PROCEDURES TO FACILITATE DISCRIMINATION OF PICTURE CARDS DURING COMMUNICATION TRAINING

By

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To my Mother and Father

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After acquiring single picture-object matching skills and subsequently failing to show the ability to discriminate between picture-card pairs, individuals with developmental disabilities were exposed to two procedures to facilitate discrimination. Both procedures attempted to increase responding toward the S+ (preferred) rather than the S- (nonpreferred) card. One procedure emphasized differential consequences by increasing the magnitude of reinforcement for selecting S+ and decreasing the preference ranking of S-. The other procedure emphasized stimulus control by initially increasing the visual salience of S+. The procedures were compared on a within-subject basis in multielement designs (Study 1). Results showed that the consequence-based intervention was sufficient to produce discrimination for some participants; however, other participants benefited only from the stimulus-control intervention. Therefore, the procedures compared in Study 1 were combined during Study 2. Results showed that the combined procedures produced discrimination for all participants. Results are discussed in terms of relative efficacy of the procedures and the need to determine which approach seems appropriate on an individual basis.

CHAPTER 1

INTRODUCTION

Overview

In basic research on learning, stimulus control is said to occur when a change in some property of a stimulus produces a change in the rate or probability of a response (Rilling, 1977). For example, a stimulus is said to control behavior if responding occurs at a higher or lower rate in the presence of the stimulus than in its absence. Stimulus control is commonly established by differentially reinforcing responses in the presence of different stimuli (Dinsmoor, 1995; Reynolds, 1961; Rilling, 1977; Staddon, 2003; Terrace, 1963), which produces discrimination in that the different stimuli exert control over responding. In a typical discrimination training procedure, the stimulus correlated with reinforcement is referred to as the S+, whereas the stimulus correlated with non-reinforcement, or extinction, is referred to as the S-. Correct responses are those that occur in the presence of S+, and incorrect responses are those that occur in the presence of the S-. Reinforcing responses to S+, and placing responses to S- on extinction, is generally an effective teaching procedure for establishing stimulus control by the S+ and S-.

Reynolds (1960) presented an early demonstration of establishing stimulus control via differential reinforcement. Two pigeons were trained to peck or not peck an illuminated key with a white triangle on a red background. Key pecks in the presence of the white triangle with the red background were reinforced on a VI 3-min schedule, whereas key pecks in the presence of a white circle with a green background were not reinforced. Results showed that both birds learned to peck only in the presence of the white triangle on the red background. The pigeons subsequently were exposed to each stimulus (triangle, circle, red, green) separately, and no pecks were reinforced. An analysis of response rates during the exposure to each stimulus separately showed that response rates were higher in the presence of the stimuli associated with

reinforcement and lower in the presence of stimuli associated with extinction, suggesting that stimulus control was established via differential reinforcement. A second study replicated these findings using different stimuli.

Eckerman (1969) assessed the effects of reinforcement probability on stimulus control. Using differential reinforcement, she trained 12 pigeons to peck a stimulus designated as S+ and not to peck a stimulus designated as S-. Pecks to S+ were reinforced according to 1 of 4 probability values, whereas pecks to S- were never reinforced. Results showed that higher response rates occurred in the presence of the S+ stimulus than in the presence of the S-. Furthermore, reinforcer probability affected responding to the S+ stimulus, as well as the rapidity with which responding to the S- approached zero.

Although differential reinforcement has been shown to be an effective procedure for establishing stimulus control by S+ stimuli, responses to S- stimuli typically persist during training. Terrace (1963a) noted that responses to S- (errors) were accepted as a necessary part of learning. A seminal line of research was conducted by Terrace (1963a, b), which demonstrated the effectiveness of “stimulus fading” for producing near error-free discrimination learning, referred to as errorless learning. Terrace conducted a series of three studies to evaluate various methods for presenting the S- during discrimination training. In Study 1, four groups of pigeons were first exposed to a procedure during which pecks to a red key (S+) were reinforced, and pecks to a green key (S-) were not. Next, discrimination training was conducted for each group of pigeons using one of four methods: early-progressive, early-constant, late-progressive, and late-constant training. The early-progressive training was implemented 30 seconds after pecking the S+ was established and consisted of gradually increasing the intensity of the S- from a dark key to a bright green key. Early-constant training also began 30 seconds after pecking the S+

was established; however, in contrast to the early-progressive training, the S- was presented at full intensity. The late-progressive and late-constant training methods were identical to the early-progressive and early-constant training methods except the S- was not introduced until after 21 sessions. Results showed that pigeons in the early-progressive training group acquired the red-green discrimination with few or no errors compared to the pigeons in the other training groups. The results obtained by Terrace demonstrated that errors (key pecks to S-) were not a necessary condition to facilitate the acquisition of visual discriminations.

Terrace (1963b) then used the same fading method described in the previous study to transfer stimulus control from a color discrimination to a line-orientation discrimination. After training pigeons to key peck correctly during a color discrimination (red-green) task, Terrace transferred stimulus control to a line discrimination (vertical-horizontal). Eight pigeons were divided into four experimental groups. One group was exposed to a procedure (Abrupt) that consisted of presenting line stimuli superimposed on keys abruptly after 15 sessions with the red-green keys. The second group was exposed to a procedure in which the line stimuli were superimposed onto the color keys after 10 sessions. Pigeons in the third group were trained using a combination of superimposition and fading. First, the pigeons received 15 sessions of the red-green discrimination. On the 16th session, the line stimuli were superimposed on the red and green keys and the intensity of the red and green keys was decreased until the keys contained only the line stimuli. All the pigeons learned the red-green discrimination, but only the pigeons in the fading group performed without errors. Three groups were then exposed to the red-green discrimination a second time, whereas the fourth group was immediately exposed to the line discrimination at the final criterion. Results showed that all the pigeons in each training group acquired the red-green discrimination without errors. However, only the pigeons in the

superimposition and fading group continued to respond without errors during the line discrimination. Terrace noted that the critical feature of the training procedures was the slow transition from an easy discrimination to a more difficult discrimination.

Transfer of stimulus control procedures, such errorless learning, have been widely used to establish correct responding in the context of discrimination tasks (see Schoen 1986 for a review). The term "transfer" refers to the acquisition of stimulus control by a stimulus that has been paired with an unrelated stimulus that already controls responding (Terrace, 1963b, Touchette, 1971). During discrimination training, a stimulus that reliably controls responding can be incorporated into the training procedure and then gradually eliminated until only the new training stimuli exert stimulus control. Transfer of stimulus control procedures can be divided into three general categories: stimulus-prompt manipulations, response-prompt-manipulations, and procedures that facilitate transfer without explicit training (e.g., matching-to-sample). Stimulus-prompt procedures, such as stimulus shaping, facilitate transfer of stimulus control by adding stimuli to, or manipulating the topography of the training stimuli. Response-prompt procedures facilitate the transfer stimulus control through the use of an extra-stimulus prompt, one that is not related to the discrimination task, such as a physical gesture by a teacher. For the purpose of this dissertation, I will focus primarily on stimulus-prompt manipulations, as they are commonly employed to establish discrimination performance, and briefly review response-prompt procedures.

Transfer of Stimulus Control Procedures

The ability to discriminate among visual stimuli is critical to the success of students in both regular and special education classrooms (Lancioni & Smeets, 1986). Students are often required to discriminate among academic materials such as numbers, letters, words, colors, and communication pictures. Acquiring visual discriminations that serve as the basis for learning can

be especially difficult for students with developmental disabilities, who often fail to acquire simple visual discriminations under standard teaching conditions. As a result, an extensive line of research has focused on procedures to facilitate the acquisition of visual discriminations in this population.

Stimulus-prompt procedures, such as stimulus fading and stimulus shaping, are frequently used to transfer stimulus control. Lancioni and Smeets (1986) noted that teachers can prompt students to make correct responses by making certain features of a discrimination task more salient. Stimulus fading facilitates correct responding by initially enhancing specific stimulus features (e.g., luminance or intensity) within a discrimination task and then gradually fading the enhancements contingent on correct responding. Stimulus shaping facilitates correct responding by incorporating stimulus features that already exert stimulus control and then fading these features into the criterion stimuli. The difference between fading and shaping is in the dimension along which the stimuli are manipulated, but the terms are sometimes used synonymously in the literature.

Sidman and Stoddard (1967) demonstrated the effectiveness of a variation of stimulus fading for teaching visual discriminations to 19 boys with developmental disabilities. They used the term “stimulus shaping” to describe a procedure that entailed fading along a dimension relevant to the final form of a stimulus. The experimenters compared stimulus shaping plus differential reinforcement to differential reinforcement alone in teaching shape discriminations. The participants were divided into two groups (program and test), who were presented with an apparatus that consisted of a square matrix containing 9 keys. Participants in the program group were taught to respond to a bright key that contained a circle and not to respond to dark keys. Stimulus control then was transferred from the bright-dark discrimination to a form-no form

discrimination by gradually increasing the brightness of the dark keys (S-) until all keys were bright, but only the center key (S+) contained a circle. Stimulus control was transferred from the form-no form discrimination to a circle-ellipse discrimination by superimposing faint ellipses on the S- keys and gradually increasing the intensity of ellipses until they equaled the intensity of the key containing the circle.

Participants in the test group were exposed to the circle-ellipse discrimination without stimulus fading. Results showed that 7 of the10 subjects in the program group but only 4 participants in the test group learned the circle-ellipse discrimination with few errors. The results obtained by Sidman and Stoddard (1967) showed that stimulus fading plus reinforcement was more effective than reinforcement alone in training visual discriminations to individuals with developmental disabilities.

In light of the data that demonstrated the effectiveness of stimulus fading for transferring stimulus control, Doran and Holland (1979) designed an experiment to identify factors associated with successful and unsuccessful fading. Sixteen children were taught to press a circle of a given size and luminance (S+) and not to press other circles (S-). The size and luminance of the S+ were held constant, whereas the size and luminance of the S- initially differed, but then were faded in until they were equal to those of the S+. Two types of probe trials were conducted during each fading step in which (a) a circle having brightness equal to that of the S+ but size equal size to that of the S- was presented, or (b) a circle having equal size to that of the S+ but brightness equal to that of the S- were presented. Results indicated that participants whose responding was under control of both size and luminance acquired the discrimination without errors, whereas those whose responding was controlled only by luminance were unsuccessful in acquiring the discrimination without making errors. These data

further underscored the importance of fading along a stimulus dimension (i.e., size) that is relevant to the task. Furthermore, the methods used illustrated stimulus shaping as a variation of stimulus fading.

The results of several studies showed the superiority of stimulus fading and/or stimulus shaping relative to standard reinforcment-extinction procedures for facilitating discrimination performance. Egeland and Winer (1974) compared the effects of stimulus fading to those of a reinforcement-extinction procedure on letter-discrimination performance by 64 preschool children. The participants were divided into two training groups. Participants in Group1 were trained using stimulus fading in which features of the letter discrimination were highlighted initially. For example, the diagonal-lower stem of the letter "R" was initially highlighted in the letter pair "R-P" and was gradually faded over subsequent training trials. Participants in Group 2 were trained using a basic reinforcement-extinction method in which the experimenter delivered reinforcement for correct responses and placed incorrect responses on extinction. Results showed that children trained using stimulus fading (Group 1) made fewer errors compared to the children trained using reinforcement-extinction (Group 2). Egeland suggested that the effectiveness of stimulus fading might be due to the fact that the added stimulus cues were faded along dimensions relevant to the training stimuli. To test this hypothesis, Egeland (1975) extended his earlier study by comparing the effects of two methods for stimulus-fading to those of a reinforcement-extinction training method on the letter-discrimination performance of 108 preschool children. The procedures were identical to those used in the earlier study; however, one group (Group 2) was exposed to a stimulus-fading method in which an irrelevant feature was highlighted. Thus, in the letter pair "R-P," the letter R was initially underlined, and the underline was gradually faded. Results showed that children trained using stimulus fading (Groups 1 and

2) made fewer errors compared to the children trained using reinforcement-extinction (Group 3). Furthermore, the children in Group 1 (relevant feature highlighted) made fewer errors than did children in Group 2 (irrelevant feature highlighted). Egeland concluded that the effectiveness of stimulus fading depended on whether or not the added cue highlighted a relevant or irrelevant feature of the stimulus.

Schilmoeller, Schilmoeller, Etzel, and LeBlanc (1979) compared the effectiveness of stimulus shaping, stimulus fading, and trial-and-error for training shape discriminations to 3 groups of children. All stimuli consisted of shapes presented on white index cards. The stimulus-shaping group initially was trained to respond to a tree on a hill (S+) and not to an apple with a worm through it (S-). Over consecutive trials, the S+ stimulus was shaped into a triangle with a single-line background, and the S- was shaped into a circle with single-line background. The stimulus-fading group initially was trained to respond to a black triangle with a single-line background, and not to a blank index card. Over consecutive trials, a circle with a single-line background was faded in. The children in the trial-and-error group were presented with the stimuli at criterion level (i.e., a triangle and a circle with a background of 1 line). Then each group was trained on a second set of stimuli in which the S+ and S- from the first set were reversed and presented on a background that consisted of 7 lines. After each group was trained on both sets of stimuli, the experimenters conducted a conditional discrimination test. During this test, stimuli were randomly presented in their criterion form, and the children were required to select the correct S+ based on the background (1 line or 7 lines). Results showed that children in the stimulus shaping and stimulus fading groups performed better on the conditional discrimination test than did children in the trial-and-error group, and children in the stimulus shaping group performed slightly better than those in the stimulus fading group.

Smeets, Lancioni, and Hoogeveen (1984) compared the effects of stimulus shaping versus stimulus fading for transferring stimulus control from pictures to written words. Children diagnosed as trainable mentally retarded, educable mentally retarded, and normal, were taught four sets of three words that consisted of either Roman or Hebrew letters. Both training procedures began with a word superimposed on picture. Stimulus shaping involved gradually reducing the size of the picture followed by transforming the picture into one of the letters of the word. Stimulus fading consisted of gradually reducing the size of the picture and then eliminating parts of the picture until only the word remained. The results showed that the educable mentally retarded and normal participants learned the words regardless of which training procedure was used. By contrast, the trainable mentally retarded participants only learned the words after additional training and under the stimulus shaping.

Much of the early research on stimulus fading and stimulus shaping illustrated various methods of manipulating and fading stimulus prompts or cues. In general, fading occurred along stimulus dimensions of either the S+ or S-, or in some cases, both. Schreibman and Charlop (1981) evaluated the efficacy of stimulus fading along dimensions of the S+ versus the S-. Eight children diagnosed with autism were taught two visual discriminations using within-stimulus prompt fading. The training stimuli and procedures identical to those used in Schreibman (1975), and the results showed that fading on the S+ stimulus was more effective than fading on the S- stimulus for 7 of the 8 participants. These results suggested that fading along stimulus dimensions of the S+ may be more effective than fading along dimensions of the S-.

In a similar study, Strand (1989) compared the effects of two stimulus-fading procedures relative to a trial-and-error procedure for teaching two line-form discriminations to 27 special education students. The experimenters divided the students into 3 groups of 9 participants each,

and each group was taught using one of the three procedures. The fading procedures consisted of fading along stimulus features of the S+ while keeping the S- constant versus fading along stimulus features of the S- while keeping the S+ constant. Both fading procedures initially enhanced a relevant stimulus feature of the S+ or the S- by increasing size and adding the color blue. Contingent on correct responding, the enhancements were gradually minimized across trials until both the S+ and S- were similar except for one relevant feature. Contingent on incorrect responding, the participant returned to the previously mastered step. Trial-and-error training simply entailed reinforcing correct responses, whereas incorrect responses were placed on extinction. Results for the first line-form discrimination showed that 1 subject from each group acquired the discrimination, thus showing no differences among procedures. Results of the second line-form discrimination showed that 94.4% participants in the stimulus fading groups acquired the discrimination compared to only 66% from the trial-and-error group. Furthermore, participants in the S+ group progressed faster through fading steps and made fewer errors.

Touchette (1971) was interested in measuring the point in time during training at which transfer of stimulus control occurred. To accomplish this, rather than using a stimulus fading procedure, he used a delay procedure (prompt delay) to transfer stimulus control from colored keys to black forms presented on keys. Three participants with severe mental retardation were trained initially to press a red key and not to press a white key. Next, black forms, consisting of the letter E with the legs facing down (S+) and up (S-), were superimposed onto the keys. Initially the color keys were simultaneously presented with the superimposed forms. Correct responses (i.e., responses to S+) on each trial delayed the onset of the color stimuli on subsequent trials in 0.5 s increments, whereas incorrect responses decreased the delay on subsequent trials in 0.5 s increments. Results showed that all participants acquired both the color

discrimination and then the form discrimination with relatively few errors, and that the point of stimulus control transfer occurred abruptly. Touchette conducted a second experiment using the same delay procedure to transfer stimulus control from colored keys to tilted lines, and results showed that 2 of the 3 participants acquired the line discrimination. Although the focus of Touchette's study was to measure the moment of stimulus control transfer, this study also demonstrated the utility of using a stimulus-prompt delay to facilitate discrimination.

Prompt delay has also been applied to response-prompt procedures. Touchette and Howard (1984) used a prompt delay with response-prompting while investigating the influence of reinforcer probability on the transfer of stimulus control. To accomplish this, they used 3 different schedules of reinforcement while teaching visual discriminations to 3 students. One schedule (CRF/CRF) arranged the probability of reinforcement so it was equal prior to and after the prompt, a second schedule (CRF/FR3) favored responses before a prompt by increasing the probability of reinforcement for those responses, and the third schedule (FR3/CRF) favored responses following a prompt by increasing the probability of reinforcement for those responses. During the delayed-prompting trials, an experimenter presented an array of four stimulus cards to a participant and asked the participant to point to a letter, word, or number. Initially, the experimenter simultaneously pointed to the corresponding stimulus card and delivered the instruction to point to the letter, word, or number. The experimenter subsequently inserted a delay between the vocal instruction and point prompt and gradually increased the delay across trials. Results showed that the prompt-delay procedure produced successful transfer of stimulus control from the experimenter's point prompt to the vocal instruction regardless of which reinforcement schedule was used, but that the CRF/FR 3 schedule resulted in more rapid acquisition of the discrimination task for all participants. Touchette and Howard concluded that

reinforcement probability contributed to, but did not necessarily determine transfer of stimulus control from a delayed prompt.

The success of the prompt delay procedure used by Touchette and Howard (1984) can be attributed to a disparity in the immediacy of reinforcement. As the prompt delay increased, reinforcement was available sooner if the participant responded prior to the onset of the prompt. Touchette and Howard noted, however, that despite the effectiveness of prompt-delay procedures, the reinforcement schedules may be complex for teachers to arrange, and as such, may not be practical for use in classroom settings. Furthermore, the results of comparison studies have shown that stimulus-prompt procedures can be more effective then response prompt procedures.

Schreibman (1975) compared the effects of fading stimulus prompts versus fading response prompts while training 6 children with autism both visual and auditory discriminations. The visual discrimination tasks included stimuli that consisted of black line forms printed on index cards. Baseline trials consisted of the experimenter presenting the S+ and S- index cards and then asking the participant to point to the correct card; no additional prompts were delivered. Response prompting, referred to as extra-stimulus prompting, consisted of the experimenter initially pointing to the S+ to prompt correct response. The experimenter then faded the point prompts by increasing the distance between the point prompt and the S+ across trials until the prompts were eliminated. Stimulus prompting, referred to as within-stimulus prompts, initially consisted of the experimenter presenting only one critical component of the line form depicted on the S+ while the S- contained no form. Contingent on correct responding, the experimenter gradually faded in the critical component of the S-, and then faded in the components that were similar to both the S+ and S-.

Auditory discrimination tasks consisted of two-syllable nonsense words (e.g., magoo versus mago) presented via prerecorded audiotape. Participants initially were trained to press a bar in the presence of the extra-stimulus prompt, which consisted of a buzzer. Training began with a baseline condition during which the audio-taped stimuli were presented, and participants were required to press the bar in the presence of the word designated as S+ and not to press the bar in the presence of the word designated as S-. Training with the extra-stimulus prompt was implemented by initially presenting the buzzer and the S+ simultaneously. The decibel level of the buzzer prompt was decreased until it was faded out completely. The within-stimulus prompt involved the experimenter initially presenting the last syllable of the words, which was the basis on which the discrimination was possible, and additional syllables were faded in gradually by increasing the decibel level. For example, during training of mago *versus* magoo, initially only "go" and "goo" were presented. Then "ma" was faded in. Results showed that, of 24 total discriminations presented, participants only learned 8 without prompting. All participants failed to learn the 16 discriminations when training utilized an extra-stimulus prompt. When within-stimulus prompting was applied, participants were able to learn 15 of the previously unlearned discriminations. These results were independent of modality (i.e., visual versus auditory). Schreibman suggested that within-stimulus prompting was superior because a relevant feature of the training stimuli was enhanced, and the procedure did not require a participant to respond to multiple stimuli unrelated to the training stimuli.

More recently, Repp, Karsh, and Lenz (1990) compared response prompting (referred to as prompt fading) to stimulus fading while teaching 8 participants diagnosed with moderate to severe mental retardation to discriminate 2- and 3-digit numbers. Training was conducted using a prompt fading procedure referred to as the standard-prompting hierarchy (SPH), or a stimulus

fading procedure referred to as the task-demonstration model (TDM). The SPH entailed the experimenter using a sequence consisting of a verbal prompt to touch the S+, followed by either a point prompt, model, or if needed, physical guidance to get the participant to emit the correct response. During the TDM, the S+ was always presented in the criterion format, whereas the S- initially varied along one relevant dimension (the shape of the stimulus) and 4-5 irrelevant dimensions (e.g., color, location, texture). Additionally, the S+ was placed closer to the participant and the distance was faded across trials. Contingent on correct responding, the relevant and irrelevant dimensions of the S- were gradually faded until the S- was similar to the S+. Results showed that the TDM resulted in more correct responses and fewer errors than did the SPH. The results, however, should be viewed tenuously. During the TDM, incorrect responses resulted in a series of remedial trials that was not included in SPH. These remedial trials may have accounted for the differences in the results.

Collectively, the results of research on the transfer of stimulus control suggest that procedures based on stimulus fading or stimulus shaping are more effective than response prompting procedures for transferring control during visual discriminations training. Furthermore, stimulus fading should be implemented along a stimulus dimension that is relevant to the discrimination task, and may be more effective when fading along the dimensions of the S+ rather than the S-.

The experimental tasks used in studies on transfer of stimulus control typically have consisted of simple visual discriminations, including line forms (Doran & Holland, 1979; Schilmoeller et al., 1979; Schreibman, 1975; Schreibman & Charlop, 1981; Sidman & Stoddard, 1967; Strand, 1989; Terrace, 1963a, 1963b; Touchette, 1971), letters and numbers (Egeland, 1975; Egeland & Winer, 1974; Repp et al. , 1990; Touchette & Howard, 1984), and words (e.g.,

Smeets et al. , 1984). A notable exception was a study by Berkowitz (1990), who compared two methods of prompting during picture-card discrimination training. Four males with autism were taught to discriminate three picture cards that contained communicative referents using either delayed prompting or prompt fading. Training consisted of the experimenter placing two picture-communication cards in front of a participant and then providing a verbal instruction, which consisted of the name of an item depicted on one of the picture cards. Participants were required to point to the correct picture card. The delayed prompting procedure began by the experimenter initially pointing to the correct picture card while simultaneously providing the verbal instruction. Then a 1-second delay was inserted between the point prompt and the verbal prompt following each correct response. Prompt fading consisted of the experimenter initially using hand-over-hand guidance to prompt the correct response following the verbal instruction. Contingent on correct responding, the prompting was gradually decreased in three steps (light-physical prompt, gestural prompt, no prompt). Results showed that all four students required fewer trials to meet the training criterion under the delayed prompting procedure relative to the prompt fading procedure. This study illustrated a different experimental context in which to study transfer of stimulus control procedures.

Picture Card Communication

The Picture Exchange Communication System (PECS) (Bondy & Frost, 1994, 2001) is augmentative communication system that is used to teach functional communication to developmentally disabled children with speech deficits. PECS utilizes 2.5 cm x 2.5 cm picture cards on which various communicative referents (e.g., pictures or iconic drawings) are printed. PECS training is typically divided into six phases (see Bondy & Frost for descriptions). During the initial phases (1-3), training focuses on establishing requesting responses, during which the participant is taught to exchange a picture card for a specific reinforcer. Phases 4-6 focus on

expanding a participant's communication repertoire to include using phrases (e.g., I want…), question answering, and commenting. Phases 1-3 are critical to a participant's successful use of PECS. In order to expand a participant's communication repertoire, the participant must first be able to select the correct picture card from a pair of picture cards.

Prior to the start of training, a preferred stimulus is identified for a participant by observing stimuli that the participant approaches. During Phase 1, a participant is initially taught to make a communication response by selecting a picture card from a book of cards and then handing it to a "communication partner." Following a communication response the "communication partner" delivers the item or activity depicted on the picture card. After the participant acquires basic communication responses, Phase 2 training focuses on establishing generalized responding across settings, picture cards, and communication partners. Then, Phase 3 of PECS training focuses on picture-card discrimination, during which a participant is taught to select one picture card from a pair of picture cards. Phase 3 is particularly critical in that successful PECS usage depends on a participant's ability to discriminate among multiple pictures cards. Training begins by a therapist placing two picture cards in front of a participant, and two-stimulus items represented by the picture cards directly behind the cards. One picture card, referred to as the S+, represents a preferred item; the other picture card, referred to as the S-, represents a non-preferred item. The participant must discriminate between the two cards, select the S+ card, and hand it to the therapist. Selections of the S+ card are reinforced by the therapist delivering the item depicted on the picture card. By contrast, incorrect responses (i.e., selecting the S- picture card) result in delivery of a non-preferred item, followed by an error correction procedure that involves the therapist (a) prompting the correct response (by tapping on the correct card or physically guiding the participant to touch to the card), (b) providing only praise for the correct

response, and (c) beginning a new trial. Under these training conditions, it is expected that a participant will select the S+ instead of the S- because stimulus control by the picture cards has been established via differential reinforcement.

According to Bondy and Frost (1994, 2001), several features of PECS may make it more appealing then other communication systems, such as American Sign Language, for training individuals with communication deficits. First, PECS training utilizes both tangible stimuli and pictures; and as such, they have a direct effect on both the participant and the communication partner. Second, because PECS initially focuses on teaching responses in the form of requests, those responses are reinforced and maintained by immediate access to the requested item. Third, the system does not require complex imitation skills that are often necessary to teach other forms of communication. Fourth, Bondy and Frost suggest that there is evidence that participants can acquire PECS usage rapidly, and in some cases have gone on to develop vocal speech.

Several studies have evaluated the effects of PECS training on picture-card communication, as well as other communicative behaviors (e.g., vocal speech). Bondy and Frost (1994) reported PECS outcome data for 85 participants who were diagnosed with autism and who displayed significant communication difficulties. Over 95% of the participants were able to communicate using two or more picture cards with 1 month of training. Individual data were reported for only one participant and showed that he progressed through the initial phases (1-3) of training within 1 month, and began to communicate using vocal speech within 11 months. Schwartz and Garfinkle (1998) evaluated the effectiveness of PECS for teaching picture-card communication, as well as spoken language, to developmentally disabled pre-school children with severe communication deficits. During Study 1, the experimenters used the procedures described in the PECS manual (Frost & Bondy, 1992, 1994, 1996) to train 31 participants to

communicate with adults and peers using picture-communication cards. Results showed, that on average, participants successfully completed each phase (1-5) of training within 14 months (range 2-28) in a classroom setting. Eighteen of the participants from Study 1 participated in second study during which the experimenters assessed generalization of picture-card communication and the emergence of vocal speech. The participants had access to picture cards and were observed during free choice and snack times. The experimenters recorded spontaneous communicative responses (i.e., gestures, manual signs, picture-card communications, and vocal speech) during 30 min. observations. The results of Study 2 showed that all of the participants continued to communicate using picture cards, and 44% of the participants acquired vocal speech. The experimenters aptly note that the data are not experimental, and as such, they cannot account for the emergence of vocal speech.

Kravits, Kamps, Kemmerer, and Potucek (2002) examined the effects of PECS training on the spontaneous communication of a 6-year-old female with autism. Five minutes of PECS training was followed by a 10-min. observation, during which the experimenters recorded the frequency of spontaneous language (i.e., picture-card communication and vocal speech). Results showed that participant's use of picture-card communication, as well as vocal speech, increased in all settings following the initiation of PECS training.

Results of a study conducted by Charlop-Christy, Carpenter, LeBlanc, and Kellet (2002) suggested that PECS usage can be trained quickly, and attempted to empirically validate some of the ancillary gains (e.g., decreases in problem behavior, increase in spontaneous speech) that have been anecdotally report. The experimenters used the PECS curriculum to train three boys with autism and then measured PECS usage, spontaneous and imitative speech, and problem behaviors during free-play and academic sessions. Results showed that all participants met

criterion on each training phase within an average of 246 trials (average duration =170 min.). Furthermore, the data showed an increase in spontaneous and imitative speech and a decrease in problem behaviors. Although results of this study suggested that PECS usage can be acquired relatively quickly, the study is limited in that only three individuals participated.

Stoner, Beck, Jones-Brock, and Thompson (2006) examined the effectiveness of PECS training with 5 developmentally disabled adults with severe communication deficits. The experimenters implemented PECS training for each participant according to ABAB design, and recorded the percentage of unprompted picture-card communications during sessions consisting of 10 trials. The results showed that unprompted picture-card communication increased, relative to baseline, for 4 of the 5 participants. The data for the remaining participant did not show any increases in unprompted picture-card communications following the implementation of PECS training.

It is important to note that most studies on the use of PECS do not show individual data on correct picture card selections (i.e., S+) during each phase of training. Therefore, many of the conclusions regarding the efficacy of PECS, such as speech development, remain tenuous at best. Also, given the lack of individual data, it remains unknown which, if any, of the training phases present difficulties for some participants and not others, or why some participants never acquire PECS usage. Bondy and Frost (1994) noted that Phase 3 of training ordinarily requires the most training time for participants and can range from several days to several months. Schwartz and colleagues (1998) indicated that participants required 3 months training to successfully acquire picture card discriminations during Phase 3. However, acquisition problems may begin as early as Phase 1. During Phase 1, a participant's responding is brought under the stimulus control of the picture card by differentially reinforcing responses in the presence of the picture card, and

not reinforcing responses in the absence of the card. However, it is not clear whether the subject has discriminated the correspondence between the picture card and the reinforcer, or simply responds in the presence of any picture card. Phase 3 focuses on establishing discrimination (i.e., differentially responding in the presence of 2 picture cards) via differential consequences. However, there are 2 possible limitations to the procedures used during Phase 3. First, as discussed earlier, differential reinforcement may not be the most effective way to establish visual discriminations (e.g., Egeland, 1975; Egeland & Winer, 1974; Schilmoeller et al., 1979; Strand, 1989). Second, the S+ and S- are defined as preferred and nonpreferred somewhat arbitrarily. Preferred items are identified by observing what the participant interacts with, while the nonpreferred items are selected based on assumptions regarding what the participant may not prefer. As a result, variability in responding may result from changes in preference for S+ versus S- (e.g., Koehler, Iwata, Roscoe, Rolider, & O'Steen, 2005), and not from a lack of discrimination. Given the possible procedural limitations, and data showing that not all individuals acquire PECS usage, other procedures may be necessary to establish picture-card discrimination.

Berkowitz (1990) showed that prompt delay was effective for establishing correct responding during picture-card communication training. In addition to prompt delay, Bondy and Frost (1994) suggest a few training procedures, based on stimulus fading and stimulus shaping, that may be used to facilitate discrimination between picture-cards. However, the relative efficacy of those methods for training picture-card discriminations during PECS remains unknown. Based on the transfer of stimulus control literature, stimulus fading and/or stimulus shaping suggest a training approach that focuses on the manipulation of antecedent conditions.

However, manipulation of the consequences that follow correct or incorrect picture card selections may also influence these responses.

The delivery of differential consequences can influence choice and, as a result, facilitate discrimination. During PECS training, a participant's preference and nonpreference for stimuli is accomplished by observing what the participant interacts with. However, there are several methodologies for empirically identifying preferred and nonpreferred stimuli (e.g., DeLeon & Iwata, 1996; Fisher et al., 1992; Pace, Ivancic, Edwards, Iwata, & Page, 1985) which could be used to identify both S+ and S- stimuli. There are also a number of reinforcer characteristics (rate, delay, quality, and magnitude) that can influence response allocation among concurrently available alternatives. Hoch, McComas, Johnson, Faranda, and Guenther (2002) examined the effects of magnitude and quality on selections by three boys with autism to play in an area in which a peer was either present or absent. Results showed that participants more often chose the play area with the peer present when this selection resulted in either longer access to toys (magnitude) or access to more highly preferred toys (quality). Similarly, Mace, Neef, Shade, and Mauro (1996) examined the effects of reinforcer rate and quality on the amount of time that students with learning disabilities allocated to easy versus difficult arithmetic problems. The authors observed increases in time spent working on the difficult problems when this choice produced higher quality reinforcers but not when it produced more reinforcers. Similar results have been obtained that demonstrated the influence of reinforcer quality on choice responding (e.g., Neef, Bicard, & Endo, 2001; Neef & Lutz, 2001; Neef, Mace, Shea, & Shade, 1992; Neef et al., 2005; Neef, Shade, & Miller, 1994) and as such, suggest a method of influencing picture card selections.

Purpose

Although training procedures based on differential reinforcement alone may fail to influence the transfer of stimulus control for some individuals, enhancing the magnitude or quality of the differential reinforcers could increase the efficacy of these procedures. Therefore, the purpose of the current study was to first train participants with developmental disabilities and communication deficits to communicate via a single picture-communication card, and then to evaluate the relative efficacy of two procedures to train discrimination between two picture-communication cards. Specifically, an antecedent based procedure was compared to a procedure during which the consequences associated with picture card selections were enhanced. The antecedent procedure consisted of stimulus fading whereas the enhanced consequences procedure consisted of increasing the magnitude and the quality of reinforcers available for picture card selections. The purpose of study 2 was to evaluate the effects of stimulus fading combined with enhanced consequences to train discrimination between two picture cards.

CHAPTER 2

STUDY 1 METHODS

Participants

Nine individuals with developmental disabilities who attended a sheltered-vocational workshop were selected for participation based on a demonstrated need to acquire communication skills. Four of the nine individuals showed a failure to discriminate between pictures of edible items (see discrimination baseline) and continued participation in the study. Victor was a 46-year-old male diagnosed with moderate mental retardation, Alex was a 30-year-old male diagnosed with severe mental retardation and cerebral palsy, and Perry was 27-year-old male diagnosed with severe mental retardation. All participants were nonverbal and communicated using gestures. Alex had minimal exposure to picture card training prior to the start of the study but was not using picture cards when he was selected for participation in this study.

Setting

All sessions were conducted in observation cubicles or in a therapy room adjacent to the workshop. During all sessions, an experimenter and a participant were seated at a table across from each other. One to two observers were present during all sessions to collect data.

Materials

All picture-communication cards were made by digitally photographing stimuli identified from preference assessments as preferred and non-preferred. The photographs were printed as 2.5cm x 2.5cm picture-communication cards and then were laminated prior to use in training sessions.

Data Collection and Response Definitions

During all preference assessments, participants were presented with either one or two items and were requested by the experimenter to select one. A selection response was defined as the participant approaching and then consuming a stimulus (i.e., eating an edible stimulus). Observers recorded selection/consumption responses to each of the items presented. Preference was summarized as the number of trials each stimulus was approached and consumed divided by the number of trials each was presented and multiplying by 100%.

During single-card training, data were collected on the frequency of prompted and unprompted responses made with the S+ picture card. Prompted responses were defined as the participant handing the experimenter the S+ card following a gestural and physical prompt, whereas unprompted responses were defined as the participant independently handing the experimenter the S+ card. Single-card training data were calculated as percentage of trials with unprompted responding by dividing the number of unprompted responses by the total number of trials in a session and multiplying by 100%. During discrimination training, data were collected on the frequency of responses made with the S+ picture card, defined as the participant handing the experimenter the card depicting a preferred item. Data were calculated as percentage of trials with S+ selections by dividing the number of S+ selections by the total number of trials in a session and multiplying by 100%.

Interobserver Agreement

Interobserver agreement was assessed for each experimental phase by having a second observer simultaneously but independently collect data with the primary observer. Observers' records were compared on a trial-by-trial basis, and interobserver agreement was calculated by dividing the number of agreements by the number of agreements plus disagreements and multiplying by 100%. An agreement was defined as a trial in which observers recorded the same

occurrence of a response. Interobserver agreement was assessed during 71% of all paired-stimulus preference assessments and 50% of all single-stimulus assessments. The mean agreement score for all assessments was 100%. Interobserver agreement was assessed during 48% of both single-card training and discrimination training sessions, and the agreement scores always were 100%.

Preference Assessments

Preference for edible items was assessed using a paired-stimulus procedure (Fisher et al., 1992). Separate assessments were conducted to identify edible items for each S+/S- picture card pair. Prior to each assessment, participants consumed each item to ensure familiarity with all of the stimuli. During each trial, the experimenter presented a pair of stimuli in front of the participant and prompted the participant to "Pick one." An approach response to one item was followed immediately by access to that item. The item not approached was removed, and the next trial was presented. Approach responses to both items simultaneously were blocked, and the trial was repeated. If an approach response did not occur within 5 s, both items were removed, and the trial was repeated. Each item was paired once with every other item in a semi-random order (the same item was not presented twice in a row). The S+ was chosen from items selected on 80% or more of the trials, whereas the S- was chosen from items selected on 20% or fewer of the trials.

A single-stimulus preference assessment (Pace et al., 1985) was used to identify non-preferred stimuli for the enhanced consequences procedure (see details below). This procedure was chosen because it limits the response options to either approaching or not approaching only one item; therefore, failure to approach a stimulus likely serves as a strong indicator that the item presented is not preferred. Prior to the assessment, participants were allowed to consume each stimulus to ensure familiarity with all of the stimuli. If a participant did not actually consume

(i.e., ingest) the stimulus, the experimenter ensured that the participant touched each stimulus. During each trial, the experimenter presented one item in front of the participant for 5 s. An approach response was followed immediately by access to that item. If an approach response was not made within 5 s, the item was removed, and a new trial was begun. Each item was presented for 5 trials in a semi-random order (the same item was not presented twice in a row). An item was designated as non- preferred if it was never approached on any trial and was used as the S- during the enhanced consequences procedure.

Single-Card Training

Participants initially were trained to request a preferred item by handing an S+ picture card to the experimenter. Training sessions consisted of 10 trials, and each trial was 10 s in duration. Each trial began by the experimenter placing the S+ card on the table 30 cm in front of the participant. The S+ card represented a preferred item from the paired-stimulus assessment, which was on a plate 10 cm directly behind the picture card. If the participant handed the card to the experimenter, the experimenter delivered the edible item to the participant. If the participant did not respond within 10 s, the experimenter physically guided the participant to pick up the card and place it into the experimenter's hand, at which time the experimenter delivered the edible item. Training continued until the participant exhibited 90% or greater unprompted responses over three consecutive sessions. Responding to two different S+ was conducted in this manner. One card served as the S+ for one discrimination-training procedure; the other card served as the S+ card for the second discrimination-training procedure.

Discrimination Baseline

Baseline began after participants learned to select each S+ during single-card training. The baseline condition served as a screening procedure to determine whether participants would learn to select the S+ picture card when both the S+ and S- cards were presented, simply as a function

of the natural consequences for making a selection. Ten training trials were conducted per session. Each trial began with the experimenter placing the S+ and S- cards 30 cm in front of the participant with corresponding edible items directly behind the pictures cards. The positions of the cards and items were reversed on each trial. If the participant selected one of the picture cards within 10 s, the experimenter delivered the corresponding item. If no response occurred within 10 s, the experimenter simply rearranged the picture cards and the items, and then initiated another trial. Three of the four participants failed to acquire the S+/S- discrimination and continued on to training.

General Procedure

Following baseline, training procedures were implemented in a multiple baseline design across participants. Training effects were also assessed on a within-subject basis using elements of a reversal design. The relative efficacy of stimulus fading versus enhanced consequences was assessed by alternating both procedures according to a multielement design in which different S+/S- discriminations were taught using each procedure. The following methods were used during all conditions.

Ten trials were conducted during each session. Each training trial began by the placing two picture cards (S+ and S-) on the table 30 cm in front of the participant with the corresponding edible item 10 cm directly behind each card. The positions of the cards and edible items (left or right) were reversed on each trial. Contingent on a selection of either the S+ or the S- picture card, the experimenter delivered the item depicted on the picture card according the one of the training procedures described below. Discrimination training continued until a participant exhibited 90% or more unprompted-correct responses toward the S+ card during the final step of one of the training conditions. Baseline data then were taken for new S+ and S- cards, and training continued until two or three picture-card discriminations were acquired.

Stimulus Fading

Stimulus fading consisted of modifying both the position and the size of the S+ card. Initially, the 2.5 cm x 2.5 cm S+ card was enlarged to 10 cm x 10 cm and was placed closer (10 cm instead of 30 cm) to the participant. The size and position of the S- were identical to those during baseline. Fading began by first moving the S+ card further away from the participant in three increments (10 cm, 20 cm, 30 cm) until it was 30 cm from the participant (equal to that of the S- card). The size S+ card was decreased in 3 steps (10 cm, 7.5 cm, 5 cm, 2.5 cm) until it was the same size as the S- card. Each fading step was initiated when a participant exhibited S+ selections at 90% or more of the trials for three consecutive sessions.

Enhanced Consequences

Enhanced consequences consisted of modifying the magnitude and quality of reinforcement for selecting the S+ or S- picture cards. Reinforcer magnitude was enhanced by increasing the quantity of reinforcers that were delivered following S+ selections. During baseline, selection of the S+ card resulted in 1 edible item; during this condition, selection of the S+ card resulted in 3 edible items. Reinforcer quality was manipulated by replacing the S- stimulus (an item ranked low in the paired-stimulus preference assessment) with a new S- stimulus, one that was never selected on any trial in the single-stimulus preference assessment. The reinforcer magnitude was systematically decreased following 3 consecutive sessions during which a participant selected the S+ on 90% or more of the trials.

CHAPTER 3

STUDY 1 RESULTS

Paired-Stimulus Preference Assessments

Results of the paired-stimulus preference assessments for each participant are shown in Table 3-1. Listed in the table are the stimuli identified as the S+ and S- for each picture-card pair that was taught, and the percentage of trials during which the stimuli were selected. Four assessments were conducted for Victor and Alex; six assessments were conducted for Perry. One S+/S- stimulus pair was identified during each assessment. S+/S- stimulus pairs identified for Victor were (a) Circus Peanut/Almond, (b) Peanut Butter Bite/puffed wheat, (c) chip/Good & Plenty, and (d) Skittle/Cheerio. The stimulus pairs identified for Alex were (a) Rice Krispy Treat/Skittle, (b) Peppermint Patty/black licorice, (c) gum drop/puffed wheat, and (d) Peanut Butter Bite/Altoid). Perry's stimulus pairs included (a) Nilla Waffer/raisin, (b) Peppermint Patty/cinnamon, (c) Peanut M&M/Cheerio, (d) Peanut Butter Bite/Gummi Bear, (e) Kit Kat/Shredded Wheat, and (f) Frito/marshmallow. All S+ and S- stimuli were digitally photographed, made into picture cards, and used during training sessions.

Single-Stimulus Preference Assessments

Two assessments were conducted for Victor, and several assessments were conducted for Alex and Perry (Table 3-2). Apricot and French Peanut were identified as new S- stimuli for Victor. An initial assessment consisting of 9 stimuli failed to identify a new S- stimulus for Alex because he consumed all the stimuli presented. Therefore, preference for non-edible stimuli was assessed, during which Alex did not select yarn. Subsequent assessments again included edible stimuli, and radish was identified as second S- stimulus. Multiple assessments (total stimuli = 41) were conducted with Perry and failed to identify any edible item that Perry would not

consume. Rather than conducting an assessment using non-edible stimuli, as was done with Alex, we selected the S- identified from the paired-stimulus preference assessments to serve as the S- during the enhanced consequences training procedure. All S- stimuli identified were digitally photographed, made into picture cards, and used during the enhanced consequences procedure during training sessions.

Single-Card Training

Alex and Perry acquired the response of selecting a single S+ picture card within 3 sessions during the training of all S+ picture cards. Victor acquired the single S+ selection within 3 sessions for all but one S+ picture card (Skittle), which required 5 sessions to train to criterion. These data are not shown.

Discrimination Training: Stimulus Fading vs. Enhanced Consequences

Figure 3-1 shows results of the stimulus fading versus enhanced consequences comparison during picture-card discrimination training. Each data path represents S+ picture card selections in the presence of an S+/S- picture card pair. During baseline 1, all participants selected the S+ picture card at chance levels (i.e., 50%-60%), which represented failure to discriminate the picture cards. Following the implementation of training, all participants' performance improved during at least one training condition as evidenced by increases in the percentage of trials during which the S+ picture card was selected. Victor's training data are shown in the top panel. During baseline 1, Victor's S+ selections were low when presented with picture-card pairs 1 and 2 (M=53% & 55% respectively). His discrimination performance for picture-card pair 1, which was trained using enhanced consequences, was initially variable but increased until Victor met the performance criterion. Victor's discrimination performance for picture-card pair 2, trained using stimulus fading, was initially high but became more variable as fading progressed. Given that Victor met the performance criterion under the enhanced consequences procedure before all

the stimulus-fading steps were completed, a probe of the terminal stimulus-fading step (denoted *1) was conducted and showed that Victor's S+ selections remained low. During baseline 2, picture-card pairs 3 and 4 were introduced, and his S+ selections again occurred at chance levels (M=60% & 67%, respectively). Victor's performance on picture-card pair 3, trained using enhanced consequences, was variable throughout the phase. Stimulus fading was used to train picture-card pair 4, and although S+ selections were variable, Victor eventually met the performance criterion.

During Baseline 1, Alex (middle panel) selected the S+ from picture-card pair 1 on an average of 56 & of trials and selected S+ from picture-card pair 2 on an average of 55% of trials. Stimulus fading (picture-card pair 1) resulted in an increase in S+ selections, but S+ selections deteriorated during the terminal fading step. By contrast, Alex's S+ selections were initially variable during the enhanced consequences procedure (picture-card pair 2), but eventually increased and met the training criterion. Picture-card pairs 3 and 4 were introduced during baseline 2 and Alex's S+ selections were at chance levels (M=65% & 47%, respectively). During the second comparison of stimulus fading versus enhanced consequences, Alex's S+ selections increased during both procedures, but he met the training criterion under the enhanced consequences procedure before all the stimulus-fading steps were complete. Therefore, several probes of the terminal-fading step (denoted *1) were conducted, during which his S+ selections were variable and well below criterion.

Perry's results (bottom panel) were consistent across all phases. His S+ selections for both picture-card pairs were low during the three baseline phases. During each of the three training phases, his S+ selections met criterion under the stimulus fading procedure but showed little improvement under the enhanced consequences procedure.

In summary, all participants responded to the S+ at or near chance levels during all baseline phases. Victor acquired 1 S+/S- picture-card discrimination during the enhanced consequences and a second S+/S- picture-card discrimination during the stimulus fading procedure. These results were unusual because his performance during the first training phase suggested that stimulus fading was not as effective as enhanced consequences; that is, the visual enhancements to S+ had little effect over Victor's S+ selections. Alex acquired 2 S+/S- picture-card discriminations during the enhanced consequences procedure, whereas Perry acquired 3 S+/S- picture-card discriminations during the stimulus fading procedure. On average, each participant required approximately 30 training sessions to acquire a picture card discrimination. Collectively, the results indicated that both procedures were effective in establishing picture-card discriminations but not equally so across participants. The inconsistencies in Victor's results, and the differences between Alex's and Perry's results suggested that further comparisons would yield similar mixed results. A logical extension to Study 1 might involve the systematic manipulation of one or both procedures to identify the conditions under which they were effective. Rather than following that plan, we decided to determine whether the two procedures, when combined, would prevent discrimination failures.

The procedures compared in Study 1 represent two distinctly different ways to facilitate discrimination. Stimulus fading assumes that control by enhanced features of the stimuli is already established. In order to transfer control from the enhanced stimuli to the original training stimuli, the stimulus enhancements (i.e., size of the picture card) must exert stimulus control over selection responses. If stimulus control is not established during the initial steps of fading, then consistent responding to the S+ may never occur. The enhanced consequences procedure on the other hand, represents an alternative approach to training visual discriminations in which

stimulus control is facilitated by placing highly disparate values on the S+ and S-. Selection of the S+ picture card results in more reinforcement, and selection of the S- results in a non-preferred item. Given these procedural differences and the fact that data from Study 1 supporting the use of both stimulus fading and enhanced consequences, the possibility existed that an intervention combining both procedures might produce more consistent performance than that observed in the three participants include in Study 1. Therefore, stimulus fading and enhanced consequences were combined during the training of a larger number of participants in Study 2.

Table 3-1. Results of the paired-stimulus preference assessments

Stimulus Pairs		Victor		Alex		Perry	
		Stimuli	%Selected	Stimuli	%Selected	Stimuli	%Selected
1	S+	Circus Peanut	100.00	R. Krispy Treat	87.5	Nilla Waffer	100.00
	S-	Almond	0.00	Skittle	12.5	Raisin	0.00
2	S+	PB Bite	87.50	Pepp. Patty	87.5	Pepp. Patty	87.5
	S-	Puffed Wheat	0.00	Blk Licorice	12.5	Cinnamon	12.5
3	S+	Chip	100.00	Gum Drop	100.00	Peanut M&M	87.5
	S-	Good & Plenty	0.00	Puffed Wheat	0.00	Cheerio	0.00
4	S+	Skittle	87.50	PB Bite	100.00	PB Bite	100.00
	S-	Cheerio	0.00	Altoid	0.00	Gummi Bear	12.5
5	S+					Kit Kat	87.5
	S-					Shredded Wheat	12.5
6	S+					Frito	87.5
	S-					Marshmello	12.5

Table 3-2. Results of the single-stimulus preference assessments

Picture-Card Pairs		Victor		Alex		Perry	
		Stimuli	%Selected	Stimuli	%Selected	Stimuli	%Selected
1	S-	Apricot	0.00	Yarn	0.00	N/A	N/A
2	S-	French Peanut	0.00	Radish	0.00	N/A	N/A

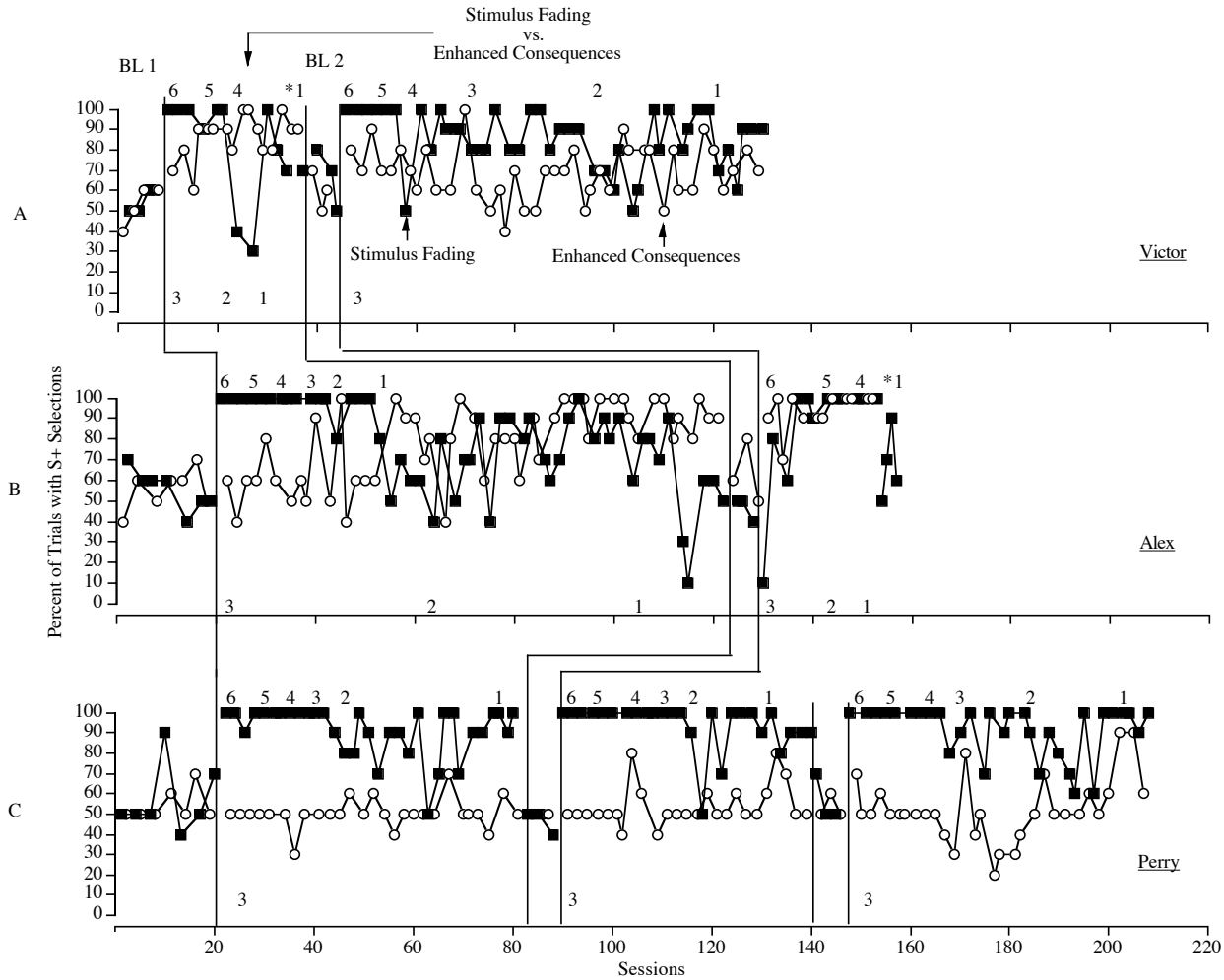

Figure 3-1. Results of the Stimulus Fading vs. Enhanced Consequences comparison. Each data path represents S+ responding in the presence of an S+/S- picture card pair. Stimulus fading steps (6-1) are denoted at the top of each graph, and Enhanced Consequences thinning steps (3-1) are denoted above the X axes.

CHAPTER 4

STUDY 2 METHODS

Participants

Five individuals with developmental disabilities participated. They attended either a sheltered-vocational workshop or a special-education school. Andrew was 24-year-old male diagnosed with Downs Syndrome and severe mental retardation, Billy was a 25-year-old male diagnosed with moderate mental retardation, David was a 42-year-old male diagnosed with mild mental retardation and cerebral palsy, Donald was 16-year-old male diagnosed with severe mental retardation, and Kevin was 53-year-old male diagnosed with severe mental retardation. All participants were nonverbal, except for Kevin who emitted 3-5 words.

Setting

Sessions were conducted in therapy rooms adjacent to a vocational workshop or in a therapy room on the premises of a special-education school. During all sessions, the experimenter and a participant were seated at a table across from each other. One to two observers were present during all sessions to collect data.

Experimental Sequence

During Study 2, training was implemented according a multiple-baseline design across participants.

Data Collection and Response Definitions

During Study 2, all data were collected using the same procedures and response definitions described in Study 1.

Interobserver Agreement

Interobserver agreement was assessed for each experimental phase by having a second observer simultaneously but independently collect data with the primary observer. Observers' records were compared on a trial-by-trial basis, and interobserver agreement was calculated by dividing the number of agreements by the number of agreements plus disagreements and multiplying by 100%. An agreement was defined as a trial on which observers recorded the same occurrence of a response. Interobserver agreement was collected during 81% of all paired-stimulus preference assessments, and 89% of all single-stimulus assessments. The mean agreement scores were 100% and 99% (range, 94% to 100%), respectively. Interobserver agreement was assessed during 72% of all single –card training sessions, and 57% of all discrimination training session; all agreement scores were 100%.

Materials

All picture-communication cards used during Study 2 were made by digitally photographing stimuli identified from preference assessments as preferred and non-preferred, and then were constructed in a similar manner to those described in Study 1.

Procedures

Preference assessments were conducted followed by single card training, and then baseline discrimination was conducted followed by discrimination training. The general procedures used in Study 2 were identical to those described in Study 1. Discrimination training was implemented according to a multiple baseline across participants design.

Stimulus Fading plus Enhanced Consequences

The stimulus fading and enhanced consequences training methods described in Study 1 were combined to determine whether the two procedures, when implemented jointly, would either (a) increase the effectiveness of discrimination training (i.e., prevent failures), or (b)

decrease the number of sessions need to meet the training criterion. Initially, the S+ card was increased in size to 10 cm x 10 cm and was placed closer (10 cm) to the participant. Additionally, the magnitude of reinforcement for selecting the S+ was increased (3 items given per selection instead of 1), and the quality of reinforcer associated with the S- card was decreased by replacing the S- card used during baseline with a new S- card (representing an item never approached during the single-stimulus preference assessment). Responses made using the S+ or S- card produced access to the corresponding edible item.

Stimulus fading began by first increasing the distance between the participant and the S+ card in three increments (10 cm, 20 cm, 30 cm) until the S+ card was 30 cm from the participant (equal to that of the S- picture card). Then, the size of the S+ card was decreased in 3 steps (10 cm, 7.5 cm, 5 cm, 2.5 cm) until it was the same size as the S- card. Magnitude thinning occurred simultaneous with the last two steps of stimulus fading, and consisted of decreasing the number of reinforcers by 1 until it equaled the number used during baseline (i.e., 1). Fading steps were initiated when a participant exhibited 90% or more correct responding for three consecutive sessions. If that criterion was not met within 10 sessions, one of two procedures was implemented. The first procedure consisted of returning to the previously mastered fading step. The second procedure consisted of dividing the last fading step into 2 sub-steps such that size of the picture card was decreased first followed, by a decrease in the number of reinforcers associated with S+.

CHAPTER 5

STUDY 2 RESULTS

Paired-Stimulus Preference Assessments

Results of the paired-stimulus preference assessments for each participant are shown in Table 5-1. The table shows stimuli identified as the S+ and S- for each picture-card pair, and the percentage of trials during which the stimuli were selected. Stimuli selected on 80% or more of the trials served as a S+, whereas items selected on 25% of fewer of the trials served as a S-. Two paired-stimulus preference assessments were conducted for Andrew and Billy, and 3 assessments were conducted for David. Two S+/S- picture-card pairs were identified for both Andrew, which consisted of Raisinette/Teddy Graham and Skittle/Frito. The stimulus pairs identified for Billy were Peppermint Patty/Cheerio and M&M/raisin. The results of David's assessments identified Peanut M&M/noodle, jelly bean/cracker, and animal cracker/Good & Plenty as S+/S- stimulus pairs. The S+/S- stimulus pairs identified for Donald included Veggie Booty/corn chip, rice chip/ranch-soy nut, and rosemary chip/soy nut. Peppermint Patty/orange slice was the only S+/S- pair identified for Kevin. As in Study 1, all S+ and S- stimuli were photographed and made into picture cards.

Single-Stimulus Preference Assessment Results

Single-stimulus preference assessments were conducted and stimuli that were never selected during any trials of the single-stimulus preference assessment were identified as S- stimuli (Table5-2). Two assessments were conducted with Andrew and Billy, three with David and Donald, and one with Kevin. Nori and mushroom were identified as S- stimuli for Andrew, and applesauce and ginger were identified to serve as S- stimuli for Billy. The results of the assessments for David identified radish, sprouts, and cilantro to serve as S- stimuli. Donald's

assessment results identified celery, grape, and orange as S- stimuli. Date was the only S- stimulus identified for Kevin. All S- stimuli identified via the single-stimulus preference assessment were photographed and made into picture cards that were used during the enhanced consequences training procedure.

Single-Card Training Results

Four of the five participants acquired the response of selecting a single S+ picture card within 3 sessions for S+ cards identified. One participant, David, required 4 single-card training sessions to acquire 1 S+ picture selection response, but learned to select the remainder of the identified S+ picture cards within 3 sessions.

Discrimination Training: Stimulus Fading + Enhanced Consequences

Figure 5-1 shows the results, depicted as the percentage of trials with S+ selections, of the combined stimulus fading + enhanced consequences training procedure for all participants. During the initial baseline phase, all participants selected the S+ an average of at chance levels (M=50.4%). Following the implementation of the stimulus fading + enhanced consequences, S+ selections increased for all participants. Andrew (top panel) selected the S+ on 100% of the trials during all sessions in the first training phase. Picture-card pair 2 was introduced during the second baseline, and S+ responding remained low (M=53%). When stimulus fading + enhanced consequences was introduced, Andrew again showed perfect performance throughout the fading steps until he met the performance criterion. The results for Billy (second panel) were similar in that, following both baseline conditions, his selections with the S+ increased and maintained throughout training. The results for David are shown in the third panel. During the first training phase, his S+ selections initially increased, but became more variable as the fading steps progressed. Following 10 sessions at fading step 1, during which S+ selections remained less than 90%, fading step 2 was re-implemented followed by fading steps 1b and 1a. S+ selections

increased and then David eventually met the performance criterion under the modified fading procedure. This modified fading procedure was used during all subsequent training phases with David. S+/S- picture-card pair 2 was introduced during baseline 2 and David selected the S+ an average of 50% of all trials. Following baseline 2, training was implemented, and S+ selections increased and maintained at high levels until he met performance criterion. The third S+/S- picture-card pair was introduced during baseline 3 and David's S+ selections averaged 60%. Results of the final training phase showed that David's S+ selections were initially high, but became slightly variable during the final fading steps. David, however, did meet the performance criterion. The results of Donald's training are shown in the fourth panel. The implementation of training resulted in initial increases in Donald's S+ selections, but S+ selections decreased sharply during the final stimulus-fading step. As sessions continued, S- responding gradually increased until Donald met performance criterion (M=88%). Picture-card pair 2 was introduced during baseline 2 and S+ selections averaged 40%. During the second training phase, S+ selections were consistently high and Donald met performance criterion. The third S+/S- picture card pair was introduced and Donald's S+ selections averaged 50%. When the third training phase was implemented, S+ selections increased and performance criterion was met. The bottom panel shows the results for Kevin. Kevin's S+ selections were initially variable during the first few sessions of training, but eventually stabilized until he met performance criterion. Unfortunately, Kevin refused to participate in any additional session and was dropped from the remainder of the study. After completing training on his first S+/S- pair of pictures, Kevin was unable to participate any additional sessions.

Collectively, these results suggest that the combination of stimulus fading and enhanced consequences was highly effective for training discrimination between picture-communication

cards, and preventing discrimination failures. Although some participants required a modified stimulus fading procedure, none failed to acquire a picture-card discrimination. Both Andrew and Billy acquired 2 S+/S- picture-card discriminations in relatively few training sessions (M=18 & 21 respectively). David and Donald acquired 3 S+/S- picture-card discriminations. They initially required numerous training sessions, but then acquired the remaining discriminations in relatively few sessions (M=28 & 22). Kevin acquired 1 S+/S- picture-card discrimination in relatively few training (26). Based on the results of Study 2, it did not appear that combining stimulus fading with enhanced consequences had much of an effect decreasing the number of training sessions required to facilitate acquisition of the picture-card discriminations.

Table 5-1. Results of the paired-stimulus preference assessments.

Picture-Card Pairs		Andrew		Billy		David	
		Stimuli	% Selected	Stimuli	% Selected	Stimuli	% Selected
1	S+	Raisinette	100.00	Pepp. Patty	87.50	P. M&M	87.50
	S-	Teddy Graham	12.50	Cheerio	25.00	Noodle	12.50
2	S+	Skittle	100 .00	M&M	87.50	Jelly Bean	87.50
	S-	Frito	12.50	Raisin	0.00	Cracker	12.50
3	S+					Animal Cracker	100.00
	S-					Good & Plenty	0.00

Table 5-1. Continued

Picture-Card Pairs		Donald		Kevin	
		Stimuli	% Selected	Stimuli	% Selected
1	S+	Veggie Booty	100.00	Pepp. Pattty	80.00
	S-	Corn Chip	0.00	Orange Slice	0.00
2	S+	Rice Chip	87.50		
	S-	R. Soy Nut	12.50		
3	S+	Rosemary Chip	100.00		
	S-	Good & Plenty	0.00		

Table 5-2. Results of the single-stimulus preference assessments.

Picture-Card Pairs		Andrew		Billy		David	
		Stimuli	% Selected	Stimuli	%Selected	Stimuli	% Selected
1	S-	Nori	0.00	Applesauce	0.00	Radish	0.00
2	S-	Mushroom	0.00	Ginger	0.00	Sprouts	0.00
3	S-					Cilantro	0.00

Table 5-2. Continued

Picture-Card Pairs		Donald		Kevin	
		Stimuli	% Selected	Stimuli	% Selected
1	S-	Celery	0.00	Date	0.00
2	S-	Grape	0.00		
3	S-	Orange	0.00		

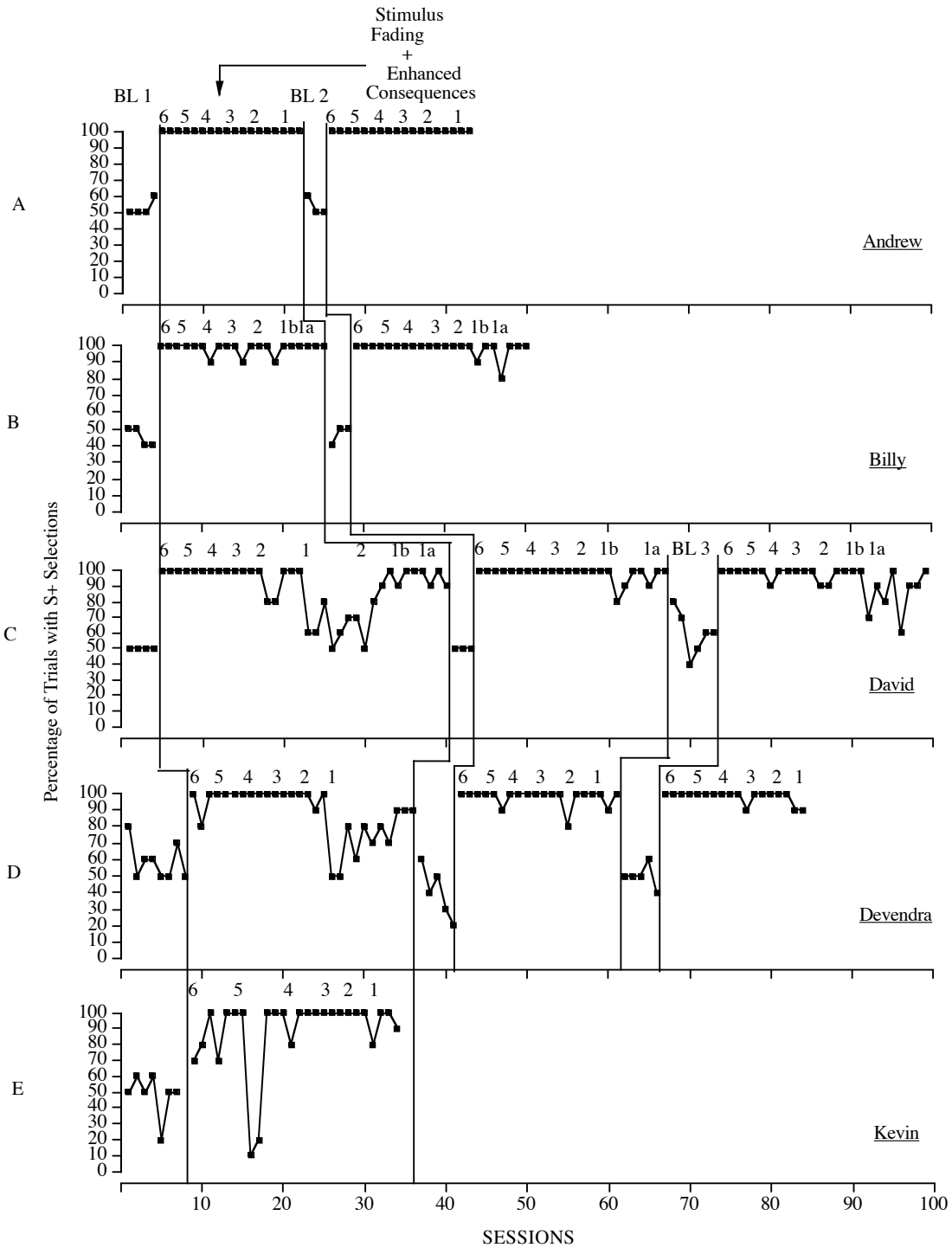

Figure 5-1. Results of he stimulus fading + enhanced consequences training procedure. Each baseline represents the introduction of a new S+/S- picture-card pair. Stimulus fading steps are denoted (6-1 or 6-1a) at the top of each graph.

CHAPTER 6

DISCUSSION

Data from a number of studies have shown that, when differential consequences alone are ineffective in establishing visual-discrimination performance, stimulus fading is an effective method for facilitating acquisition. As a result, instructors of students with developmental disabilities frequently employ training procedures based on stimulus fading. Surprisingly, only one approach, the prompt-delay procedure, has focused on manipulating characteristics of the reinforcer (i.e., delay) associated with the discrimination task.

In Study 1, we compared the effectiveness of stimulus fading to a procedure in which the magnitude of reinforcement associated with tasks+ selections was enhanced. Three of the four participants failed to acquire S+/S- discriminations under baseline conditions and were exposed to the additional training procedures. Results showed that both procedures were somewhat effective in improving visual discrimination between picture-communication cards. Both procedures were effective for Victor; he acquired 1 picture-card discrimination under enhanced consequences and another under stimulus fading. Enhanced consequences was the only effective procedure for Alex (he acquired two picture-card discriminations). By contrast, Perry acquired discriminations only under stimulus fading. The variability in the results across participants in Study 1 may be explained in three ways. First, it is possible that the enhancements made during stimulus fading were not sufficiently salient for Victor and Alex. In this study, we simply increased the size of the S+ picture card so that the visual enhancement was closely related to the target-training stimuli, and also manipulated the distance. It is possible other manipulations to the S+ would have been more effective in the context of training picture-communication cards. For example, experimenters have enhanced training stimuli by adding color or texture to the S+ (Egeland, 1975; Repp, Karsh, & Lenz, 1990). Second, stimulus changes (i.e., decreasing the size

of the S+) made during each step of stimulus fading may have been too extreme, and as a result, disrupted the stimulus control exerted by the S+. To minimize decrements in S+ selections following stimulus changes, more gradual stimulus changes could have been made. However, doing so may have significantly extended the number of training sessions. Alternatively, some studies have used criteria for introducing a previous fading step. For example, Strand (1989) minimized stimulus enhancements contingent on correct responding during a stimulus fading procedure but returned to a previous fading step contingent on incorrect responding. Returning to a previously mastered fading step may re-established stimulus control and allow for additional training before progressing through fading steps. Third, the variability Alex's responding during stimulus fading may have resulted from reinforcement delivered following S- responses. Although the reinforcer associated with S- was less preferred, it may have been effective enough to maintain responding to the S-.

Results also revealed variability in S+ selections during enhanced consequences for Victor, and Alex. The most likely explanation for this variability is that the consequences were not enhanced enough. That is, the reinforcement for S+ selections may not have been of a large enough magnitude to establish stimulus control by the S+ picture card. Data from the first phase of discrimination training for Alex seem to reflect this. S+ selections were initially low and gradually increased as exposure to the training sessions continued. It is possible that the reinforcer magnitude was not large enough to increase S+ selections initially, and that the delayed increases in S+ selections may have instead resulted from repeated exposure to the training procedures. A potential problem associated with increasing the magnitude of the reinforcer associated with S+ selection is that doing so could produce satiation or a decrease in reinforcer effectiveness due to continued exposure. For example, results of a study conducted by

North and Iwata (2005) showed that participants' response rates decreased across sessions as a function of repeated reinforcer consumption, and perhaps data from the second phase of Victor's training have reflected this influence. S+ selections were high early in the phase, but then decreased and became more variable as enhanced consequences sessions continued. Finally, Perry's results should be viewed with caution given that we were unable to identify any edible stimuli that he would not consume during the single-stimulus reinforcer assessment, and thus were unable to substitute the S- used during baseline with one of a no preference ranking. Therefore, the enhanced-consequences procedure was different, and perhaps less effective, for Perry than for the other participants.

It is also possible that stimulus fading and enhanced consequences had different effects across participants because their discrimination failures during baseline resulted from different problems. Victor's (during the first training phase) and Alex's discrimination failures may have resulted from indifference to consequences for selecting S+ versus S-. As a result, enhanced consequences was more effective than stimulus fading for improving S+ selections. By contrast, Victor's (during the second training phase) and Perry's discrimination failures may have resulted from a failure to visually attend to the picture cards. Thus, stimulus fading was more effective than enhanced consequences for increasing S+ selections for these participants. The possibility that discrimination failures may arise from different sources and ameliorated by different interventions suggests that might be helpful to identify the source of the discrimination failure before selecting an intervention.

Because the procedures compared in Study 1 were complimentary (i.e., one represented an antecedent strategy; the other, a consequence strategy) they were combined in Study 2. All participants succeeded in acquiring all picture-card discriminations, and there was relatively little

variability, with the exception of David's results. As may have been the case in Study 1, the stimulus changes from step 2 to step 1 during Study 2 could have been too extreme to maintain S+ selections. Therefore, we used a modified fading procedure that consisted of separating step 1 into two sub-steps. Step 1b consisted of first fading the enhancement to the S+ picture card, and step 1a consisted of thinning the reinforcement associated with the selection of S+. This modified procedure was successful in minimizing variability in S+ selections during subsequent training phases for David. The modified procedure was also used for Billy, and his data show that S+ selections remained stabled across the two training phases.

Results of this study have several implications for PECS training, and for teaching discrimination among visual stimuli in general. Despite the widespread use of picture-card communication training, little research has experimentally evaluated methods to establish picture-card discrimination or to prevent acquisition failures. Overall, the data obtained during Study 2 contribute to the existing literature on picture-card communication training and stimulus control in several ways. First, in contrast to most research on PECS (exceptions: Berkowitz, 1990; Charlop-Christy et al., 2002), the procedures used in the current study were empirically assessed, and individual training data were analyzed. Second, the methods used in the current study also incorporated empirical methods for identifying preferred and nonpreferred stimuli. The use of the single-stimulus preference assessment represented a novel, yet effective, approach to identifying S- stimuli. During this assessment, response options were limited to approaching or not approaching during single- stimulus presentations. Therefore, not approaching a stimulus served as a strong indicator that the item presented is not preferred, thereby enhancing the effectiveness of the consequences for S-. Third, the combined procedure specifically addresses 2

possible sources of discrimination failures (e.g., lack of stimulus control or weak consequences) by altering both the antecedent and consequence conditions of the training context.

There are several limitations to the procedures used in both Study 1 and Study 2, which included the amount of time spent training, the number of fading steps, and the amount of preparation to generate the enhanced-picture cards. In general, participants required an average of 30 sessions (range: 16-44) sessions to acquire a picture-card discrimination during Study 1 and an average of 23 (range: 18-36) training sessions to acquire a picture-card discrimination during Study 2. This may have been related to the number of fading steps (i.e., 6), and the criterion for mastery of each step. It may have been possible to decrease the number of fading steps or to use a less stringent criterion for fading but at the risk of making stimulus changes too extreme. Using a less stringent fading criterion may have been a better option. We used a criterion of 3 consecutive sessions during which the participant selected the S+ on 90% of more of the trials to ensure that S+ selections were under strong stimulus control. It is possible that a criterion of 1 session with 90% or more trials with S+ selections would have been sufficient. Another manipulation to the fading procedure that may have facilitated rapid training would have been to conduct stimulus fading within session rather than across sessions.

The stimulus fading methods described in this study entailed increasing the size of the S+ photograph, which was relatively easy to accomplish utilizing a digital camera and computer. However, one criticism of some stimulus fading procedures is that preparing the stimuli to be used during stimulus fading requires too much time. Stimulus preparation could be time consuming for special education teachers and therapists, but the time spent creating the stimuli only occurs once. That is, once the initial training stimuli are created, the teacher or therapist can utilize those same stimuli to train multiple students.

Another potential limitation to this study is that we used only edible stimuli during the training. Edible stimuli were used because they tended to produce a clear preference hierarchy, be highly motivating, and allowed for easy manipulation of magnitude. Therefore, it is unknown how effective each procedure would have been for training discrimination of picture-communication cards that represented non-edible stimuli such as toys, music, or play. Future research could easily address this limitation by including the presentation leisure items during the paired- and single-stimulus assessments, and then creating picture-communication cards based on the results of those assessments.

In conclusion, stimulus fading plus enhanced consequences is an effective procedure for facilitating discrimination of picture-communication cards. Failures to acquire picture-card discriminations may be corrected and improved a number of ways. The results Study 1 showed that picture-card discrimination can be facilitated by making specific features of the training stimuli more salient or by making the consequences for correct responding more valuable. However, either procedure alone may not be as effective for all individuals; thus, combining the procedures seemed a logical approach. Other combinations of procedures, such as stimulus fading plus error correction, enhanced consequences plus response prompting, or even some combination of all those procedures may also be effective in facilitating visual discriminations.

Future research could also address the noted limitations of the current study in several ways. First, experimenters could utilize the stimulus fading plus enhanced consequences training procedure and attempt to expand the array of picture-communications among which a participant has to discriminate. For example, during training sessions, the experimenter could present 3 or more picture-communication cards (i.e., 1 S+ card vs. 2 S- cards). Second, future research might also focus on refinement to the stimulus-fading plus enhanced consequences procedure. As

noted, the procedures used in this study may have entailed too many fading steps or too strict of a fading criteria. Future studies can evaluate various manipulations to the number of fading steps, and/or the fading criteria, to minimize the number of fading steps while maintaining the integrity of the procedure. Third, studies should be conducted to assess the maintenance and generalization of the effects produced by the stimulus fading plus enhanced consequences procedure.

Given the widespread use of picture-card communication, additional research on the effectiveness of commonly used training procedures seems warranted. Future research can compare the effects of PECS training vs. other communication training procedures on the the acquisition of communication, as well as the development of vocal speech. Data from several studies (e.g., Bondy & Frost, 1994; Charlop-Christy et al., 2002; Kravits et al., 2002; Schwartz and Garfinkle; 1998) suggested that PECS participants acquire vocal speech. However, it is unclear whether or not the participants in those studies would have acquired speech more rapidly under other training conditions. Researchers may also examine picture-card discrimination performance more closely. Studies 1 & 2 focused solely on teaching S+/S- picture-card discriminations. However, the participants' ability to discriminate among multiple S+ picture cards remains unknown. This question seems particularly important given that an expected outcome of PECS training is for participants to communicate using multiple picture cards associated with preferred items. Gutierrez et al. (in press) addressed this question by manipulating the establishing operations associated with picture card selections in order to assess for and establish discriminated responding between two S+ picture cards. The manipulation involved providing free access to the stimulus associated with one S+ card, and not providing

access to the stimulus associated with the other S+ card. The results showed that three of four participants acquired discriminated responding between S+ picture cards.

The results of this study should be of interest of special education teachers, therapists, and caregivers of individuals who have no, or limited use of visual-communication systems, such as PECS, due to the inability to discriminate between picture-communication cards. Furthermore, the training procedures described in this study may have extended applications to other visual discrimination.

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BIOGRAPHICAL SKETCH

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