laptop computers. A second observer independently collected data during at least 55% of the sessions for each participant. Interobserver agreement was calculated on a point-by-point basis using the mean occurrence agreement method. Interobserver agreement was 99.7% (range, 90% to 100%) for Tyler, 99.3% (range, 90% to 100%) for Kyle, 99.4% (range, 87.5% to 100%) for Jacob, and

100% for Johnny. The primary dependent measure was the number of sessions to reach the discrimination criteria under each of the reinforcement conditions.

#### Procedures – Discrimination Pre-Test

To be eligible for the study, participants had to successfully pass (i.e., respond correctly on 8 out of 10 trials) an initial discrimination pretest. At the beginning of each trial, the experimenter simultaneously presented two familiar items (identified via parent or teacher report) on the table in front of the child and delivered the instruction, “Give me \_\_\_\_\_”. The two test items were presented at equal distance from the child. The order of the items requested and the left-right position of each item were randomized. If the child responded correctly (i.e., picked up the correct item and placed it in the experimenter’s open hand) within 10 s of the instruction, brief verbal praise (e.g., “Good job”) was delivered, the items were removed, and the trial was terminated. If the child did not respond within 10 s or responded incorrectly, the items were removed and the trial was terminated. No consequences were provided for incorrect responses or for the absence of a response. The test consisted of 10 trials (5 trials for each item).

#### Procedures - Preference Assessments

Prior to the study, paired-choice preference assessments were conducted to identify preferred toys and food for each participant using procedures similar to those described by Fisher et al. (1992). The purpose of this assessment was to identify the items that were used in the discrimination training conditions (see further discussion below). The various food items and toys were selected from among those nominated by parents and teachers as potential reinforcers and from items commonly used as reinforcers. Food and toys were evaluated in separate preference assessments (DeLeon, Iwata, & Roscoe, 1997). A total of 14 items were used in each

assessment with the exception of Tyler's toy assessment, which included 13 items due to a malfunction of one of the toys.

During the assessments, two items were presented simultaneously at equal distance from the child. The experimenter directed the child to, "Pick one." The child was given brief access (i.e., 20-s access to toys or a small piece of food) to the first item that the child approached. If the child approached both items simultaneously, the experimenter blocked the approach response and re-presented the items. If the child did not approach either item, the experimenter briefly exposed the child to both items (allowed 5-s access to the toy or permitted consumption of a small piece of the food) and then re-presented the items to the child. The left-right presentation of the items was randomly determined. Items were presented in pairs until each item had been paired with every other item once. Each food and toy assessment was conducted twice.

The percentage of opportunities in which the item was approached was calculated by totaling the number of times each item was approached across the two assessments, dividing this number by the total number of opportunities to select the item, and multiplying this number by 100. For each participant, the six highest preferred items with the most comparable approach percentages (from the separate food and toy assessments) were then selected for the study. Thus, a total of 12 items (6 food items and 6 toy items) were used in the study for each participant. For each reinforcer type (food versus toys), the six items were divided into three pairs (see further explanation below). The items that comprised each pair were associated with a similar percentage of approach responses and a "split" preference during the two preference assessments (see Table 1). Preference for two items was considered "split" when the child chose one item the first time the two items were paired together and the other item the second time the items were paired together. For example, a split preference was identified for a ball and top if the child

Table 1  
 Percentage of Opportunities Each Item was Chosen During Preference Assessment and  
 Reinforcers per Child and Condition

Child/Type of Reinforcer	Condition	Nonsense Word	Item	Percent Approached	Reinforcer
Jacob/Food	Matched	CĀD	Cheeto	54%	Cheeto
		SĔG	Oatmeal	58%	Oatmeal
	Unmatched	FĪS	Sugar Cookie	50%	Cheeto
		MŎD	Nutter Butter	50%	Oatmeal
		No DOE	TĪJ	Fruit Loop	46%
PŎF	Apple Juice	46%	Cheeto or Oatmeal		
Jacob/Toys	Matched	BĀN	Radio	85%	Radio
		RĪL	Slinky	66%	Slinky
	Unmatched	DĔG	Rainstick	54%	Radio
		VŎM	Keyboard	54%	Slinky
		No DOE	HŎB	Lightstick	69%
NĪZ	Bubbles	58%	Radio or Slinky		
Johnny/Food	Matched	CĀD	Pretzel	77%	Pretzel
		SĔG	Bacon Chip	73%	Bacon Chip
	Unmatched	FĪS	Oreo Cookie	73%	Bacon Chip
		MŎD	Frito	54%	Pretzel
		No DOE	TĪJ	Cheeto	65%
PŎF	Cracker	65%	Pretzel or Bacon Chip		
Johnny/Toys	Matched	BĀN	Lightstick	77%	Lightstick
		RĪL	Guitar	77%	Guitar
	Unmatched	DĔG	Radio	54%	Lightstick
		VŎM	Car	58%	Guitar
		No DOE	HŎB	Keyboard	69%
NĪZ	Plastic Food	65%	Lightstick or Guitar		
Kyle/Food	Matched	CĀD	Funyon	88%	Funyon
		SĔG	Cheeto	92%	Cheeto
	Unmatched	FĪS	Brownie	54%	Funyon
		MŎD	Jelly Bean	50%	Cheeto
		No DOE	TĪJ	Sugar Cookie	54%
PŎF	Fruit Loop	58%	Funyon or Cheeto		
Kyle/Toys	Matched	BĀN	Slinky	73%	Slinky
		RĪL	Dolphin	88%	Dolphin
	Unmatched	DĔG	Car	46%	Slinky
		VŎM	Plastic Food	42%	Dolphin
		No DOE	HŎB	Bumble Ball	65%
NĪZ	Helicopter	69%	Slinky or Dolphin		
Tyler/Food	Matched	CĀD	M&M	85%	M&M
		SĔG	Cookie	73%	Cookie
	Unmatched	FĪS	Kit Kat	46%	Cookie
		MŎD	Nutter Butter	65%	M&M

(Table 1 Continued)

Child/Type of Reinforcer	Condition	Nonsense Word	Item	Percent Approached	Reinforcer
Tyler/Toys	No DOE	TĪJ	Brownie	65%	M&M or Cookie
		PŌF	Snickers	58%	M&M or Cookie
	Matched	BĀN	Top	92%	Top
		RĪL	Dolphin	88%	Dolphin
	Unmatched	DĒG	Radio	58%	Top
		VŌM	Signs	58%	Dolphin
	No DOE	HŌB	Keyboard	75%	Top or Dolphin
		NĪZ	Slinky	75%	Top or Dolphin

chose the ball when the ball and top were paired together during the first preference assessment but chose the top when the items were paired together during the second preference assessment. If a split preference was not identified for any of these six items, the highest preferred item from the remaining array was selected until the criteria for grouping the items were satisfied.

However, items chosen on less than 40% of the trials during the assessments were excluded.

Although this was not necessary in the current study, additional preference assessments would have been conducted with alternative items until six items meeting the criteria were identified.

#### Procedures - Discrimination Training

Each pair of items described above was assigned to one of three conditions: (a) DOE-Matched, (b) DOE-Unmatched, or (c) No DOE (see further description of these below) and remained in the same condition throughout the study. The three conditions included only food items or only toy items. The pair with the highest percentage of approach responses was assigned to the DOE-Matched condition and served as the reinforcers for correct responding in all three conditions. The reinforcers were held constant across the conditions to eliminate the possibility that differences in the rates of learning might be attributed to differential reinforcer effectiveness (i.e., that the reinforcers provided for correct responses in the DOE-Matched

condition were more effective than those provided in the DOE-Unmatched condition) instead of to the differential outcomes. This was a potential confound in numerous previous studies on the DOE (e.g., Estevez et al., 2001; Maki et al., 1995; Miller et al., 2002; Saunders & Sailor, 1979). The remaining pairs were randomly assigned to the DOE-Unmatched and No DOE conditions.

To control for possible exposure to the correct item names during the study, a different nonsense one-syllable word was assigned to each item in each pair. Nonsense words consisted of three letters and were in a consonant-vowel-consonant format (e.g., CĀD, PŌF, TĬJ). Pairs consisted of one nonsense word with a short vowel and one nonsense word with a long vowel to control for the level of difficulty in differentiating the word pronunciations for each condition. All food items were placed in clear quart-sized sealed Ziploc bags. A more complete description of the specific reinforcers used, assignment to various conditions, and nonsense words used for each child is provided in Table 1.

In all conditions, the child was seated at a table with the experimenter. Each session consisted of 10 trials (5 trials per item). Each trial consisted of a verbal instruction to hand the experimenter one of the two item(s) based on its assigned label name (and prompts if necessary), the child's response to the instruction, and a consequence provided by the experimenter (except in baseline). The order of the items requested and the left-right position of each item were randomized. Approximately three to seven sessions were conducted per day for each child, four to five days per week.

The acquisition criteria were 8 of 10 correct independent responses for 3 consecutive sessions. In addition, the child had to respond correctly on at least 4 out of 5 trials for each of the two items per session to meet the criteria. Once responding met the criteria in a particular

condition, no further sessions were conducted under that condition. The remaining condition(s) continued to be implemented until the acquisition criteria were met.

**Baseline.** During baseline, a new trial was presented approximately every 10 s. At the beginning of each trial, the experimenter placed the paired items for that condition on the table in front of the child and delivered the instruction, “Give me \_\_\_\_\_”. If the child responded correctly within 10 s of the instruction, the items were removed and the trial terminated. If the child did not respond within 10 s or responded incorrectly, the items were removed and the trial was terminated. No consequences were provided for correct or incorrect responses, or for the absence of a response. At least three sessions were conducted with each pair of items.

**DOE-Matched.** Procedures were the same as those described above except that prompts were provided, and reinforcement was delivered for correct responses. If the child did not respond or responded incorrectly within 5 s of the initial instruction, the experimenter delivered a gestural prompt (i.e., pointed to the correct item). If the child did not respond or responded incorrectly within 5 s of the gestural prompt, the therapist physically guided the child to exhibit the correct response, and the trial was terminated. Any responses that immediately followed the physical prompt were ignored, and the experimenter continued to the next trial. Contingent upon correct responses to the initial verbal instruction or the gestural prompt, the child was given brief access to the requested item (i.e., allowed to consume the edible or given 20-s access to the toy). For example, if the child was learning Item A and Item B, the child received Item A as a reinforcer for responding correctly to a request for Item A and Item B as a reinforcer for responding correctly to a request for Item B. The gestural and physical prompts were faded systematically within and across sessions using a progressive time-delay procedure. Specifically, the prompts were faded by 1 s (i.e., delivered 5 s after the initial instruction, then 6

s, then 7 s, etc.) following 3 consecutive trials with independent and/or prompted correct responses until the delay reached 10 s, at which point the prompts were terminated. After the gestural prompt was faded completely, the trial was terminated if the child did not respond within 10 s of the initial verbal instruction.

DOE-Unmatched. Procedures in this condition were identical to those in the DOE-Matched condition except that, contingent on correct responses, the child received access to a food item or toy that was unique to the item and its label but was not one of the two test items in the pair. For example, if the child was learning Item C and Item D, the child received Item A as a reinforcer for responding correctly to a request for Item C and Item B as a reinforcer for responding correctly to a request for Item D.

No DOE. Procedures in this condition were identical to those described in the previous two conditions except that, contingent on correct responses, the child received randomized access to one of two food or toy items that was not one of the two test items in the pair. For example, if the child was learning Item E and Item F, the child sometimes received Item A as a reinforcer and sometimes received Item B as a reinforcer for responding correctly to a request for Item E; in a similar manner, the child sometimes received Item A as a reinforcer and sometimes Item B as a reinforcer for responding correctly to a request for Item F.

### Experimental Design

A combined multielement and non-concurrent multiple baseline design across reinforcer type (i.e., food and toys) was used. The effects of the three reinforcement conditions (i.e., DOE-Matched, DOE-Unmatched, and No DOE) were compared for one type of reinforcer (i.e., food or toys) via a multielement design by randomly alternating sessions with each condition on a

daily basis. To further strengthen the experimental design, these reinforcement conditions were also compared for the other type of reinforcer (i.e., food or toys) via a multiple baseline design.

## RESULTS

The primary dependent measure was the number of sessions to reach the discrimination criteria under each of the reinforcement conditions. Overall, the rate of acquisition was similar across the three conditions (DOE-Matched, DOE-Unmatched, and No DOE). The percentage of correct responses during each reinforcement condition is shown across reinforcer type (i.e., food and toys) for each participant in Figures 1 through 4. In the discussion below, the average percentage of correct responses from the last 3 sessions in each condition are presented in parentheses.

During the toy baseline, Johnny displayed similar low levels of correct responses with the items in all three of the conditions. As shown in Figure 1, Johnny met the criteria first in the DOE-Unmatched condition in 8 sessions ( $M = 93\%$ ), followed closely by the DOE-Matched condition in 9 sessions ( $M = 97\%$ ). He met the criteria in the No DOE condition in 13 sessions ( $M = 90\%$ ). In Johnny's food baseline, correct responding was slightly more variable but never exceeded "chance" levels. Overall, similar low levels of correct responses were found in all three conditions. As shown in the lower panel of Figure 1, Johnny again first met the criteria in the DOE-Unmatched condition in 6 sessions ( $M = 97\%$ ), followed by the DOE-Matched condition in 7 sessions ( $M = 93\%$ ), and the No DOE condition in 11 sessions ( $M = 100\%$ ).

Tyler's toy baseline, presented in the top panel of Figure 2, shows that his percentage of correct responding was variable in all three conditions. Correct responses were initially high in the No DOE condition because Tyler arbitrarily (and correctly) decided which item he would choose for each nonsense word and responded consistently in this way. However, correct responses decreased across the remaining baseline sessions, and were below "chance levels"

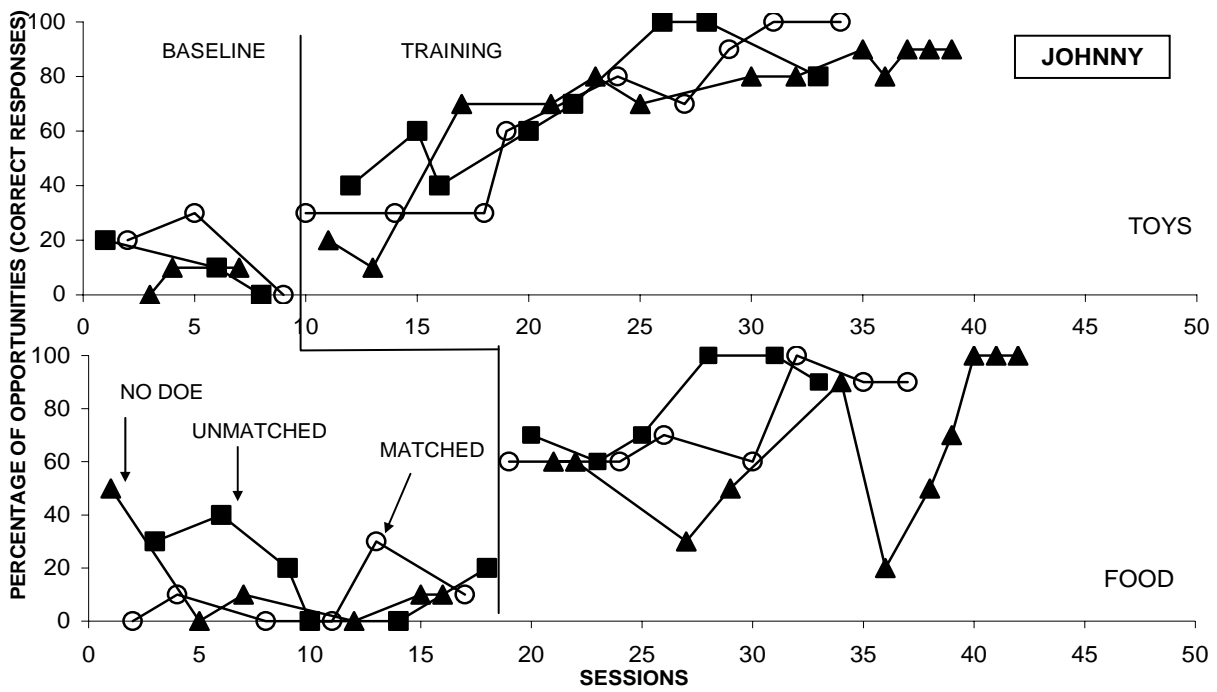


Figure 1. Percentage of opportunities followed by correct responses for Johnny during baseline and training for both toys (top panel) and food (bottom panel).

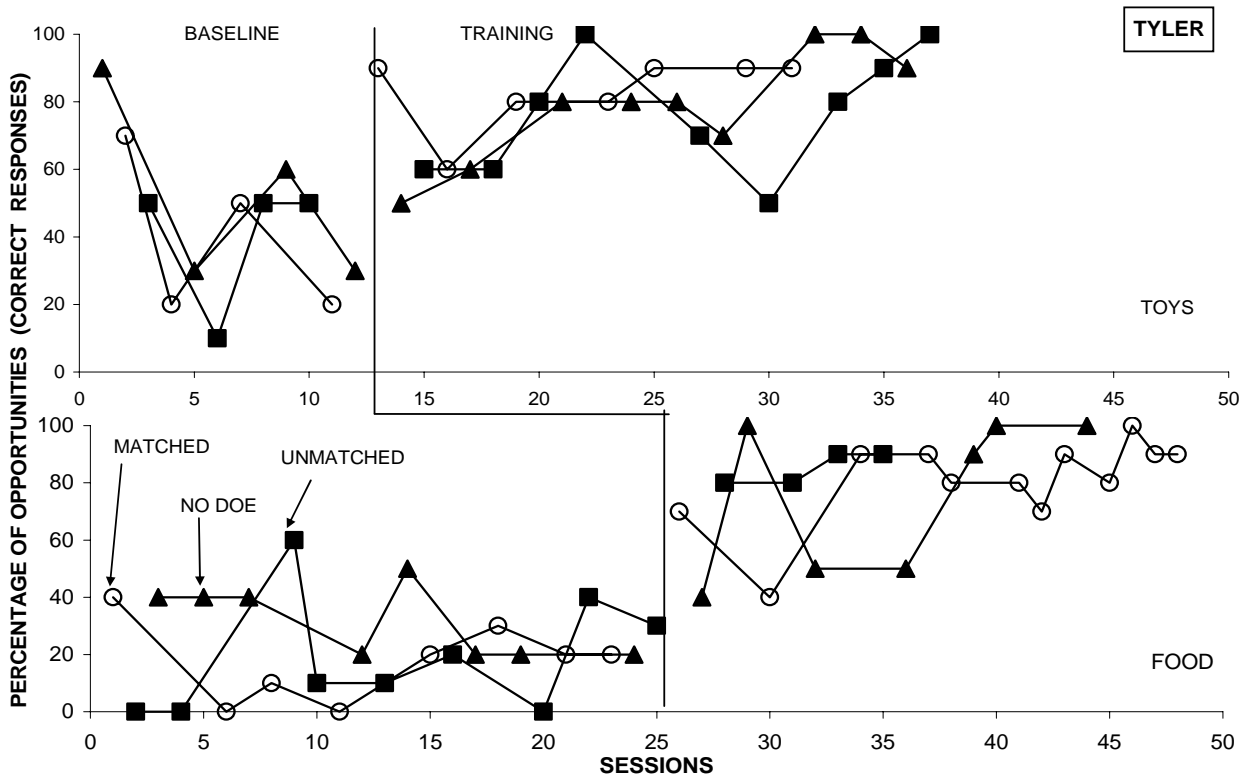


Figure 2. Percentage of opportunities followed by correct responses for Tyler during baseline and training for both toys (top panel) and food (bottom panel).

during the final sessions of each condition. Once the training phase began, Tyler met the acquisition criteria in the DOE-Matched condition in 7 sessions (M = 90%). He then met the criteria in the other two conditions, DOE-Unmatched (M = 90%) and No DOE (M = 97%), in 9 sessions. The lower panel of Figure 2 presents Tyler's data for the food items. Responding was similar across the three conditions during baseline. In the training phase, Tyler met the criteria in the DOE-Unmatched condition in 4 sessions (M = 87%), followed by the No DOE condition in 7 sessions (M = 97%), and then the DOE-Matched condition in 12 sessions (M = 93%).

Kyle's results are presented in Figure 3. The top panel shows the results of the food reinforcer sessions and the bottom panel shows the results of the toy reinforcer sessions. In his food baseline, Kyle had similar low levels of correct responding in all three conditions. In addition, correct responding decreased in all conditions during baseline. Once the food training phase began, Kyle met the criteria in the DOE-Matched condition in 7 sessions (M = 100%). He then met the criteria in the DOE-Unmatched condition in 10 sessions (M = 100%), followed by the No DOE condition in 13 sessions (M = 93%). On the left side of the lower panel are the results for Kyle's toy baseline. The highest percentage of correct responses (80%) occurred during the first No DOE session; however, responding was similarly low during all three conditions for most of baseline, eventually decreasing to zero levels. Upon the introduction of training, Kyle met criteria for the No DOE condition in 3 sessions (M = 87%), the DOE-Matched condition in 5 sessions (M = 100%), and the DOE-Unmatched condition in 6 sessions (M = 100%).

Finally, the results of Jacob's food and toy sessions are presented in Figure 4. During Jacob's food baseline, correct responding remained at zero for all sessions except for two No DOE sessions. As shown in the upper right panel of Figure 4, Jacob met criteria in the DOE-

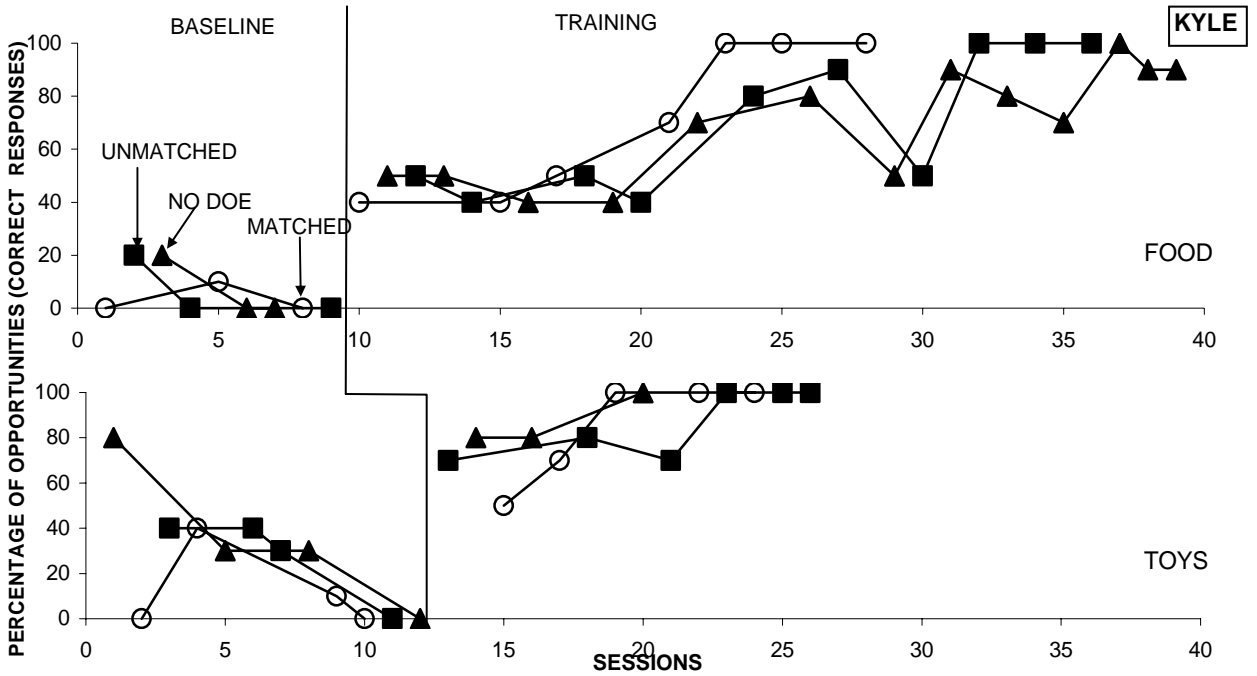


Figure 3. Percentage of opportunities followed by correct responses for Kyle during baseline and training for both food (top panel) and toys (bottom panel).

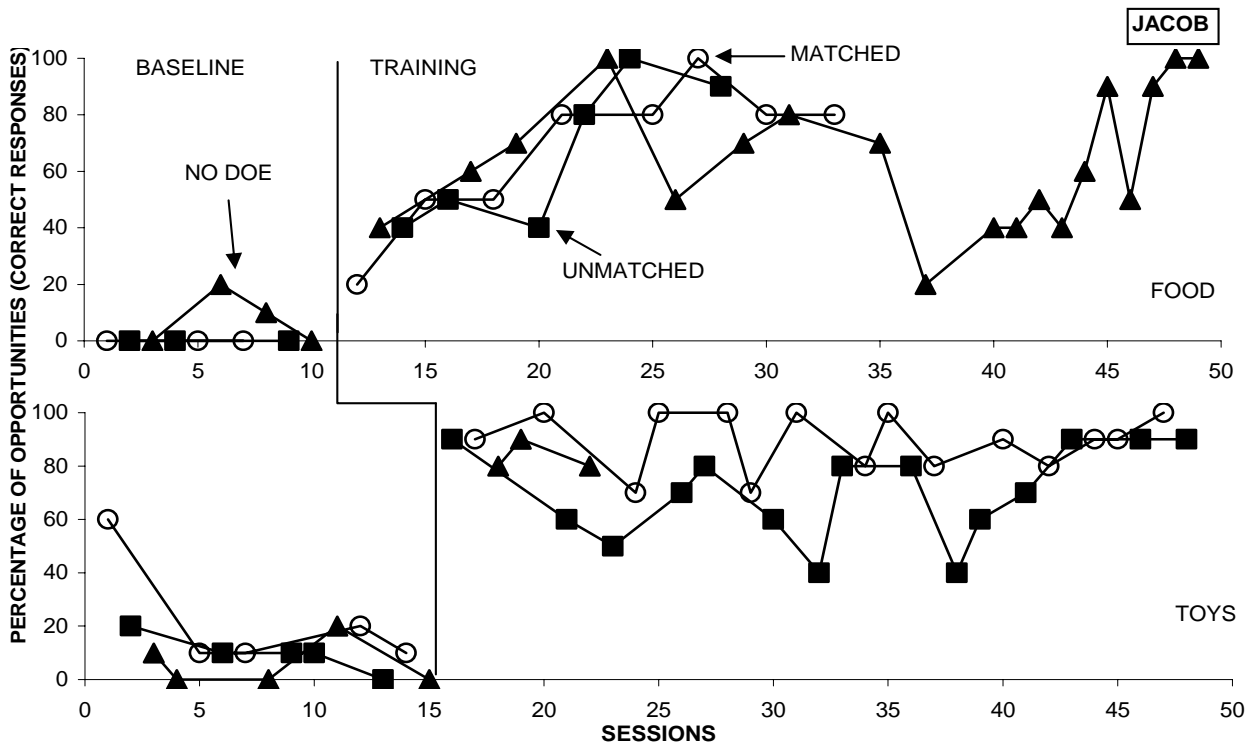


Figure 4. Percentage of opportunities followed by correct responses for Jacob during baseline and training for both food (top panel) and toys (bottom panel).

Unmatched condition in 6 sessions ( $M = 90\%$ ), followed by the DOE-Matched condition in 8 sessions ( $M = 87\%$ ). Correct responses in the No DOE condition were more variable than in the DOE conditions and he did not exceed the criteria in this condition until session 19 ( $M = 97\%$ ). The bottom panel of Figure 4 displays the results of Jacob's toy sessions. During baseline, the first DOE-Matched condition reached a level of 60% correct responding and then dropped to levels similar to those in the other conditions (all below 20% correct responding). As shown in the bottom right panel of Figure 4, Jacob met the criteria in the No DOE condition in 3 sessions ( $M = 83\%$ ). He then met the criteria in both the DOE-Matched ( $M = 93\%$ ) and DOE-Unmatched ( $M = 90\%$ ) conditions at session 15.

## DISCUSSION

The DOE is a well-known phenomenon in behavior analysis and is commonly described in basic texts and literature reviews (e.g., Chance, 1999; Goeters, Blakely, & Poling, 1992). To date, the majority of research on the DOE has been conducted in the laboratory setting with rats and pigeons. Only three applied studies have been conducted on the DOE even though basic findings have important implications for teaching discriminations to individuals with developmental disabilities. Applied studies generally have not shown clear differences in responding under DOE and No-DOE conditions. Moreover, these studies contained a number of methodological weaknesses, including the failure to conduct preference assessments when identifying reinforcers, use of weak experimental designs, and the lack of proper control over the preference level of stimuli and reinforcers within and across conditions.

The current study attempted to control for these limitations while also investigating one factor that may influence the DOE. Nevertheless, similar patterns of response acquisition were observed in all three conditions (DOE-Matched, DOE-Unmatched, and No DOE). These findings are not consistent with those obtained in the basic laboratory, but they are similar to those reported in the applied literature. In the basic literature, only one study has failed to support the DOE (e.g., Santi & Savich, 1985). As noted above, a clear advantage of using reinforcement procedures based on the DOE has not been demonstrated in the applied literature. Although the authors of three studies reported the successful demonstration of the DOE, visual inspection of the data revealed similar levels of correct responding under the DOE and No DOE conditions (Janssen & Guess, 1978; Litt & Schreibman, 1981; Saunders & Sailors, 1979). Thus, although the DOE might be a robust phenomenon in the basic laboratory, this relationship may not easily translate into an applied technology.

Furthermore, the DOE-Matched condition resulted in faster acquisition than the DOE-Unmatched condition in just 3 of 8 comparisons, an outcome that likely occurred due to chance alone. The average percentage of correct responses across the last 3 sessions was similar for the DOE-Matched condition ( $M = 94\%$ ) and the DOE-Unmatched condition ( $M = 93\%$ ). This finding is inconsistent with a stimulus control interpretation of the DOE.

### Contributions to Current Literature

Despite the negative findings, this study extends the current literature in several ways. As noted above, the majority of the investigations on the DOE have been conducted with nonhumans. The current investigation contributes to the limited number of applied studies conducted with participants who would greatly benefit from improvements in educational interventions (i.e., children with developmental disabilities). This is especially important because the DOE has not been convincingly replicated with clinical populations although it is considered a durable finding in the basic literature.

The current study also extends that conducted by Shepp (1963) in several ways. First, a single-subject design was used in lieu of a between-group design. Under a group design, levels of responding are averaged across participants, making it difficult to determine if any obtained differences in responding are clinically significant. With a single-subject design, visual inspection allows the researcher to examine the impact of the DOE on the response acquisition of each individual. A combined multielement and non-concurrent multiple baseline design was employed to improve upon the experimental rigor of previous applied investigations that examined the DOE within subject via a series of AB comparisons (e.g., Janssen & Guess, 1978; Litt & Schreibman, 1981; Saunders & Sailors, 1979). Second, Shepp (1963) used food items as reinforcers, whereas both food and toy reinforcers were assessed in the current study to

investigate whether the type of reinforcer might influence the results. Food reinforcers have been used in most of the previous studies on the DOE.

An additional limitation of Shepp (1963) and many other studies on the DOE (e.g., Estevez et al., 2001; Maki et al., 1995; Miller et al., 2002; Saunders & Sailor, 1979; Shepp, 1963) was the failure to conduct a preference assessment. Without knowledge of relative preference for the items included in the evaluation, one of the discriminative stimuli may develop more control over the participant's behavior because it is a more highly preferred stimulus. In the current study, paired-choice preference assessments were conducted with each participant based on procedures described by Fisher et al. (1992). In addition, to decrease the possibility of differential reinforcer effectiveness, the same reinforcers were used in all of the conditions, a control not included in a number of previous studies on the DOE (e.g., Estevez et al., 2001; Maki et al., 1995; Miller et al., 2002; Saunders & Sailor, 1979).

#### Limitations

Despite the methodological strengths of the study, a number of possible limitations should also be discussed. First, the most preferred toys and food items were delivered for correct responding in all three conditions to maximize reinforcement effects. Thus, the highest preferred items were necessarily used as the discriminative stimuli in the DOE-Matched condition. This procedural arrangement could have influenced the speed with which responding reached the acquisition criteria in the DOE-Matched condition. That is, acquisition might have been most rapid in the DOE-Matched condition because of this confound. However, results indicated that the DOE-Matched condition often resulted in slower acquisition than the other conditions. Second, the discriminative stimuli were of similar but not equal preference levels within and across conditions. One might argue that the slight difference in preference levels of the stimuli

could have resulted in faster acquisition for those items that were most preferred. However, this also seems unlikely to have occurred because the DOE-Matched condition was not consistently the first condition to reach criteria.

Third, because three conditions (DOE-Matched, DOE-Unmatched, and No-DOE) were rapidly alternated in a multielement design, the effects observed in one condition may have carried over to other conditions. Thus, the DOE may not have been apparent due to interaction effects. To reduce interaction effects, future research might implement an alternative design, such as a reversal design. With this method, a series of sessions are conducted with each condition before implementing the next condition and then each of the series are replicated to demonstrate control. It should be noted, however, that the DOE also has not been demonstrated when alternative experimental designs were used (e.g., Janssen & Guess, 1978; Saunders & Sailors, 1979). A related limitation is that the same reinforcers were delivered across all conditions. Even though a particular stimulus was associated with a particular consequence in one condition, that same consequence was associated with different stimuli in other conditions. This procedure may have reduced the saliency of the stimulus-reinforcer pairings, thereby interfering with the DOE.

Fifth, each condition was discontinued when the participant met the acquisition criteria under that condition. This approach was used to limit potential interaction effects across conditions and to increase the efficiency of the assessment. However, results do not provide any information about the maintenance of responding under each condition. It is also possible that responding reached the acquisition criteria more quickly in the remaining condition(s) once the other condition(s) were discontinued. The alternative would have been to continue the assessment until responding met the criteria in all conditions. However, this approach also might

have introduced confounds because one or two maintenance conditions (i.e., the mastered conditions) would have been interspersed with one or two acquisition conditions (i.e., the conditions that did not meet criteria yet).

Finally, it is difficult to compare these findings to those reported in other studies because the participants may have been somewhat heterogeneous. All of the participants had similar diagnoses (autism and developmental delay/speech and language impairment) and communication skills, and all demonstrated basic visual discrimination skills by passing a discrimination pre-test. However, the participants' skill levels may have varied in important ways and may have differed from those who participated in previous research. In fact, one of the children in this study did not have a formal diagnosis of autism. Kyle was included because he appeared to be of a similar functioning level as the other children. It should be noted that many previous studies also failed to include potentially important information about participant characteristics. Information garnered from the administration of standardized tests (e.g., intelligence tests, adaptive behavior scales, etc.) could be included to better define the participants in future research.

#### Potential Explanations for the Outcomes and Directions for Future Research

There are several potential explanations as to why basic findings on the DOE have not been replicated in the applied literature with clinical populations and tasks. Group designs were employed in the majority of basic studies with nonhumans. However, this explanation is questionable because several basic studies on the DOE employed single subject reversal designs (e.g., Ailing, Nickel, & Poling, 1991; Honig, Matheson, & Dodd, 1984; Peterson, Wheeler, & Armstrong, 1978). Another possible explanation, described by Dube, Rocco, and McIlvane (1989), is that nonhuman subjects were highly deprived of the reinforcer (i.e., food) in basic

research. Similar deprivation levels were not used with human participants. Therefore, the motivation to gain access to the reinforcer might have been higher in basic studies than in applied studies where no (or a limited degree of) deprivation for the reinforcer had been established. This potential difference in the establishing operations for responding might interact with the DOE.

Other variables might interact with the DOE, thereby limiting its utility when these variables are present. The type of task is one such variable that might influence the effectiveness of the DOE. The MTS task that has typically been implemented in basic studies on the DOE involved the presentation of a sample visual stimulus followed by the presentation of two comparison visual stimuli. In the current investigation and previous applied studies, the DOE was examined within the context of teaching receptive language skills using three-dimensional objects (e.g., Janssen & Guess, 1978; Litt & Schreibman, 1981; Saunders & Sailor, 1979). The verbal instruction was the sample stimulus and the two edible or toy items in the discrimination pair were the comparison stimuli. As such, the sample and comparison stimuli were presented in two different modalities (i.e., auditory and visual), whereas the stimuli in basic research were presented in the same modality (i.e., visual). The effects of this factor on the DOE should be examined in future research.

An additional consideration is task difficulty. It is possible that, due to ceiling effects, the DOE will not enhance the outcomes of discrimination training when the discriminations are relatively easy for the participant to acquire. In general, the participants in the current study met the acquisition criteria in relatively few sessions during all conditions. The potential beneficial effects of the DOE may have been evident if the participants had been given more difficult discriminations. In fact, Estevez et al. (2001) initially failed to obtain the DOE with older

children until more difficult tasks were introduced. This factor should be evaluated in further research. For example, a pretest could be conducted to identify task dimensions that might be altered to make the discrimination more difficult (e.g., increase the number of stimuli in the discrimination, decrease the number of physical differences between stimuli). Using a multielement design embedded in a multiple baseline across reinforcer type, researchers could expose the participant to a DOE-Easy discrimination condition (e.g., two-choice discrimination), a DOE-Difficult discrimination condition (e.g., four-choice discrimination), and a No-DOE condition. This procedure would then be replicated with a variety of reinforcer types (e.g., food and toys).

Characteristics of the participants also might account for the inconsistent results obtained in basic versus applied research on the DOE. Participants in the majority of basic studies with humans were either typically developing children (e.g., Estevez et al., 2001; Maki et al., 1995) or typically developing adults (Miller et al., 2002). The children in the current study, as well as those in other applied studies that did not obtain the DOE, were diagnosed with a developmental disability (e.g., Janssen & Guess, 1978; Saunders & Sailor, 1979). Furthermore, in one basic study, no differences in accuracy scores were obtained when adults with developmental disabilities were exposed to DOE and No-DOE conditions (Dube et al., 1989). It is possible that the DOE might not have a significant influence on discrimination training for individuals with developmental disabilities. As noted above, the participant sample must be carefully identified (perhaps via standardized measures) to identify the potential impact of participant characteristics on the DOE in further research.

## Theoretical Considerations

One question raised by the current investigation involved the role of stimulus control as an underlying explanation for the DOE. That is, is it possible that the degree of similarity between the stimulus and the outcome will influence the saliency of the stimuli and, thus, the amount of control over responding? The results of this investigation indicated that the DOE-Unmatched condition resulted in faster acquisition than the DOE-Matched condition in 5 of 8 comparisons. These findings do not provide support for stimulus control as an underlying process of the DOE. However, it is possible that this procedure did not support the stimulus control theory because the saliency of the stimulus was influenced by other variables. That is, several factors might have influenced the ease with which a particular stimulus achieved control over responding, including the participant's sensory capabilities, past history of reinforcement, or potential confounding variables in the environment (e.g., noises outside of the room; Cooper et al., 1987). An additional consideration is that a phenomenon called "overshadowing" might have influenced the saliency of the stimuli for some of the participants. That is, the acquisition of one stimulus might have interfered with the acquisition of the second stimulus (Urcuioli & Honig, 1980; Zentall, 2004). For example, the DOE-Unmatched condition resulted in faster acquisition than the DOE-Matched condition with food reinforcers for Tyler. In the DOE-Matched condition, Tyler reached the acquisition criteria with one of the items 7 sessions sooner than with the other item. However, in the DOE-Unmatched condition, the two items reached acquisition criteria only 1 session apart from each other. It is possible that the first item that was learned overshadowed the other stimulus in the DOE-Matched condition.

Future research might further investigate the possibility of stimulus control as an explanation of the DOE. These studies might evaluate this theory in the basic laboratory using

the same procedures that have successfully demonstrated the DOE while also including the additional unmatched DOE condition. For example, researchers might present a pigeon with food. After a brief delay, the researcher might present the pigeon with food and water. Upon the pigeon's correct response (i.e., choosing food), the pigeon would be allowed to consume the reinforcer that is identical to the correct stimulus. In a non-differential outcomes condition, the pigeon would receive a third reinforcer not specific to the stimulus for responding correctly. This type of DMTS procedure might also be investigated with humans. An additional strategy would be to implement techniques to decrease the likelihood of overshadowing. According to Cooper et al. (1987), some of these techniques might include: (a) altering the physical environment to decrease the saliency of the learned stimulus, (b) working at a quicker pace and increasing the number of opportunities to respond, and (c) providing high rates of reinforcement for responding to the acquisition stimulus.

Alternatively, some researchers have suggested that the DOE is based on Pavlovian trace-conditioning procedures (Savage, 2001). That is, the stimulus acts as a conditioned stimulus which is terminated and then followed by a response and an unconditioned stimulus or outcome. Investigations of the Pavlovian trace-conditioning theory of the DOE are typically conducted using transfer-of-control studies. In a transfer-of-control study, Pavlovian conditioning of novel stimuli to differential outcomes is implemented (Ramos & Savage, 2003). Several transfer-of-control investigations of the DOE have suggested that Pavlovian conditioning (e.g., stimulus-stimulus pairings) is sufficient in explaining the DOE (e.g., DeLong & Wasserman, 1981; Honig et al., 1984; Peterson, 1984; Peterson & Trapold, 1980, 1982).

## Implications for Teaching Autistic Children

Results of this study did not support the clinical utility of the DOE for children with developmental disabilities. Research investigating techniques such as the DOE is especially important for children with autism and other developmental disabilities, who have difficulty learning discriminations. A wide variety of strategies have been developed to improve discrimination training for children with disabilities including (a) errorless learning techniques, (b) exclusion training, (c) differential reinforcement, (d) prompts, (e) interspersal of known and unknown tasks, and (f) use of maximally different stimuli and responses. Errorless discrimination training and exclusion training are two strategies that would benefit from further research.

With errorless discrimination training, the  $S^D$  is presented along with a modified version of the S-Delta that is unlikely to set the occasion for a response. The S-Delta is then gradually faded to its original form. For example, in teaching a child to discriminate between the letter B and D, the S-Delta (e.g. letter D) might be presented in a smaller font than the letter B (the  $S^D$ ). The font size of the letter D is then increased until it is eventually at the same font size as the letter B. Research has shown several benefits of errorless learning including: (a) a decrease in inappropriate behavior, (b) fewer errors, and (c) an increase in instructional time (Martin & Pear, 1983). However, further research is needed to identify and compare various ways in which the S-Delta might be modified (e.g., altering size versus color) while teaching discriminations to children with developmental disabilities. For example, certain fading procedures might restrict an individual's attention to certain attributes of a stimulus (Golin & Savoy, 1968), thereby limiting the effectiveness of errorless learning when these modifications are used. This is especially important for children with autism because they often display stimulus overselectivity

in which learning is atypically limited with respect to the range, breadth, or number of stimuli or stimulus features.

An additional strategy for teaching discriminations to children with developmental disabilities is known as exclusion training. With exclusion training, an unknown stimulus (the  $S^D$ ) is always presented simultaneously with a previously learned stimulus (the S-Delta) during discrimination training. Research has found that individuals generally respond correctly to the unknown stimulus by “excluding” the known stimulus (McIlvane, Bass, O’Brien, Gerovac, and Stoddard, 1984). Applied research on exclusion training with individuals with developmental disabilities is limited. Furthermore, future research might compare the efficiency of errorless learning versus exclusion training in teaching discriminations to children with developmental disabilities.

In conclusion, results of this investigation did not demonstrate differences in the acquisition of receptive language skills under differential and non-differential outcomes conditions for four children with developmental disabilities. Although the DOE has been supported in the basic literature, findings in the applied literature have typically not supported the DOE in teaching discriminations to individuals with developmental disabilities.

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