

*CONTRIVING TRANSITIVE CONDITIONED ESTABLISHING
OPERATIONS TO ESTABLISH DERIVED MANDING SKILLS IN
ADULTS WITH SEVERE DEVELOPMENTAL DISABILITIES*

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The purpose of this study was to demonstrate derived manding skills in 2 adults with severe developmental disabilities and language deficits by contriving transitive conditioned establishing operations. Specifically, we evaluated whether a history of reinforced conditional discrimination learning would ultimately result in a derived mand repertoire, in which participants manded for items that were needed to complete chained tasks. After mastering the first three phases of the picture exchange communication system (PECS), participants were taught to mand for the needed items by exchanging pictures of the items for the items themselves. They were then taught to conditionally relate the dictated names of the items to the corresponding pictures of the items and to relate the dictated names to the corresponding printed words. We then tested, in the absence of reinforcement, whether participants would mand for the items needed to complete the chained tasks using text rather than pictures. Both participants showed the emergence of derived mands and some derived stimulus relations as a result of this instruction. Some of the derived relations were shown to be intact at 1-month follow-up, and scores on derived mand probes were higher at follow-up than before training. In addition, the 2 participants vocally requested the needed items on maintenance test probes, a skill that was never trained and was not previously in their repertoires. These results suggest that a history of reinforced relational responding may facilitate the expansion of a number of verbal skills and emphasize the possibility of a synthesis of Skinner's (1957) analysis of verbal behavior and derived stimulus relations into language-training efforts for persons with significant disabilities.

DESCRIPTORS: stimulus equivalence, manding, establishing operations

Individuals with severe developmental disabilities often display substantial limitations in functional communication. Communicating one's wants and needs is critical for these individuals to sustain a meaningful quality of life. Skinner's (1957) analysis of verbal behavior, which provides a taxonomy of verbal operants, has met with considerable success in establishing

rudimentary verbal repertoires in individuals with severe disabilities (e.g., Stafford, Sundberg, & Braam, 1988). These language-training curricula often make the mand an initial focus of intervention. The mand, "a verbal operant in which the response is reinforced by a characteristic consequence and is therefore under the functional control of relevant conditions of deprivation and aversive stimulation" (Skinner, pp. 35–36), is often granted emphasis in basic language-training programs because it functions primarily for the benefit of the speaker: Regardless of whether vocal communication, picture pointing or exchanging, or manual sign is the chosen modality, mands are maintained by specific, concrete, and effective reinforcers (Bondy & Frost, 1994; Yamamoto & Mochizuki, 1988), and are for this reason likely to be acquired rapidly.

Skinner's (1957) notion of the conditions of deprivation and aversive stimulation under

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which mands are emitted was further articulated by Michael (1988), who defined such conditions in his analysis of the establishing operation (EO), or “an environmental event, operation, or stimulus condition which affects an organism by momentarily altering (1) the reinforcing effectiveness of other events, and (2) the strength of that part of the organism’s repertoire that has been reinforced by those other events” (p. 3). Michael distinguished between unconditioned establishing operations (UEOs), which are EOs whose value-altering effects are unlearned, and conditioned establishing operations (CEOs), which are EOs that depend on individual learning histories. More recently, Laraway, Snyckerski, Michael, and Poling (2003) suggested that applied behavior analysts adopt the term *motivating operation* in lieu of *establishing operation*, because the newer term more directly refers to events that increase and decrease the effectiveness of reinforcers and punishers (see also Call, Wacker, Ringdahl, & Boelter, 2005).

Contriving the motivating operation originally identified by Michael (1988, 1993) as the transitive CEO—a CEO in which one stimulus increases the reinforcing value of a second stimulus—has been shown to be a particularly effective means of establishing manding skills in individuals with developmental disabilities. One procedure, known as the interrupted chain procedure (Hall & Sundberg, 1987), involves contriving a situation so that a portion of a behavior chain is interrupted and cannot be completed unless a mand occurs, thereby creating the relevant conditions of deprivation. In other words, the inaccessibility of an item needed to complete a chained task creates conditions under which the needed item increases in value, thus making a mand for that item more probable. To use the interrupted chain procedure, the practitioner typically selects a chained task already in the individual’s repertoire, and a mand instructional trial is inserted into the chain. For example, the

headphones needed to complete the chained task of assembling a portable compact disc player may be withheld as the individual begins the chained task. When the individual reaches the point in the chain in which headphones are needed to complete the next step, he or she may be required to exchange a picture of headphones for access to the headphones. The headphones can then be plugged into the compact disc player and the remainder of the task can be completed (see also Hunt, Goetz, Alwell, & Sailor, 1986).

The research program on derived stimulus relations has provided an additional conceptualization of verbal behavior. Stemming from Sidman and Tailby’s (1982) original account, a number of studies have shown that when a small number of conditional discriminations are explicitly reinforced, additional relations will emerge on the basis of that prior history of reinforcement. For example, a verbally proficient individual who is taught to conditionally relate dictated names to their corresponding pictures and text is likely to name the pictures, read the text, and match the pictures to the text and text to the pictures in the absence of further instruction. When such derived or untrained relations are observed, the stimuli are said to be functionally substitutable or symbolic for one another (Sidman & Tailby). This finding is educationally relevant, for it suggests that a number of new skills may emerge in the absence of direct reinforcement solely on the basis of a history of reinforced conditional discrimination learning. Several studies have highlighted the practical significance of expanding verbal repertoires by training derived stimulus relations. Cowley, Green, and Brauning-McMorrow (1992) taught adults with brain injuries to conditionally relate their therapists’ dictated names to their photographs and their written names. Posttests showed the emergence of untrained conditional relations involving photos and written names, and 2 participants were capable of orally naming the photos.

Kennedy, Itkonen, and Lindquist (1994) used a similar procedure to establish untrained concept formation and sight-word recognition skills in individuals with moderate disabilities, and de Rose, de Souza, and Hanna (1996) taught children with reading deficiencies to match printed words to dictated words and to copy and name printed words with movable letters. All of the children showed the emergence of reading skills, and some also read generalization words at the conclusion of training.

Although a fair amount of research in this area has been conducted with individuals with mild or moderate disabilities, a paucity of research has focused upon derived stimulus relations in individuals with severely limited verbal repertoires, such as persons with severe mental retardation (O'Donnell & Saunders, 2003). Because of the time- and labor-intensive instruction that this population demands, individuals with severe developmental disabilities may benefit from a language training program that focuses on establishing derived stimulus relations, because all desired skills would not have to be directly taught. Furthermore, because it is critical for these individuals to acquire a rudimentary mand repertoire, incorporating elements of both Skinner's (1957) analysis of verbal behavior and the current conceptualization of derived stimulus relations into language training efforts might prove to be particularly useful. Although the two areas of study have evolved separately, it is increasingly evident that there are similarities between their subject matters and their potential for expanding repertoires (Hall & Chase, 1991).

A synthesis of Skinner's (1957) analysis of verbal behavior and derived stimulus relations was recently proposed by Barnes-Holmes, Barnes-Holmes, and Cullinan (2000). These authors propose that unlike Skinner's analysis of verbal behavior (which contends that like nonverbal behavior, verbal behavior is contingency shaped), true verbal behavior is not established via direct contact with contingencies

of reinforcement but emerges via a reinforced history of relational responding. Regarding the mand specifically, Barnes-Holmes et al. (2000) argue that the mand as described by Skinner (1957) may not account for a novel object that "(a) has never reinforced the mand in the past, (b) has never reinforced a different mand that might induce the current mand, (c) does not physically resemble an object that previously reinforced the mand, and (d) has never been paired with an object that previously reinforced the mand" (p. 72). As the authors describe,

A nonverbal type involves the explicit training of a particular mand to a particular object, as when a child in a toy shop mands for a toy car because in the past manding for a car resulted in the parent actually buying the toy car and presenting it to the child. The verbal type, however, involves the manded stimulus participating in relational frames with other stimuli. In this example, the frame may contain toys in general. The child learns to say "toy" in the presence of cars, train sets, dolls, and so forth, and the child learns to mand at least one toy. Then, the child need not learn to ask for each specific toy from scratch; the child merely has to respond to the object as participating in a frame of coordination with other toys. (p. 72)

Vocally requesting a novel toy, then, would constitute an example of a *derived mand*. Derived mands may be nonvocal in form as well, as in the case of an individual who requests a preferred item by exchanging a picture of the item for the item itself, and who is then taught to conditionally relate the dictated name of the item to the picture and to its corresponding text. Ultimately the individual may request the preferred item by exchanging its text rather than its picture (Rehfeldt & Root, 2005). Programming for the emergence of derived mands may be an economical and efficient means of expanding verbal repertoires.

An advantage of adults with severe disabilities requesting items via the exchange of text rather than pictures is that using text to communicate may be more easily understood by community listeners. Also, exchanging text may be viewed as more adult-like for individuals for whom community integration and inclusion are pri-

orities. In addition, if such a skill is shown to emerge from a history of conditionally relating dictated names to pictures and text, additional derived stimulus relations (e.g., naming pictures, reading text, matching pictures to text and text to pictures) are likely to emerge as well, as was the case in the study reported by Rehfeldt and Root (2005). A limitation of that study, however, is that preferred items were present on all mand instructional and derived mand test trials, thus calling into question whether the participants' exchanging of text for preferred items was exclusively under the control of motivating operations and not the preferred items themselves. An important next step in further synthesizing Skinner's (1957) analysis of verbal behavior and the derived stimulus relations research program into language training protocols is to demonstrate the emergence of derived mands that are solely under control of relevant conditions of deprivation. In the present study, transitive CEOs were contrived by teaching adults with severe developmental disabilities to mand for inaccessible items needed to complete chained tasks by exchanging pictures of those items. They were then taught to conditionally relate the dictated names of those items to the corresponding pictures and to the corresponding printed words. Finally, participants were tested for their ability to exchange the correct text when in need of an item to complete a task as well as for the emergence of derived stimulus relations (e.g., naming pictures, reading text, matching pictures to text and text to pictures) among the stimuli.

METHOD

Participants

Two adults with severe mental retardation who lacked functional communication skills were recruited from a community rehabilitation program in southern Illinois to participate in this study. Lucy was a 34-year-old woman who had also been diagnosed with Down syndrome.

The Stanford Binet Intelligence Test indicated an IQ of 36. The social and communicative subsection of the Inventory for Client and Agency Planning (ICAP), which measures functional communication, imitation, receptive and expressive language, and reading and writing skills, indicated that Lucy communicated at an age equivalent of 3 years 11 months. Lucy was taking 0.075 mg of Levoxyl four times a day, 10 mg of Zocor once a day, and 500 mg of Glucophage four times a day throughout the study. Tony was a 58-year-old man who had also been diagnosed with anxiety disorder and psychotic disorder not otherwise specified. Although a current IQ score was not available, a previous examination specified an IQ score of 24. The social and communicative subsection of the ICAP indicated that Tony communicated at an age equivalent of 1 year 8 months. Tony was taking 20 mg of Olanzapine once daily, 0.5 mg of Lorazepam twice daily, and 15 mg of Moexipiril once daily throughout the study. Tony's and Lucy's speech often consisted of poorly articulated single words and incoherent noises. Both often used gestures to communicate. Agency staff recommended both participants for this study to enhance their functional communication skills.

Setting and Stimulus Materials

Training and test sessions were conducted in either an isolated classroom or a kitchen at the participants' developmental training center. These rooms were furnished with a table, several chairs, and cabinets. Materials included, for each participant, a binder (28 cm by 25 cm) with three hook-and-loop strips spaced approximately 10 cm apart; digital photographs (9 cm by 5 cm) of items needed to complete chained tasks; printed words corresponding to those items printed on cards (9 cm by 5 cm) in boldface Times New Roman 36-point font; a stimulus placement board (28 cm by 25 cm); and the items used to complete the chained tasks.

Stimuli designated as A1, B1, and C1 corresponded to headphones used to complete the chained task of playing a compact disc (CD) on a portable stereo. Stimuli designated as A2, B2, and C2 corresponded to a cup used to complete the chained task of making a pitcher of Kool-Aid[®], and stimuli designated as A3, B3, and C3 corresponded to a spoon also used to make a pitcher of Kool-Aid[®]. In all cases, the A stimuli were the dictated names of the items, the B stimuli were the corresponding pictures of the items, and the C stimuli were the corresponding printed words for the items. The pictures were used during mand training; the printed words were used during derived mand test probes; and all of the stimuli were used during conditional discrimination training and derived stimulus relations test probes.

The materials used for the music chained task included a portable stereo, headphones, two AA batteries, and a CD. Materials needed for the Kool-Aid[®] task included a large plastic spoon, individual packets of sugar-free Kool-Aid[®], a pitcher, and Styrofoam cups.

Experimental Design

A multiple probe design (Horner & Baer, 1978) across 2 participants was used to control for the effects of history, maturation, and repeated testing. First, pretest probes of Lucy's and Tony's manding for items needed to complete the tasks by exchanging the correct text were presented. Derived stimulus relations between the stimuli were also assessed on pretest probe trials. When pretest probes were judged to be visually stable for both participants, Lucy began mand training. When she attained criterion performance during mand training, conditional discrimination training was introduced, in which she was taught to conditionally relate dictated names to their corresponding pictures and dictated names to their corresponding text. Derived mand and derived stimulus relations test probes were repeated for both Lucy and Tony following Lucy's completion of mand training and conditional

discrimination training. Once she demonstrated the emergence of derived mands on posttest probes following conditional discrimination training, Tony began mand training, followed by conditional discrimination training and the derived mand and derived stimulus relations posttest probes. Derived mand and derived stimulus relations maintenance probes were conducted approximately 1 month following Tony's and Lucy's posttest probes. All sessions were conducted 3 to 4 days per week for 45 to 60 min.

Dependent Measure and Interobserver Agreement

The dependent measures were the percentage of correct responses during derived mand and derived stimulus relations probes. A derived mand was defined as the exchange of the correct text (C1, C2, or C3) for a missing item needed to complete the task on at least eight of nine unreinforced trials (89% correct). A derived stimulus relation was defined as accurate performance on eight of nine unreinforced trials (89% correct) for each particular derived relation, including naming pictures (B-A relations), reading text (C-A relations), matching pictures to text (B-C relations), and matching text to pictures (C-B relations). Interobserver agreement was recorded by an independent observer for 33% of all sessions with Lucy and 32% of all sessions with Tony. Agreement was calculated by dividing agreements by agreements plus disagreements and multiplying by 100%. The mean percentage of observer agreement across participants was 97% for all sessions with Lucy and 100% for all sessions with Tony.

Preexperimental Procedure

PECS training. Participants were taught to mand for preferred items using procedures for the first three phases of PECS training developed by Bondy and Frost (1994). Preferred items had been identified via formal stimulus preference assessments and interviews with caregivers and staff. Briefly, the first three

phases of PECS are as follows: Phase 1 teaches the physical exchange, which consists of picking up a picture of a highly preferred item and releasing the picture into the hand of the communicative partner. Phase 2 teaches “persistence and distance,” and includes teaching the participant to remove pictures from the communication book and finding the communicative partner at increasing distances to make the physical exchange. Phase 3 consists of discrimination training, in which items of low and high preference are introduced and the participant is taught to choose a picture corresponding to a preferred item when the picture is presented in an array of pictures of preferred and nonpreferred items. Prompting and reinforcement procedures were performed in accordance with Frost and Bondy (2002) throughout all phases of PECS training. The reader is referred to Frost and Bondy for further detail on PECS.

Maintenance probes of Phase 3 skills were presented intermittently throughout the study. Retraining of Phase 3 skills was implemented if a participant scored fewer than 78% per trial block.

Chained tasks. Total task presentation (e.g., Schuster, Gast, Wolery, & Gaultinan, 1988) was used to teach Lucy and Tony the chained tasks of playing a CD on a portable stereo and making a pitcher of Kool-Aid® prior to the study. The tasks were considered mastered when the participants completed all of the steps independently on three consecutive trials.

Pretest Probes

Derived mand probes. Derived mand probes evaluated whether Lucy and Tony would mand for a missing item needed to complete a task by exchanging the text corresponding to the item (e.g., “headphones,” “cup,” and “spoon”). Trials were conducted in nine-trial blocks, with three trials presented for each stimulus (“headphones,” “cup,” and “spoon”). An array of five textual stimuli arranged on the cover of the participants’ binders was available during both

tasks. The five stimuli consisted of the textual stimuli that corresponded to the missing items and two distracter words (tissue and plate). To begin each task, participants were instructed to “play music” or “make Kool-Aid®.” A music trial began when a portable CD player and a CD in its case were placed on the table in front of the participant. The chain was as follows:

1. Pick up CD player.
2. Open face of CD player.
3. Select CD.
4. Open CD case.
5. Insert CD into CD player.
6. Close CD player.
7. Pick up headphones.
8. Plug headphones into CD player.
9. Push “play” button on CD player.

When the participant reached the point in the chain at which the headphones were needed to complete the next step, he or she was required to mand for the headphones by exchanging the corresponding text.

A Kool-Aid® trial began when a pitcher and lid, Kool-Aid® packet, and gallon-size water jug were placed on the table in front of the participant. The chain was as follows:

1. Pick up pitcher.
2. Pick up Kool-Aid® packet.
3. Open packet completely.
4. Empty packet into pitcher.
5. Pick up water jug.
6. Open water jug.
7. Pour water into pitcher at least half full.
8. Place jug back on table.
9. Select spoon from table.
10. Put spoon in pitcher of water.
11. Stir until powder completely dissolves.
12. Remove spoon from pitcher.
13. Pick up lid.
14. Place lid tightly on pitcher.
15. Pick up cup.
16. Pour Kool-Aid® into cup at least half full.

When the participant reached the point in the chain where the spoon or cup was needed to complete the next step, he or she was required to mand for the particular item by exchanging the corresponding text.

Correct mands were never prompted. Because inferring the emergence of derived skills requires that the skill be demonstrated in the absence of reinforcement, correct mands were never differentially reinforced with the delivery of the item specified in the mand or verbal praise for accuracy. Rather, the instructor obtained the needed item and completed the next step in the task independent of whether or not a correct mand was emitted, after which time the participant resumed completion of the task. Intermittent praise for effort was given throughout probe trials.

Derived relations probes. Picture naming (B-A relations), text reading (C-A relations), and matching picture to text (B-C relations) and text to pictures (C-B relations) were tested over the course of 36 test trials. Each skill was tested in nine-trial blocks, with each sample stimulus being presented three times per block for each. On picture-naming test trials, Lucy's and Tony's oral naming of the pictures of the headphones, cup, and spoon after the presentation of each individual stimulus was tested. On text-reading test trials, Lucy's and Tony's oral reading of the text corresponding to headphones, cup, and spoon after the presentation of each individual stimulus was tested. Picture-naming and text-reading probe trials began with the presentation of each stimulus and the question, "What is it?" If the participant did not respond within 5 s, the trial was scored as incorrect and the next trial was presented. Unintelligible responses were also scored as incorrect. On picture-text matching test trials, participants' matching of the pictures to their corresponding text was tested, and text-picture test trials tested their matching of text to the corresponding pictures. For matching test trials, a trial began when the instructor

presented the participant with a picture or printed word and instructed the participant to "put with same." The three comparison stimuli were evenly placed on a stimulus placement board directly in front of the participant, with their positioning varied across trials. The order of test trials for each relation was random. No feedback was delivered on test probe trials. Intermittent praise for effort was given throughout probe trials. The reader is referred to Figure 1 for a visual representation of the tested relations.

Training mands under transitive CEO control. Participants were taught to mand for three items (headphones, cup, and spoon) needed to complete specific steps in the two chained tasks by exchanging the picture corresponding to the correct item for the item itself. Training was conducted in nine-trial blocks, with three opportunities to mand for each of the three items (headphones, cup, and spoon) programmed per block. Each trial presented the opportunity to mand for one missing item. An array of five pictures arranged on the cover of the participants' binders was available during both tasks. The five stimuli consisted of the pictures of the headphones, cup, and spoon, and two distracter pictures. To begin each task, participants were instructed to "play music" or "make Kool-Aid®." Trials began with the placement of the items needed to complete the particular task on the table in front of the participant, with the exception of the headphones (needed for the music task) and the spoon and cup (needed for the Kool-Aid® task). When the participant reached the point in each chain at which the headphones, spoon, or cup was needed to complete the next step, he or she was required to mand for the particular item by exchanging the correct picture. At this time, the instructor refrained from asking "What do you want?" and delivered the item specified in the participant's mand along with descriptive verbal praise similar to that used in the third phase of PECS training (e.g., "Oh, you want the cup!").

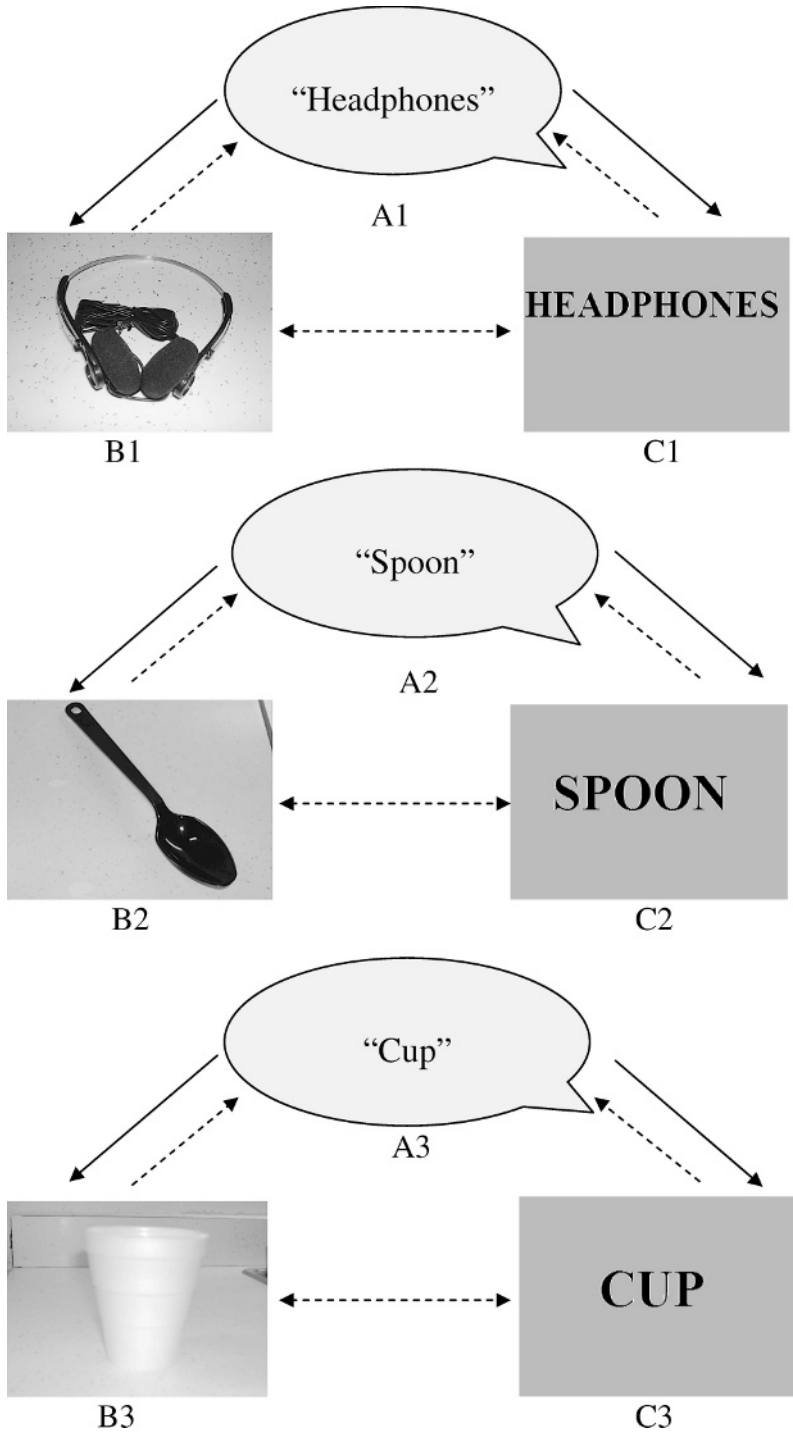


Figure 1. Trained and derived relations for Stimuli A1B1C1, A2B2C2, and A3B3C3. Derived relations are depicted by dashed arrows and trained relations by solid arrows.

When an incorrect picture exchange occurred (e.g., the participant handed the instructor a picture of an item other than the one needed to complete the task), the item specified in the picture was delivered to the participant, the item was removed after 5 to 10 s, and the trial was repeated. If the participant did not immediately respond on a given trial, non-descriptive verbal prompts such as “pay attention” or “look here” were delivered. Correct mands were differentially reinforced only by the delivery of the correct item and verbal praise if they occurred prior to the steps in the tasks when the items were needed; however, Lucy and Tony never attempted to mand for the items during other portions of the tasks. Mastery criterion was set at three consecutive blocks with eight of nine (89%) correct independent mands per trial block.

Praise for effort was delivered throughout training. Participants had the opportunity to engage in leisure activities, to drink a cup of Kool-Aid®, to listen to a chosen CD for 1 to 2 min, and to use PECS to request preferred items between training trials.

Conditional discrimination training. During conditional discrimination training, participants were taught to conditionally relate the dictated names of items to their corresponding pictures (A-B training) and corresponding text (A-C training). Participants were taught using a tabletop simultaneous match-to-sample procedure. Training throughout all phases was conducted in nine-trial blocks, with each sample stimulus, or dictated name, presented three times per block. The order of trials within each block was random, and the positioning of comparison stimuli on the stimulus placement board varied across trials.

Participants were first taught to match dictated names to the corresponding pictures (A-B training), followed by training to match dictated names to the corresponding text (A-C training) to a criterion of eight of nine (89%) correct independent responses for three consec-

utive blocks. Mixed A-B and A-C relations were trained next in 18-trial blocks, with mastery criterion of 16 of 18 (89%) correct responses for three consecutive blocks. The onset of a trial for each phase was marked by the instructor dictating the name of an item (e.g., “cup”) and displaying three comparison stimuli on the stimulus placement board. The participant was required to point to or deliver the picture or text to the instructor to indicate his or her choice. Descriptive verbal praise was provided for correct responses. Intermittent praise for effort was provided throughout training. If an incorrect response occurred, the instructor repeated the trial and provided corrective verbal feedback (e.g., “try again”). If this feedback was not effective in preventing excessive errors, gestural prompts with a graduated delay procedure were used to facilitate acquisition. Gestural prompts consisted of the instructor pointing to the correct comparison stimulus. Gestural prompts were initially presented immediately following the presentation of the dictated name. After the participant responded correctly on eight of nine trials for three consecutive blocks, the delay before the prompt was presented was increased to 1 s. After the participant again responded correctly on eight of nine trials for three consecutive blocks, the delay before the prompt was presented was increased to 2 s. This process continued until the participant selected the correct comparison stimuli independently on eight of nine trials for three consecutive trial blocks. This procedure was necessary to teach both Lucy and Tony to match dictated names to text. The reader is referred to Figure 1 for a depiction of the relations trained.

Posttest Probes

Derived mand probes. Derived mand posttest probes were conducted in the same manner as derived mand pretest probes. Following the demonstration of the emergence of derived mands on posttest probes, a second block of derived mand probe trials was presented in

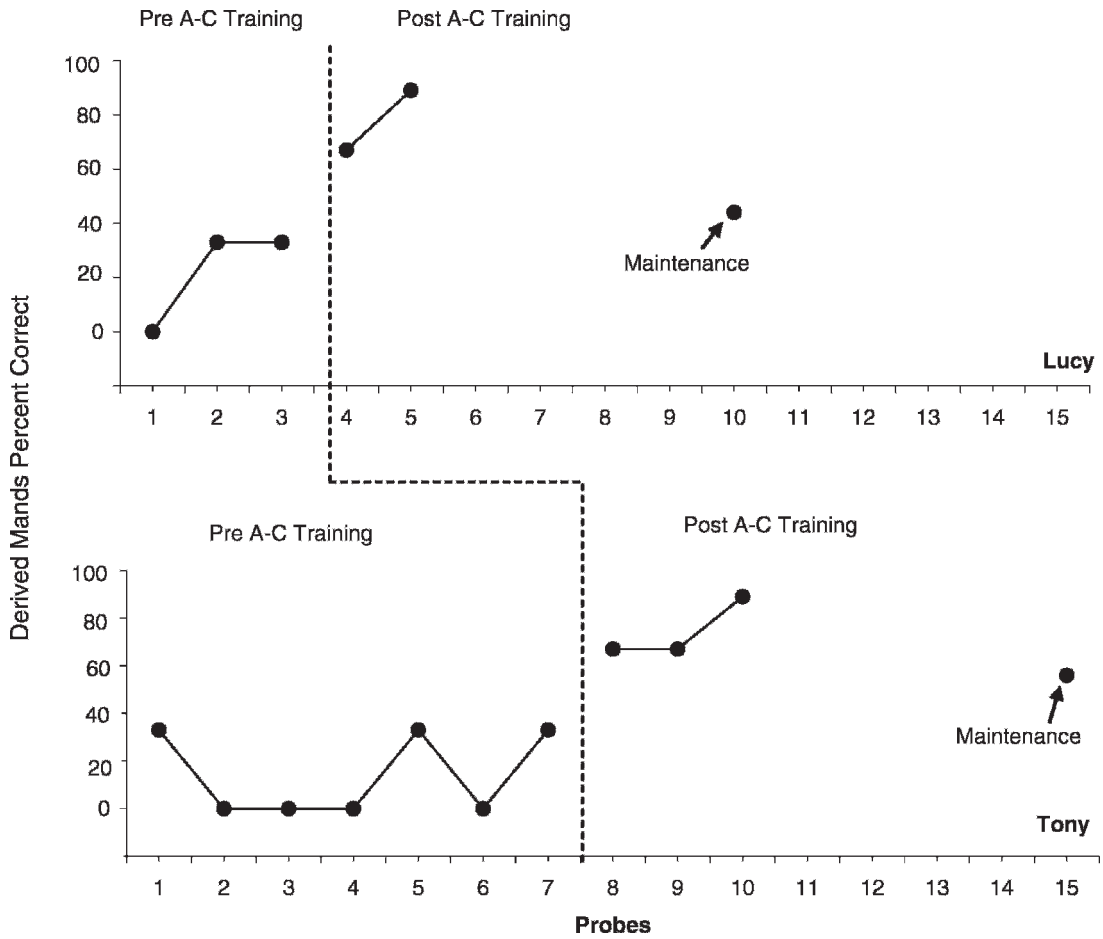


Figure 2. Percentage of correct derived mand probes per nine-trial block before and after A-C conditional discrimination training.

which correct mands were differentially reinforced by the delivery of the needed item and participants were able to complete the next step in the task. Reinforcing a correct text exchange with the delivery of the item thus satisfied Skinner's (1957) definition of the mand.

Derived relations probes. Derived relations posttest probes were conducted in the same manner as derived relations pretest probes.

Maintenance probes. Derived mand and derived stimulus relations maintenance probes were conducted in the same manner as pretest and posttest probes and were presented approximately 1 month following the emergence of derived mands for both participants.

RESULTS

The emergence of derived stimulus relations, including picture naming (B-A), reading text (C-A), picture-text matching (B-C), text-picture matching (C-B), and derived manding skills were inferred if a participant performed correctly on 89% (eight of nine) of the test trials for each respective skill.

Pretest Probes

Derived mands. Neither Lucy or Tony scored higher than 33% correct on the derived mand pretest probes (Figure 2). Thus, exchanging text to mand for the items needed to complete the chained tasks was not established

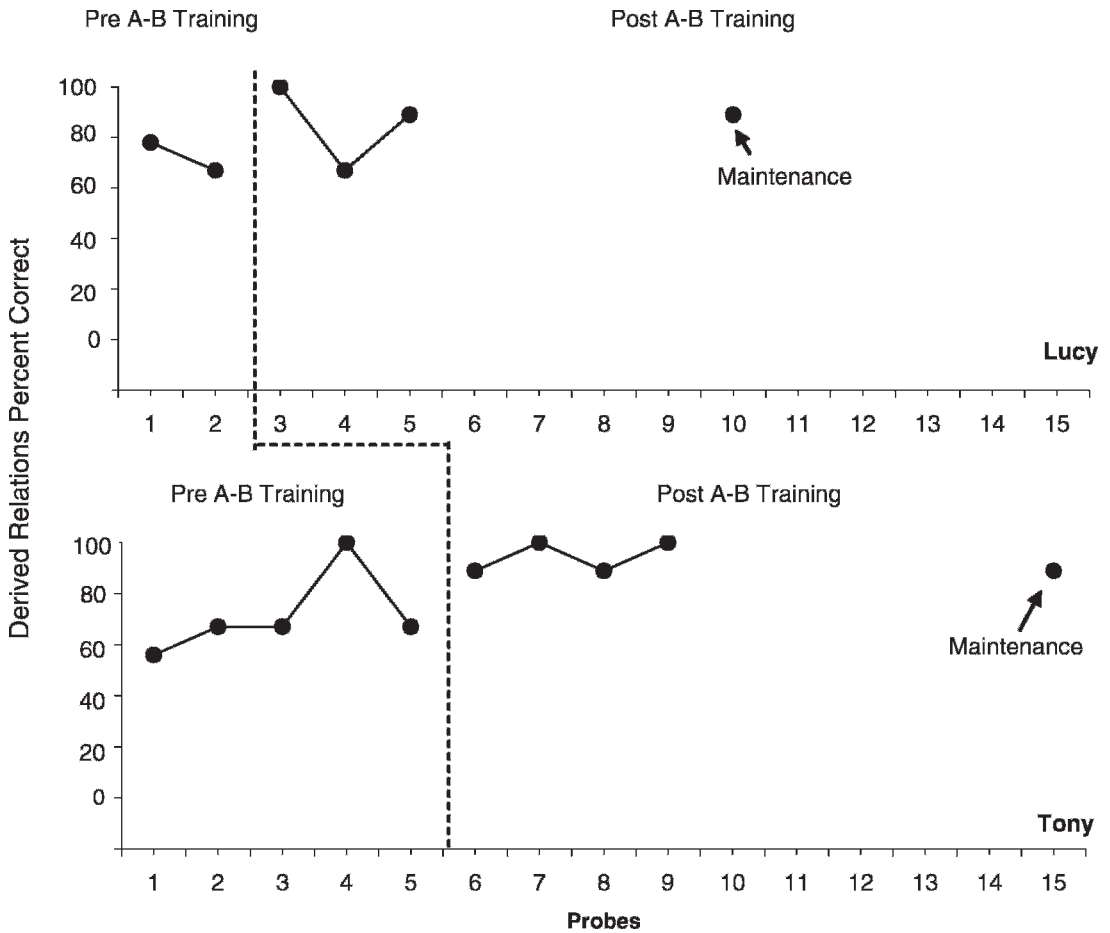


Figure 3. Percentage of correct picture-naming (B-A relations) probes per nine-trial block before and after A-B conditional discrimination training.

in either participant’s repertoire prior to the study.

Derived stimulus relations. Lucy scored as high as 78% correct on the picture-naming (B-A relations) pretest probes, and Tony’s scores on picture-naming (B-A relations) pretest probes ranged from 56% to 100% correct (Figure 3). Lucy scored 0% correct on all of the text-reading (C-A relations) pretest probes, and Tony scored no higher than 33% correct on the text-reading (C-A relations) probes (Figure 4). Lucy scored 100% correct on the second picture-text matching (B-C relations) pretest probe, and Tony scored no higher than 56% correct on the picture-text matching (B-C

relations) probes. Lucy scored 89% correct on the second text-picture matching (C-B relations) pretest probe, and Tony scored no higher than 44% correct on the text-picture matching (C-B relations) pretest probes. These scores suggest that some, but not all, of the relations were intact in Lucy’s repertoire prior to conditional discrimination training, in that she named pictures (B-A relation) correctly on all of the test trials for spoon (B2-A2 relation); matched pictures to words (B-C relation) correctly on all of the test trials for the headphones (B1-C1 relation) and spoon (B2-C2 relation); and matched text to pictures correctly on all of the test trials for the

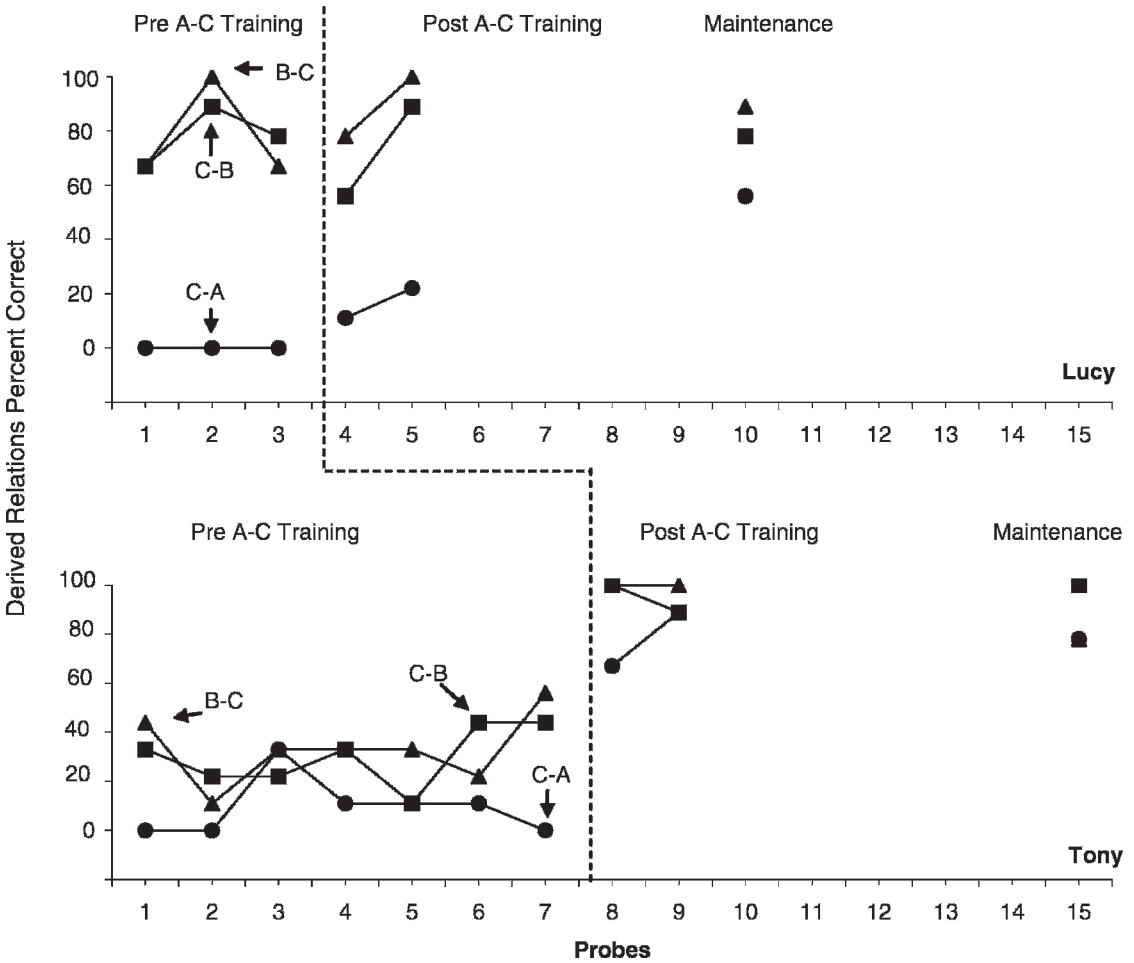


Figure 4. Percentage of correct text-reading (C-A relations), picture-text matching (B-C relations), and text-picture matching (C-B relations) probes per nine-trial block before and after A-C conditional discrimination training.

headphones (C1-B1 relation). With the exception of naming the pictures (B-A relation), the derived stimulus relations were not established in Tony's repertoire prior to conditional discrimination training.

Training

Training mands under transitive CEO control. Both Lucy and Tony performed with 100% accuracy on the first three consecutive nine-trial blocks of mand training (Figure 5). Thus, following mastery of Phase 3 of PECS, intensive training in exchanging pictures to request items

needed to complete the tasks was not necessary for either participant.

Conditional discrimination training. Three nine-trial blocks were required for both Lucy and Tony to demonstrate criterion performance in matching dictated names to their corresponding pictures (A-B training) (Figure 5). Lucy required 17 blocks and Tony required 13 blocks to demonstrate criterion performance in matching dictated names to their corresponding text (A-C training). Lucy met mastery criterion in seven 18-trial blocks and Tony met mastery criterion in three 18-trial blocks during mixed

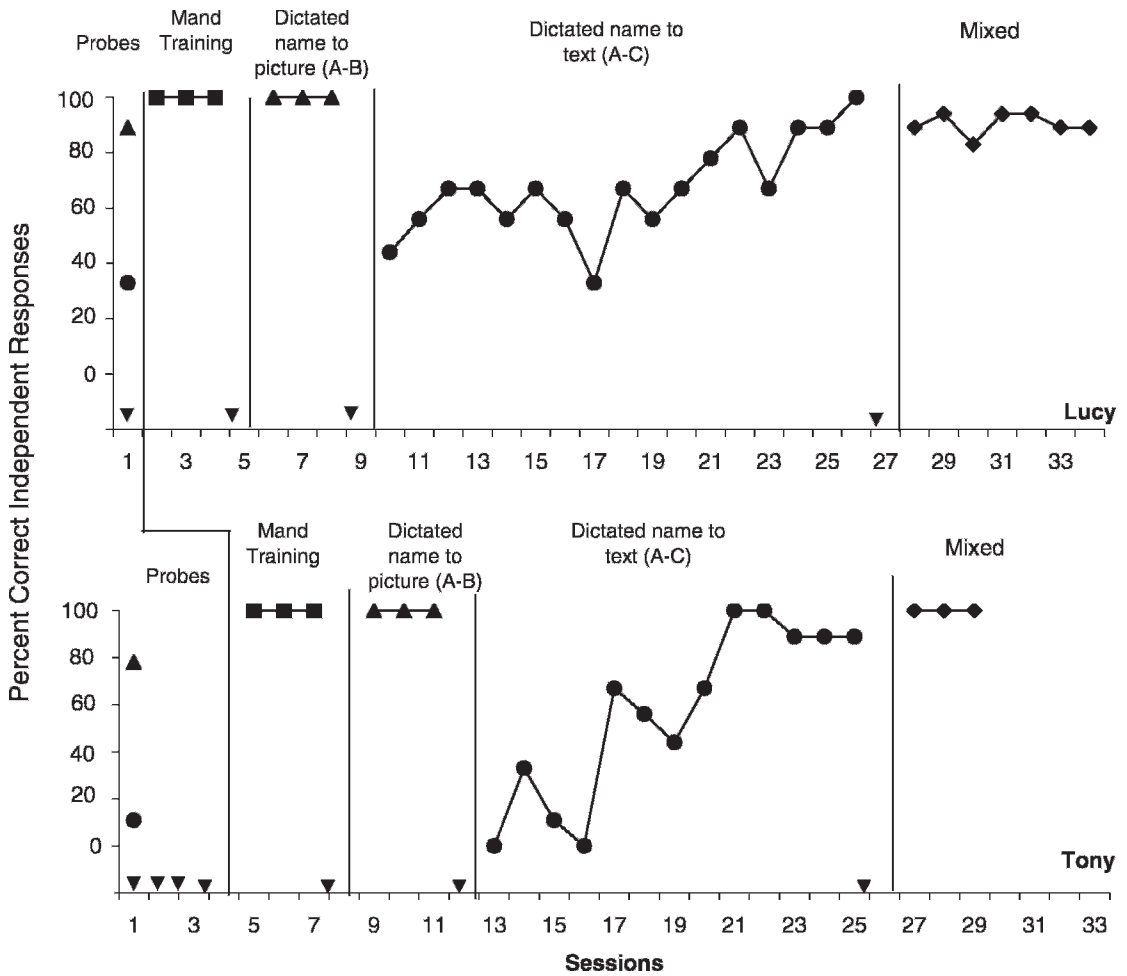


Figure 5. Percentage of correct responses per nine-trial block during mand training and conditional discrimination training. Arrows represent the point at which test probes were presented for each participant.

(A-B and A-C) conditional discrimination training.

Posttest Probes

Derived mands. Lucy scored 67% on the first derived mand posttest probe that was conducted following A-C training (Figure 2). Once she completed mixed (A-B and A-C) conditional discrimination training, Lucy scored 89% correct. Tony scored 67% correct on the first derived mand posttest probe that was conducted following A-C training (Figure 2). He again scored 67% correct after completing mixed (A-B and A-C) conditional

discrimination training, after which he completed one training block of mand training with pictures and one more training block of mixed (A-B and A-C) conditional discrimination training. He then scored 89% correct on the third derived mand posttest probe. Thus, Lucy and Tony both showed the emergence of derived mands.

Following the emergence of derived mands, Lucy and Tony's text exchanges were differentially reinforced with the delivery of the particular item. Both participants demonstrated criterion performance on differentially reinforced mand trials on the fourth block of trials.

Derived stimulus relations. Lucy scored 100% correct on the first picture-naming (B-A relations) posttest probe, and Tony scored 89% correct on the first picture-naming (B-A relations) posttest probe (Figure 3). Lucy scored no higher than 22% correct on text-reading (C-A relations) posttest probes, and Tony read text (C-A relations) with 89% accuracy on the second text-reading (C-A relations) posttest probe (Figure 4). Lucy scored 100% correct on the second picture-text matching (B-C relations) posttest probe and 89% correct on the second text-picture matching (C-B relations) posttest probe (Figure 4). Tony scored 100% correct on the first picture-text matching (B-C relations) and text-picture matching (C-B relations) posttest probes. Thus, Lucy demonstrated the emergence of almost all and Tony demonstrated the emergence of all of the derived stimulus relations following conditional discrimination training. However, some, but not all, of the derived stimulus relations were intact for Lucy prior to training. Lucy spontaneously named the stimuli on 78% of the picture-text matching (B-C relations) trials and 56% of the text-picture matching (C-B relations) trials (data not shown).

Maintenance Probes

Derived mand. Lucy performed with 44% accuracy and Tony performed with 56% accuracy on derived mand maintenance test probes (Figure 2). Thus, the derived mands were not maintained at follow-up for either participant, but the scores were higher than on pretest probes. Both Lucy and Tony vocally requested the correct items on all of the maintenance test trials, even those on which an incorrect text exchange occurred (data not shown).

Derived stimulus relations. Lucy performed with 89% accuracy on picture-naming (B-A relations) and picture-text matching (B-C relations) maintenance probes (Figures 3 and 4). She performed with 56% accuracy on the text-reading (C-A relations) maintenance

probes and 78% accuracy on text-picture matching (C-B relations) maintenance probes. Thus, naming pictures (B-A relations) and text-picture matching (C-B relations) were maintained at follow-up for Lucy. Tony performed with 89% accuracy on the picture-naming (B-A relations) maintenance probe, 78% accuracy on the text-reading (C-A relations) and picture-text matching (B-C relations) maintenance probes, and 100% accuracy on the text-picture matching (C-B relations) maintenance probe (Figures 3 and 4). Thus, naming pictures (B-A relations) and matching pictures to text (B-C relations) were maintained at follow-up for Tony, and his text-reading and picture-text matching scores were significantly higher at follow-up than on pretest probes.

DISCUSSION

The results of this study suggest that a history of reinforced conditional discrimination learning may lead to the emergence of derived manding in persons with severe developmental disabilities and language impairments. Lucy and Tony were explicitly taught to exchange pictures for items needed to complete chained tasks, and to conditionally relate dictated names of those items to the corresponding pictures and text. Both participants then exchanged text, in the absence of reinforcement, to request the needed items. Because the needed items were not present on test probe trials, the participants' exchanging of text seemed to be exclusively under control of a motivating operation, specifically, the transitive CEO (Michael, 1988, 1993). These findings thus support the proposed synthesis of derived stimulus relations with Skinner's (1957) analysis of verbal behavior, as proposed by Barnes-Holmes et al. (2000), and, more specifically, the incorporation of such a synthesis into language training curricula for persons with severe developmental disabilities. In addition to the derived mands, Lucy and Tony also showed the emergence of other skills, including picture naming, oral

reading, and matching words to pictures and pictures to words. Although Lucy displayed some of the stimulus relations prior to instruction, she nonetheless displayed new relations following mastery of the conditional discriminations.

Lucy's and Tony's performances on maintenance test probes are particularly significant. Both participants showed the maintenance of some of the derived stimulus relations approximately 1 month following instruction. That some of the derived relations were maintained is noteworthy, for few applied studies in this area have probed the long-term maintenance of such skills. Although these results are less impressive for Lucy because her pretest scores for some of the relations were high, Tony displayed none of the stimulus relations prior to training. Thus, the durability of the derived stimulus relations is particularly encouraging in his case. In addition, both Lucy and Tony vocally requested the items needed to complete the tasks on derived mand maintenance test probes. Neither participant had displayed this skill previously, and no training opportunities on the skills targeted in the study were provided during the month preceding maintenance probes. It is possible that the participants vocally manded for the items at this time because the text exchange responses had deteriorated and another form of manding was necessary. Because the emergent text exchange repertoire was intact during the initial derived mand posttest probes, vocal mands were not necessary. It is therefore important to account for the training history in this study that led to the emergence of vocal manding. One possibility is that PECS training facilitated the emergence of vocal mands. Charlop-Christy, Carpenter, Le, LeBlanc, and Kellet (2002) found that spontaneous vocalizations increased over the course of PECS training for children with autism. Because Frost and Bondy (2002) advise a proclamation of the requested item following a correct picture exchange during PECS training (e.g., "oh, you

want [name of item]," this possibility does not seem implausible. However, if PECS training was the cause of the facilitative effects on Tony's and Lucy's vocal manding, it is not clear why such vocalizations never occurred over the course of training mands under transitive CEO control. A more likely possibility is that the history of relating the dictated names of the items to their pictures and to their corresponding text facilitated the emergence of vocal requesting, because the pictures, items, text, and their corresponding names had become functionally substitutable. Thus, this history of reinforced conditional discrimination learning may have permitted the emergence of vocal manding.

In addition to demonstrating derived mands and derived stimulus relations, Lucy and Tony also manded for the items when the mands were differentially reinforced with the delivery of the needed item. This skill thus meets Skinner's (1957) definition of a mand as a response under the control of relevant conditions of deprivation or aversive stimulation that is reinforced by a characteristic consequence. It is interesting to note that both participants required additional remedial training to demonstrate accuracy on the differentially reinforced mand trials. This is most likely due to the fact that the participants' text exchanges had not previously been differentially reinforced with the delivery of the needed items; rather, Lucy and Tony were accustomed to exchanging text and having the instructor complete the next step in the chain. Thus, the participants may have simply needed more experience with this change in consequences for manding.

An important shortcoming of this study is the lack of procedural integrity data. As nonautomated procedures for teaching relational tasks become more common in educational settings, ensuring close adherence to the instructional protocol is compulsory. In addition, it should be noted that Lucy's and Tony's performances on test probe trials represent

only small samples of each participant's repertoires, in that as only three derived mands were established for each participant. The results would have been particularly noteworthy if more extensive training in relational tasks had been provided and a number of new verbal skills had been shown to emerge in a variety of situations. For these reasons, continued research efforts in this area are necessary.

In conclusion, this study represents an important step in the proposed synthesis of derived relational responding with Skinner's (1957) analysis of verbal behavior (Barnes-Holmes et al., 2000). Moreover, the results suggest that this synthesis may be particularly relevant for expanding the verbal repertoires of persons with severe developmental disabilities and significant language impairments, a population that has been neglected in research on derived stimulus relations to date (O'Donnell & Saunders, 2000). Future research should attempt to establish other derived verbal operants in applied settings as well as continue to examine the long-term maintenance and generalization of these emergent skills. Studies that do this may take applied behavior analysis a long way towards the identification of effective and efficient teaching protocols that result in the establishment of new skills in persons who lack functional communication repertoires.

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