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Emergence of Mands and Tacts of Novel Objects among Preschool Children

Anna Ingeborg Petursdottir, James E. Carr, and Jack Michael
Western Michigan University

According to Skinner's (1957) analysis of verbal behavior, the mand and the tact are functionally independent verbal operants, each of which is acquired through a unique history of reinforcement. The present study attempted to replicate the findings of Lamarre and Holland (1985), who empirically demonstrated functional independence of mands and tacts in typically developing preschool children. Five children participated. All were initially trained to complete two 4-piece assembly tasks. Four children were then trained to tact the four pieces that comprised one of the assembly tasks, and to mand for the four pieces that comprised the other task, using arbitrary vocal response forms. The remaining child received tact training only, and only on one task. The effects of training on the untrained operant were evaluated in a multiple-probe design across tasks. Following mand training, 4 out of 4 children reliably emitted tacts under testing conditions, while the effects of tact training differed across participants. The results differ from those of Lamarre and Holland, but are not necessarily surprising from the point of view of either Skinner's analysis or more recent behavioral accounts of language. Future research should attempt to identify variables that affect transfer between mand and tact relations.

Key Words: mand, tact, functional independence, verbal behavior, children.

In Skinner's (1957) analysis of verbal behavior, the distinction between the *mand* and the *tact* is a fundamental one that has far-reaching conceptual and practical implications. Skinner defined the mand as a verbal operant in which the response is controlled by a condition of deprivation or aversive stimulation, as a result of a history of reinforcement with a consequence specific to that condition. The entire class of variables that may control the form of the response in a mand relation has also been characterized as *establishing operations* (*EO*s; Michael, 1988, 1993). In the tact relation, by contrast, the response is controlled by a nonverbal discriminative stimulus (S^D) as a result of being reinforced with many different reinforcers or a generalized conditioned reinforcer in the presence of that stimulus (Skinner, 1957). According to Skinner's analysis, any particular response form may function as either a mand or a tact, depending on the type of variable that evokes the response on a given occasion. The response form "water," for example, may occur either as a mand evoked by water deprivation, or as a tact evoked by the sight of a glass of water. For either variable to evoke the response, however, the response must have been brought under the control of that variable through an appropriate history of reinforcement. In other words, the acquisition of each operant necessarily requires a learning history with respect to the relevant controlling variable. This notion of functional independence sets Skinner's analysis apart from more traditional accounts of language that assume that "the speaker acquires a word in its meaningful relation to a thing and then *uses* the word to ask for something" (p. 128). At the practical level, the functional independence of verbal operants is relevant to the design of programs that teach language, as it implies a necessity to include in training all variables that should ultimately exert control over a given response form.

Skinner (1957) noted that mand-tact independence is rarely observed among verbally sophisticated speakers in the natural environment. Rather, informal observation suggests that control over the response form transfers easily between EO and S^D, such that following the acquisition of a tact, even young children will readily emit the same response form as a mand, and vice versa. Skinner provided at least

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Address correspondence to James E. Carr, Department of Psychology, Western Michigan University, 1903 W. Michigan Ave., Kalamazoo, MI, 49008-5439; e-mail: jim.carr@wmich.edu.

four reasons why such transfer might occur. First, tact emergence may be facilitated by the acquisition of a mand in the presence of the manded stimulus. Second, similarity between the stimulus that evokes a tact and the stimulus that reinforces a mand may facilitate transfer from one operant to another. Third, transfer may occur if caregivers reinforce one operant as if it were the other; and fourth, children may early in life acquire generalized verbal skills that permit efficient acquisition of both mands and tacts. Given the number of conditions that can possibly give rise to transfer between EO and S^D control, mand-tact independence may rarely be observed except in very young children or in individuals who are not sufficiently responsive to the natural environment to allow for typical language acquisition.

Skinner (1957) did not consider childhood language acquisition in detail, and thus did not provide any suggestions as to how late in a typically developing child's life it might be possible to observe mand-tact independence. Contemporary behavioral accounts of language have suggested specific higher-order verbal skills that, once acquired, override the functional independence of mands and tacts. Relational frame theory (Hayes, Barnes-Holmes, & Roche, 2001) suggests that once a child has acquired the ability to derive arbitrary stimulus relations, untrained mands and tacts may occur for all stimuli that participate in relational frames with other stimuli that may be manded or tacted in similar contexts (Barnes-Holmes, Barnes-Holmes, & Cullinan, 2000). By contrast, an account proposed by Horne and Lowe (1996) suggests that the critical skill is *naming*, which is hypothesized to be a higher-order verbal operant consisting of interlocking tact relations, echoic relations, and listener behavior. According to this account, when mands enter into name relations, they become instances of *name-manding.* Tacts and mands may exist in isolation when not accompanied by name relations, but in typical language acquisition, this should rarely be the case once naming skills have been established. Neither relational frame theory nor the naming account has specified a timeline, in terms of chronological age, for when tact-mand independence might be overcome. However, typically developing children of preschool age have been shown to perform in accordance with the hypothesized higher-order skills; that is, arbitrarily applicable relational responding or stimulus equivalence (e.g., Goyos, 2000; Saunders, Drake, & Spradlin, 1999; Sidman, Willson-Morris, & Kirk, 1986) and naming (Horne, Lowe, & Randle, 2004; Lowe, Horne, Harris, & Randle, 2002).

Nevertheless, Lamarre and Holland (1985) successfully demonstrated functional independence of mands and tacts of typically developing 3- to 5-year-old children. Nine children were taught to emit the responses "on the left" and "on the right" as tacts (tacting the relative location of objects) and mands (manding for the experimenter to place an object either to the left or to the right of another object). The untrained operant was then tested under extinction. In no case did the training of one operant reliably result in the emergence of the other under testing conditions; some children never responded correctly in the untrained function and others did so only on a few occasions. Hence, all participants required direct training in both functions. Furthermore, when the experimenters reversed the traditional concepts of left and right, and re-trained either tacts or mands under the new contingencies, the majority of the children did not alter their responses when tested in the untrained function. This was the case even though mand training and testing were accomplished in the presence of the S^D for the tact; that is, the left and right locations were always visible to the participants.

Lamarre and Holland's (1985) results might suggest that transfer between mand and tact contingencies does not occur with the ease suggested by Skinner (1957), Barnes-Holmes et al. (2000), or Horne and Lowe (1996), and that preschool-age children do not acquire both relations unless the response is directly reinforced in the presence of both the relevant EO and the relevant S^D. However, several applied studies that have investigated the functional independence of mands and tacts of children and adults with developmental disabilities (Hall & Sundberg, 1987; Nuzzolo-Gomez & Greer, 2004; Sigafoos, Doss, & Reichle, 1989; Sigafoos, Reichle, Doss, Hall, & Pettitt, 1990; Twyman, 1996) have demonstrated a greater degree of transfer than was observed by Lamarre and Holland. Although functional independence was demonstrated in all of these studies, some or all of the participants in each study acquired some mands or tacts without

direct training. In two studies, a brief history of training in both functions for additional target responses was followed by reliable mand-tact transfer (Hall & Sundberg; Nuzzolo-Gomez & Greer). Interestingly, the participants in all of those studies either had minimal verbal repertoires (Hall & Sundberg; Sigafoos et al., 1989; 1990), or substantial language delays (Nuzzolo-Gomez & Greer; Twyman), and at least a similar, if not a greater, degree of mand-tact transfer in preschoolers without such impairments might be expected.

It is possible that some aspect of the preparation or procedures used in Lamarre and Holland's (1985) study was responsible for the absence of untrained operants under testing conditions. Some evidence that this may be the case has been presented by Egan and Barnes-Holmes (2004). These researchers initially replicated Lamarre and Holland's results with young children diagnosed with autism, but found that modifications to the testing procedures, intended to provide effective contextual cues for responding, resulted in the emergence of untrained operants. It is thus possible that the children in Lamarre and Holland's study were simply unable to respond effectively to the testing questions. Another aspect of the procedures that may have prevented transfer concerns the presence of EO control in mand training and testing conditions. For the responses "on the left" and "on the right" to function as mands, sometimes an EO would have to be in effect that increased the reinforcing value of seeing an object placed on the left, and at other times an EO would have to be in effect that increased the reinforcing value of seeing an object placed on the right. The researchers did not manipulate these EOs, and it is unclear exactly what they consisted of or whether they were at all present. If during mand testing, no EO was present that increased the reinforcing value of either location, the responses "on the left" or "on the right" would not be expected to occur, even though they had been acquired as tacts. Similarly, if during mand training, no EO was present to control the form of the response, it is possible that the responses "on the left" and "on the right" were established primarily as intraverbal responses to the experimenter's question, "Where do you want me to put the [object]?," and therefore did not occur in response to the question "Where is the [object]?" used on tact probes.

The present study was an attempt to systematically replicate Lamarre and Holland's (1985) results, while manipulating the presence of EOs during mand training and testing. Young children were trained to tact and mand for objects that comprised assembly tasks. The children received rewards upon completing the tasks. The mand condition utilized an interrupted-chain procedure similar to that used by Hall and Sundberg (1987) and Carroll and Hesse (1987). This procedure involved instructing the children to complete assembly tasks in the absence of items needed to complete them. The sight of an incomplete assembly task was intended to function as an EO that rendered the missing piece effective as reinforcement. This study differed from Lamarre and Holland's study in several ways besides the presence of EO manipulation. First, the target responses were mands and tacts of objects rather than locations or other abstract stimulus properties. Second, in order to prevent the participants from acquiring the target mands and tacts outside of the experimental situation, the response forms consisted of nonsense words rather than conventional English response forms. Third, training and testing of each operant were conducted in the absence of the controlling variable for the other operant; in other words, the S^Ds for tacts were never present on mand training or testing trials, and the EOs for mands were never present on tact training or testing trials. Fourth, the children in this study were younger than those in the Lamarre and Holland study. The last three features were incorporated specifically in order to increase the probability of demonstrating functional independence.

METHOD

Participants and Setting

Five children participated in the study: Tristan, Emma, Noah, Olivia, and Mackenzie. Their ages ranged from 2 yrs., 6 mos. to 3 yrs. 5 mos. at the time they entered the study, and from 2 yrs., 9 mos. to 3 yrs. 8 mos. at the end of the study (see Table 1 for participants' ages at the beginning of each test condition; note that age in baseline in some cases differed from age at study onset because of an intervening pretraining phase). None of them had any known developmental delays, based on parent report. The children were recruited from three

Table 1
Participants' chronological ages (in months) at the beginning of each testing condition, and response forms used for each participant.

	Baseline onset	Age in Months Post-training 1	2	3	4	Cube words	Puzzle words
Tristan	41	43	43	n/a	n/a	chey, noo sai, wa	boosha, doso heeny, middy
Emma	37	42	43	44	n/a	meep, wak soof, trog	bindow, lacket meecot, nover
Noah	40	41	43	n/a	n/a	doob, gop kig, neek	boosha, heeny voggy, noker
Olivia	37	38	39	40	41	meep, wak soof, trog	bindow, lacket meecot, nover
Mackenzie	31	33	n/a	n/a	n/a	meep, wak soof, trog	bindow, lacket meecot, nover

local child-care centers that gave permission for the study to be conducted in their facilities. Parent permission and child assent were obtained prior to each child's entry into the study.

Experimental sessions were conducted either in the children's classrooms or open areas outside of their classrooms. A number of children were typically present and engaged in regular activities while sessions were conducted. During all sessions, a child and an experimenter were seated across from or next to each other at a child-sized table. Each session lasted approximately 10-15 min, and each child was scheduled to attend 1 or 2 sessions per day, 3 to 5 days a week. A camcorder used to record testing sessions was located on a tripod behind the experimenter.

Materials and Programmed Consequences

Two assembly tasks were constructed for the purpose of the study. *The cube* consisted of four foam pieces, each made of 6 or 7 foam blocks that had been glued together to form a unique three-dimensional shape. When the four pieces were assembled correctly, they formed the shape of a cube. *The puzzle* contained four wooden puzzle pieces that differed from one another in shape and the location of colored dots on a solid-color surface. One assembly task was used in each session of the experiment. In addition, a variety of common toys (e.g., cars, dolls, animals) were used during screening and testing sessions.

At the beginning of each session, the child received a sticker sheet on which to collect stickers obtained as consequences for correct responding during the session. A variety of stickers were available throughout the experiment, and prior to each session, the child selected the type of stickers that he or she wished to receive in that session. During all sessions, stickers, along with praise, were delivered contingent on specific correct responses. At the end of each session, the child was allowed to keep the sticker sheet with the stickers that he or she had earned.

Data Collection

Dependent variable. The primary dependent measure was untrained verbal operants (mands or tacts) emitted under testing conditions. A tact was defined as a response made when the experimenter held up a piece belonging to one of the assembly tasks, and asked, "What is this?" A mand was defined as a response made when one of the pieces needed to complete an assembly task was out of sight, and the experimenter asked "What do you need?" The target response forms were determined by one- or two-syllable names that were assigned to each

of the eight pieces comprising the two assembly tasks prior to baseline testing for each child. One-syllable names were assigned to cube pieces and two-syllable names to puzzle pieces. The specific names were selected and/or modified based on each child's echoic repertoire, with the restriction that they could not be listed as words in *Merriam-Webster's Collegiate Dictionary* (Mish et al., 1993). Table 1 lists the target responses for each child.

Scoring. On each trial, during both testing and training sessions, the experimenter recorded either a correct or an incorrect response on a data sheet. A response was scored as correct if it contained the target response form and did not contain any of the other response forms defined for that child. A response was scored as incorrect if the target response form was not emitted within 20 s of the experimenter's initiation of a testing trial, or within 5 s of the initiation of a training trial; or if another response form defined for the child was emitted either before or within 5 s of the target response form.

Interobserver agreement. A second observer independently recorded data for 91% of all testing sessions, either while present during the session or subsequently from videotape. On each trial, an agreement was scored if the experimenter and the second observer both scored a response as correct or incorrect; otherwise, a disagreement was scored. Point-by-point agreement was calculated for each session by dividing the number of agreements by the sum of agreements and disagreements, and multiplying by 100%. Agreement ranged from 87.5% to 100% for individual testing sessions and averaged 97.2% for Tristan, 98.7% for Emma, 99.3% for Noah, 99.6% for Olivia, and 98.9% for Mackenzie.

During training, a second observer was present and independently recorded data for 45% of all sessions. Point-by-point agreement was calculated for each session in the same manner described for testing sessions. Agreement ranged from 87.5% to 100% for individual training sessions and averaged 99.5% for Emma, 99.2% for Olivia, and 100% for the other three children.

Independent variable integrity. The independent variable was the training of a verbal operant (mand or tact). A trained observer recorded experimenter behavior for 41% of all training sessions. A training error was scored if during the training of one operant, the experimenter delivered consequences appropriate only for training of the other operant (e.g., delivering praise following a correct response on a mand trial). An error was also scored if the experimenter failed to deliver consequences or error correction procedures. A trial was scored as correctly implemented if no errors were made on that trial. All scored trials (100%) were implemented correctly during tact training and 98.6% were implemented correctly during mand training.

Procedures

Screening. Prior to the experiment, prospective participants were screened for two prerequisite skills: (a) Tacting familiar toys (e.g., a toy car) in response to the question "What is this?" and (b) manding for familiar toys that were absent and needed to complete play routines (e.g., a baby bottle needed to feed a baby doll) in response to the question "What do you need?" The purpose of screening was to verify that the instructions used during testing were sufficient to evoke mands and tacts already in the repertoire. To qualify for participation in the study, a child had to respond correctly on either 2 out of 2 or 3 out of 4 trials of each type. No children were excluded from the study on the basis of not meeting this criterion.

Pretraining. In the pretraining phase, the children were trained to assemble the cube and the puzzle. Backwards chaining was used to teach the cube and total-task presentation for the puzzle. The experimenter began each trial by delivering the instruction "Put these together" (or "Finish putting these together," prior to the final step of training on the cube). Initially, the experimenter assisted the child with the completion of the task, following which the child received praise and a sticker. Over subsequent trials, the experimenter's assistance was gradually withdrawn until the child was performing the task independently. Training continued until the child completed the task independently on 3 out of 3 trials on two consecutive days.

Tact training. In tact training, the children were trained to tact each of the four pieces that comprised one of the assembly tasks. Training was conducted in a discrete-trial format. On each trial, the experimenter held up one piece at a time and asked, "What is this?" If the child

responded correctly, the experimenter delivered praise (e.g., "Very good!") and a sticker. If the child made an incorrect response or made no response within 5 s, the experimenter vocally prompted a correct response (e.g., "a wak"), and then repeated the trial.

Training proceeded through the following steps. Trials were first conducted with piece 1 until the child responded correctly, without prompts, for three trials in a row. Piece 2 was then introduced in the same fashion, following which presentations of pieces 1 and 2 were alternated such that every 4-trial block contained two presentations of each piece. When 100% correct responding was achieved on one block of trials, piece 3 was introduced, and its presentations alternated with piece 2 in the same manner. After 100% correct responding occurred for one block of trials, piece 4 was introduced and alternated first with piece 3 and then with piece 1, at which time presentations of each piece had been alternated with two other pieces. In the final stage of training, presentations of all four pieces were alternated in 8-trial blocks, in which each piece was presented twice, with presentation order varying across blocks. Training was completed when the child responded correctly on at least 7 out of 8 trials in three consecutive 8-trial blocks that were conducted on at least two separate days. For Olivia, who received tact training on the cube twice, the initial steps of training were omitted the second time, and, thus, training began with alternating presentations of all four pieces.

Mand training. In mand training, the children were trained to mand for each of the four pieces that comprised one of the assembly tasks. Training was conducted in a discrete-trial format. Prior to each trial, the child was presented with 3 of the 4 objects needed to complete the assembly task and given the instruction "Put these together." The fourth object was kept out of the child's sight but within the experimenter's reach. When the child had attempted to complete the task, the experimenter asked, "What do you need?" (if a correct mand occurred prior to the question, the question was omitted). If the child responded correctly with the name of the missing piece, the experimenter immediately delivered that piece without simultaneously providing any other consequences such as praise or smiles. The receipt of the missing piece enabled the child to successfully complete the task. The experimenter then praised task completion (e.g., "Good job putting them all together!") and gave the child a sticker.

If the child did not respond to the question "What do you need?" within 5 s, the experimenter vocally prompted a correct response (e.g., "the wak"), following which the trial was repeated, beginning with the instruction to complete the assembly task. If an incorrect response occurred, such that instead of responding with the name of the missing piece the child responded with the name of one of the pieces that he or she already had on the table, the experimenter picked up that piece and gave it back to the child, following which a correct response was prompted and the trial repeated. The purpose of this error correction procedure was to create a history in which the sight of the incomplete task functioned as an EO that increased the reinforcing value of the missing piece and did not function as an S^D correlated with the availability of reinforcement. That is, a mand for a particular piece (e.g., "I need the wak") always resulted in the delivery of that piece and was thus not correlated with the availability of the consequence, but the delivery of the piece was assumed to be reinforcing only if it happened to be the missing piece needed to complete the task.

The training steps and acquisition criteria were the same as those used for tact training. For Emma and Olivia, who received mand training on the puzzle and the cube, respectively, after already receiving tact training on those tasks, the initial steps of training were omitted in this additional mand training phase, such that training began with alternating presentations of trials targeting all four mands.

Testing. Testing sessions were conducted in baseline and following each training phase. Each testing session contained eight test trials presented in a variable order: one mand trial and one tact trial for each of the four pieces that comprised one of the assembly tasks. Test trials were identical to training trials with the exception that they were conducted under extinction; that is, no consequences were provided for either correct or incorrect responses. Instead, up to 20 s were allowed for a response to occur and the task materials then removed.

Modified testing trials for mands were used for Olivia only. On modified mand trials, nonspecific mands such as "I need another piece"

in response to the initial question "What do you need?" were followed by prompts to mand for a specific piece ("Which one?").

Test trials were interspersed with two types of reinforced trials: (a) tact trials in which familiar items (e.g., a toy car or a crayon) were presented along with the question "What is this?," and (b) successful task completion trials, in which the child was presented with all four pieces of the assembly task, along with an instruction to complete the task. In both types of trials, the child received praise and a sticker following a correct or a prompted response. Each test trial was followed either by one familiar tact trial or one successful task completion trial. The purpose of these trials was (a) to make reinforcement available during testing sessions, and (b) to prevent extinction of task assembly behavior by providing opportunities to complete the task successfully.

Before the first testing session in each phase following baseline, a booster pretraining session was conducted for each assembly task in order to ensure that the child could still complete the task independently. If the child had received mand training on one of the tasks immediately prior to the testing phase, the booster training session for that task was omitted.

Experimental design. The effect of training one operant on the emission of the untrained operant was evaluated in a multiple-probe design across the two assembly tasks. Four children (Tristan, Emma, Noah, and Olivia) received tact training on one task and mand training on the other task, with the order of tasks and training phases counterbalanced across participants. The fifth child, Mackenzie, completed tact training on the puzzle, but discontinued daily attendance at the child-care center before mand training could be completed.

If the untrained operant did not emerge at criterion level following training, that operant was trained separately following initial training on both tasks. Criterion was met if within six testing sessions, at least one session occurred in which the child responded correctly on 4 out of 4 trials in the untrained function, or at least two sessions occurred in which three correct responses were made. If this criterion was not achieved within six testing sessions, a new training condition commenced, except that additional modified testing sessions were conducted for Olivia.

RESULTS

Tristan (Figure 1) and Emma (Figure 2) received mand training first, followed by tact training. In the first testing session following mand training on the puzzle, Tristan responded correctly on 3 out of 4 tact trials, and in the two subsequent sessions, he responded correctly on all four. Following tact training on the cube, Tristan never responded correctly on all four mand trials in a single session. His errors, however, were not limited to mands for specific pieces; he emitted each of the four mands correctly in at least one session. Following this second training phase, performance on mands and tacts acquired during the first training phase had deteriorated.

Emma responded correctly on 3 out of 4 tact trials following mand training on the cube, and in the second session, she responded correctly on all four trials. Even though Emma had previously completed mand training, she never emitted all four mands in a single testing session; however, she emitted each of the four mands correctly in at least two sessions. Following tact training on the puzzle, Emma's correct mands ranged from 0 to 3 in each session. As with Tristan, her errors on mand trials were not limited to mands for specific pieces; she emitted each of the four mands correctly in at least one session. Because Emma's performance on mand trials did not meet the acquisition criterion, she subsequently received mand training on the puzzle. Following mand training, both mands and tacts occurred reliably. As with Tristan, Emma's performance in testing sessions for mands and tacts acquired during mand training deteriorated following the completion of tact training.

Noah (Figure 3) and Olivia (Figure 4) received tact training first, followed by mand training. In the first session following tact training on the puzzle, Noah did not make any correct responses on mand trials. However, performance increased across subsequent sessions and in the fifth session he responded correctly on all four mand trials. Following mand training on the cube, Noah's performance on both tacts and mands was variable and less than perfect, but on the sixth probe he responded correctly on all four tact trials. Mands and tacts from the first training phase were not maintained following the second phase.

Olivia did not respond correctly on any mand

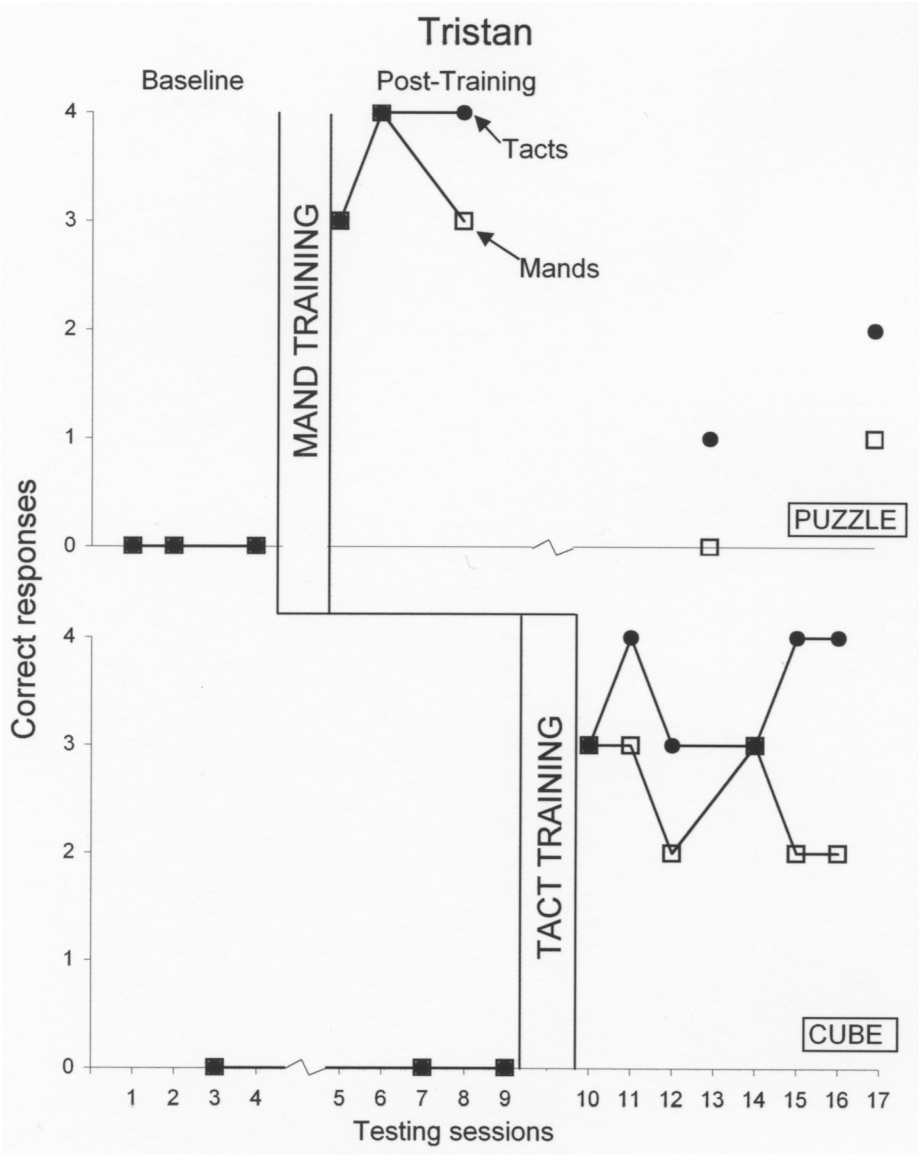

Figure 1. The effects of tact and mand training on tact (filled circles) and mand (open squares) acquisition for Tristan.

trials following tact training on the cube; instead, she responded with a nonspecific mand ("I need another piece.") on all trials. Modified mand trials, which included a prompt to mand for a specific piece, did not result in any correct mands. In the first session following mand training, Olivia also failed to respond correctly on all four tact trials. However, her performance increased across subsequent sessions and in the third session she responded correctly on all four tact trials. The tacts that Olivia acquired during tact training on the cube were not maintained following mand training on the puzzle. Therefore, tacts on the cube were retrained prior to introducing mand training on this task. Following the second round of tact training, Olivia responded correctly on all four mand trials in the first testing session, but correct mands were rarely observed in subsequent sessions. Following mand training on the cube, correct mands and tacts were reliably observed.

Mackenzie's data are depicted in Figure 5. Mackenzie received tact training on the cube, following which she never emitted any correct mands. As with Olivia, her incorrect responses frequently, but not always, consisted of nonspecific mands such as "I need another block" or "I need another one."

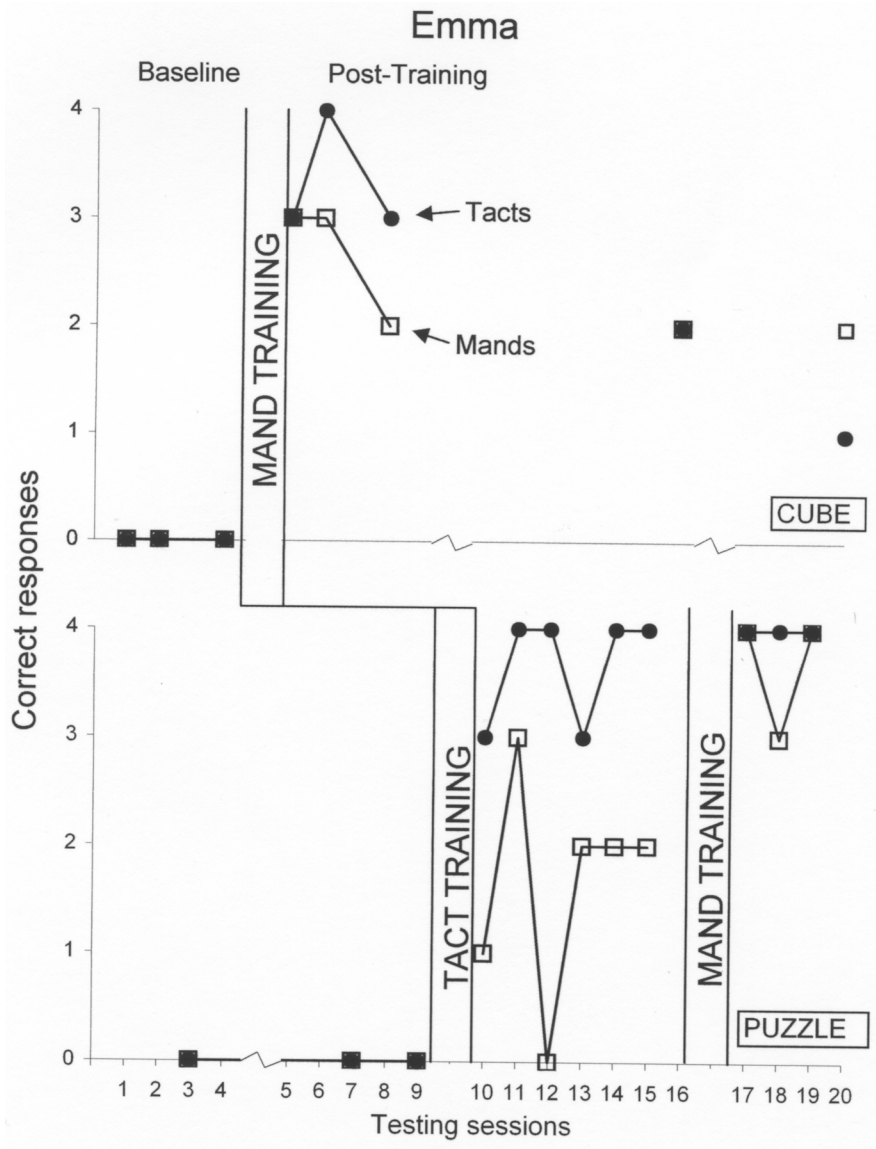

Figure 2. The effects of tact and mand training on tact (filled circles) and mand (open squares) acquisition for Emma.

As shown in Table 2, the mean number of untrained tacts following mand training was greater than the number of untrained mands following tact training for all four children who received both types of training. Table 2 also shows each child's performance on the untrained operant in the first testing session following each training phase. Although no responses were reinforced on testing trials, the increasing trend across testing sessions for Noah (following tact training on the puzzle) and Olivia (following mand training on the puzzle) indicates a possibility that some learning nevertheless occurred during testing sessions. Data on the first session following each training phase may therefore represent the effects of training alone, without any possible confounding effects of testing. For 3 out of 4 children who received mand training, three correct tacts were observed in the first testing session following training, while none were observed for Olivia. Tristan also responded correctly on three mand trials in the first session following tact training, but the other four children emitted either one correct mand or none.

Figure 6 shows the number of training trials required to reach criterion in each training phase for each child. For 3 of the 4 children

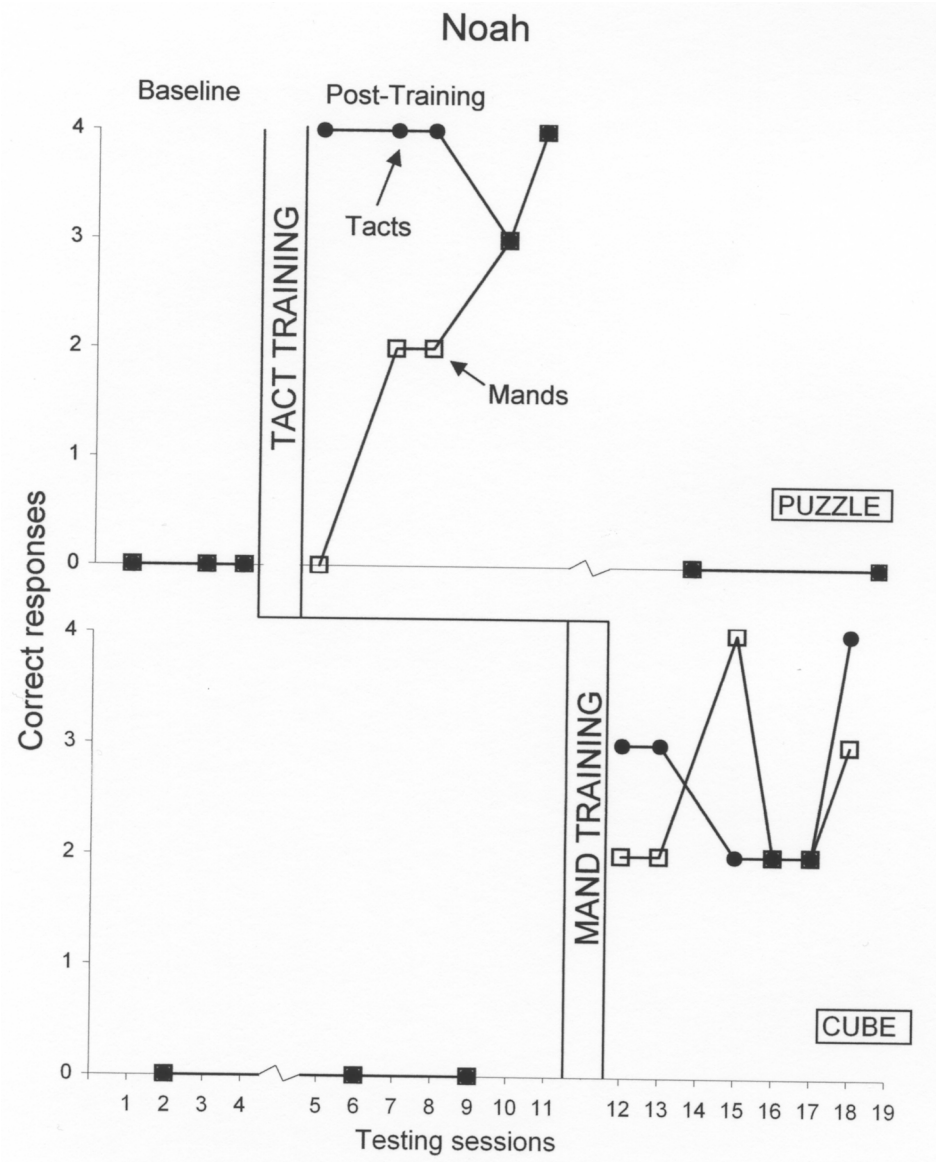

Figure 3. The effects of tact and mand training on tact (filled circles) and mand (open squares) acquisition for Noah.

who completed both mand and tact training, the first training phase took longer to complete than the second phase. Also, mand training took longer to complete than tact training for 3 out of 4 children.

DISCUSSION

In the present study, mand training resulted in reliable tact acquisition for 4 out of 4 children, but tact emergence was delayed for one of them. Tact training, on the other hand, had a less consistent effect on mand acquisition. Specifically, two children did not emit any mands following tact training, one began to emit correct mands only after repeated exposure to testing sessions, and while the remaining two children responded correctly on some mand trials in most testing sessions, they never emitted all four mands correctly in a single session.

These results differ from Lamarre and Holland's (1985) study in which preschool children completely failed to exhibit appropriate tact repertoires following mand training, as well as mand repertoires following tact training. The present study differed from that of

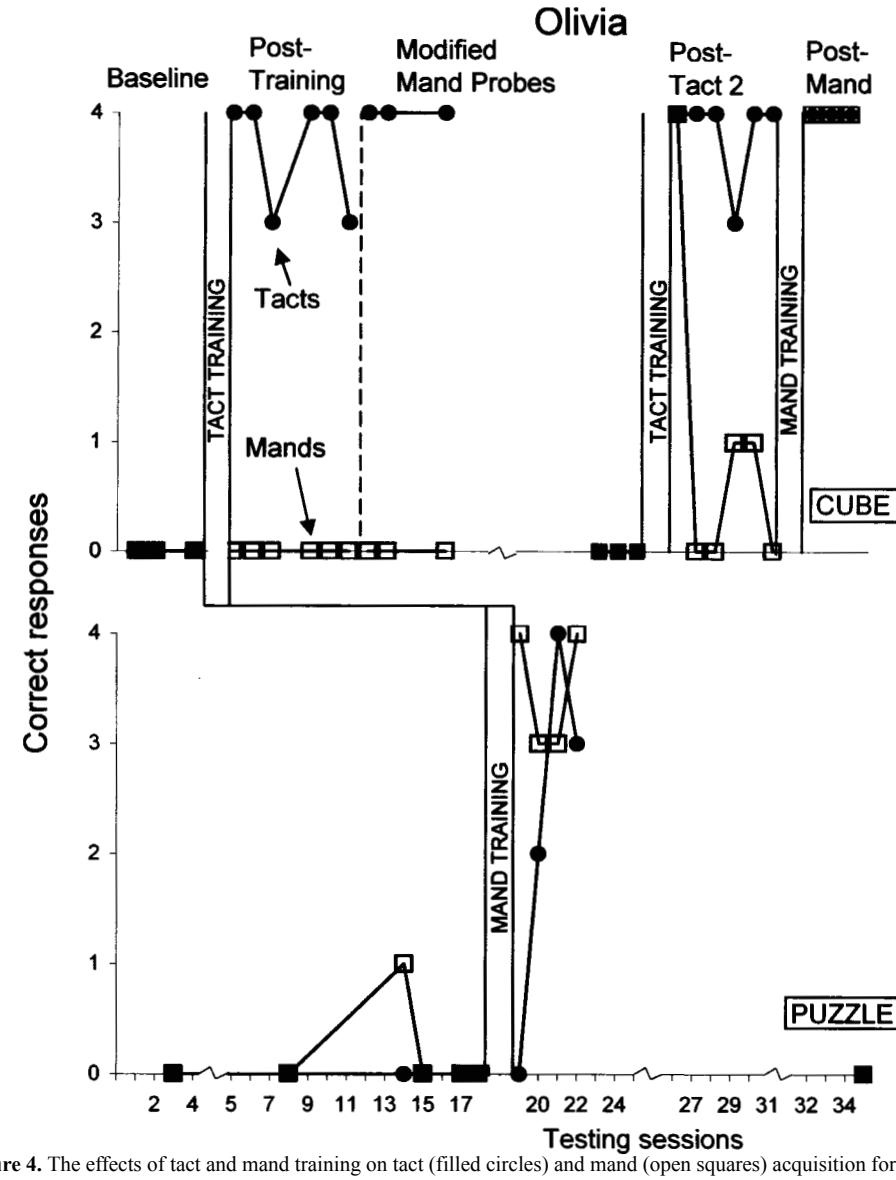

Figure 4. The effects of tact and mand training on tact (filled circles) and mand (open squares) acquisition for Olivia.

Lamarre and Holland in two ways that may have contributed to the different outcomes. First, Lamarre and Holland taught mands and tacts of relative locations of objects, which are arguably more abstract than the mands and tacts of discrete objects taught in this study. Young children may have more history with respect to manding and tacting objects than they do with manding and tacting relative locations, and even though the children in the present study were substantially younger than those in Lamarre and Holland's study, it is conceivable that such a history facilitated transfer between operants. Second, the present study utilized an interrupted-chain procedure in an attempt to contrive EOs during mand training and testing. In the Lamarre and Holland study, by contrast, EOs were not under the control of the researchers and may or may not have been present during mand training and testing. As discussed earlier, if it was the case that EOs were absent, these conditions may not have been true mand conditions, which implies that no transfer of control from EO to S^D or S^D to EO was possible. Given the discrepant results, it appears that further attempts to replicate

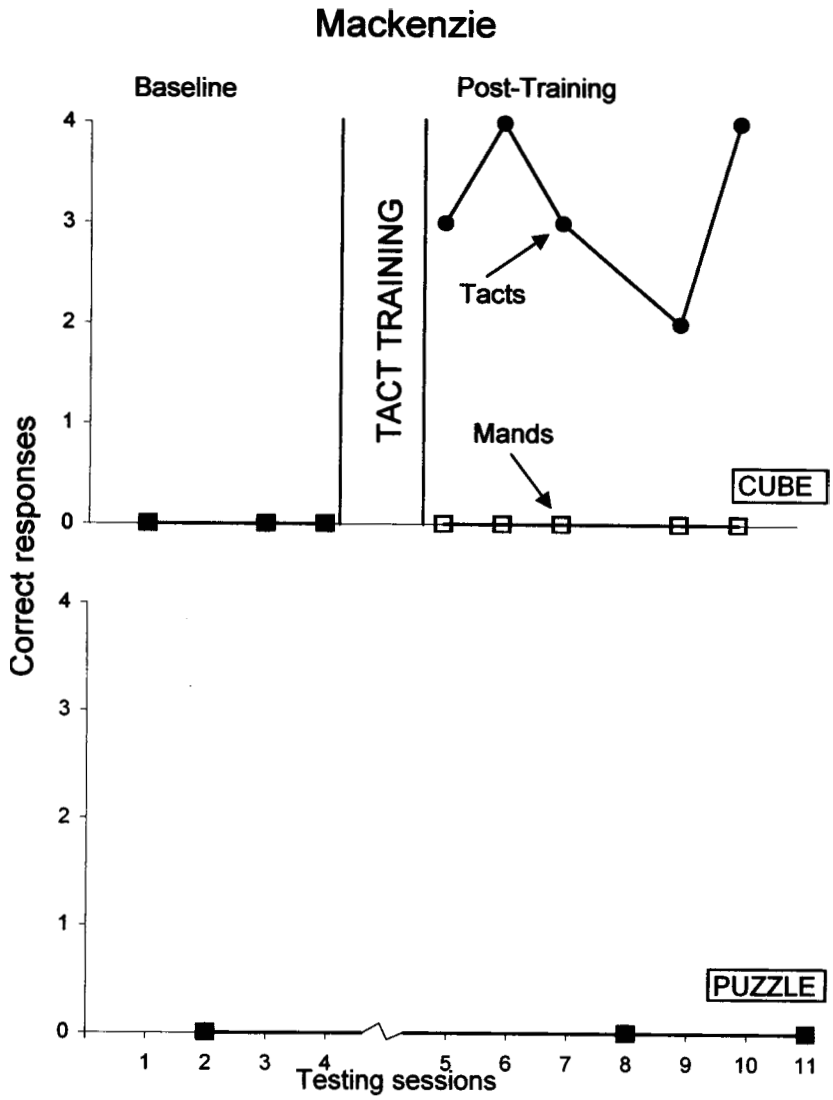

Figure 5. The effects of tact training on tact (filled circles) and mand (open squares) acquisition for Mackenzie.

Lamarre and Holland's findings are warranted. Future research should continue to incorporate variables that promote EO control over alleged mand responses and attempt to demonstrate functional independence across a variety of stimuli or events to be manded or tacted.

A second aspect of the present results that warrants discussion is that mand training produced a more consistent effect on the tact repertoire than did tact training on the mand repertoire. One potential explanation is that self-echoic responding during mand training facilitated mand-to-tact, but not tact-to-mand, transfer. Anecdotally, all of the children were observed to occasionally engage in echoic behavior following reinforcement during mand training. After successfully manding for and receiving a missing piece, the children would echo their own mands in the presence of the piece while completing the assembly task. While these self-echoic responses were observed only sporadically (formal data were not collected on their occurrence, but experimenters' notes indicate that they were observed on more than one occasion with each child), it is possible that they occurred more frequently at a covert level. If that was the case, then self-echoic responding following delivery of the reinforcing piece may have served to establish discriminative control of that piece over the response

Table 2
Mean Number of Untrained Responses Following the Initial Mand and Tact Training Phases, and Number of Untrained Responses in First Testing Session Following Training.

	Mean untrained[1]		Untrained in first session	
	Mands	Tacts	Mands	Tacts
Tristan	2.50	3.67	3	3
Emma	1.67	3.33	1	3
Noah	2.20	2.67	0	3
Olivia	0.00	2.25	0	0
Mackenzie	0.00	n/a	0	n/a

[1]For untrained responses following the first training phase, the mean number of responses is based on sessions conducted prior to the second training phase.

form. During tact training, no analogous opportunity was present for the incomplete task to acquire EO control over the response form, which may explain why mand training was more successful than tact training in producing both operants.

It should be noted that Skinner (1957) appears to have suggested an asymmetrical relationship between tact-to-mand transfer and mand-to-tact transfer, as he stated that perhaps "all mands which are reinforced by the production of objects or other states of affairs may be interpreted as manding the behavior of the listener and tacting the object or state of affairs to be produced" (1957, p. 189). As noted by Horne and Lowe (1996), this statement is consistent with their notion of name-manding. It appears to be the case that any time a mand is reinforced, a stimulus is presented that may acquire discriminative control over a tact response identical to the mand, which perhaps occurs through self-echoic responding if the stimulus is present only following, but not prior to, the occurrence of the mand. By contrast, when a tact is reinforced, there is not necessarily an EO present to acquire adventitious control over the response and establish it as a mand. The form of a response in a mand relation may sometimes be exclusively under EO control, such as when an infant's crying takes different forms when the infant is hungry and when the infant is wet. However, both Skinner (1957) and Horne and Lowe (1996) appear to suggest that if the form of the mand is identical to that which the verbal community recognizes as a tact of the reinforcing stimulus, then the mand

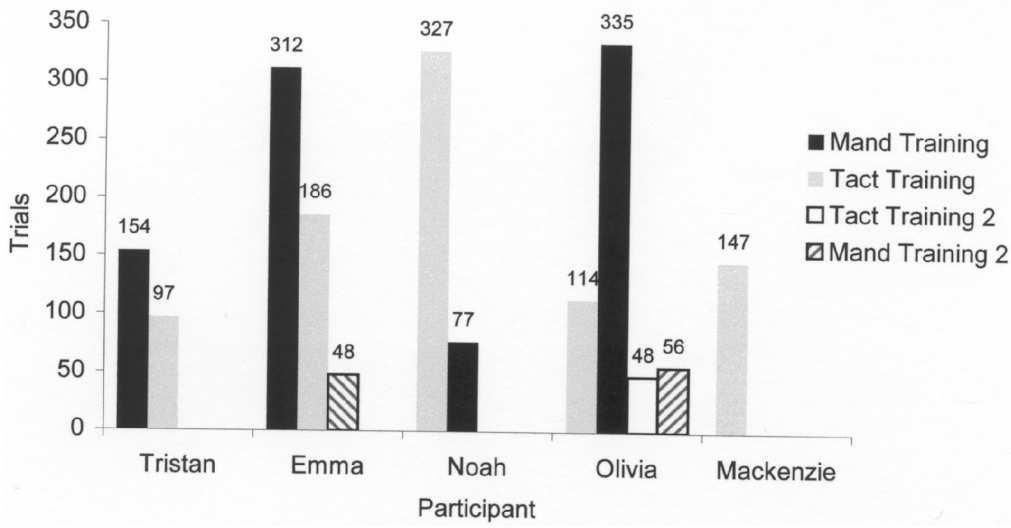

Figure 6. Trials to criterion in each training phase for each participant.

is unlikely to occur unless the tact is also in the repertoire. Hence, the training of a mand may necessarily involve implicit tact training, whereas tact training involves no such implicit mand training. The present results appear mostly consistent with that notion. A possible exception, however, is Olivia's performance in the first testing session following mand training. The fact that she did not respond correctly on any tact trials in this session may indicate that mand training alone did not suffice to establish tacts. The emergence of tacts in subsequent testing sessions remains unexplained, but in line with the previous analysis, it could be that the presence of tact trials during testing sessions prompted increased self-echoic responding, or tact rehearsal, on mand trials.

In addition to the Lamarre and Holland (1985) study, two other studies (Twyman, 1996; Nuzzolo-Gomez & Greer, 2004) have demonstrated an absence of mand-to-tact transfer in children who had already acquired a number of both mands and tacts for various objects. In both studies, however, transfer of control may have been complicated by the fact that mands and tacts with novel response forms were superimposed on existing mands and tacts with less complex response forms. Further, participants in both studies had impaired verbal repertoires. An area for future research might involve exploring further the extent to which, and under what conditions, mands occur in the absence of tacts.

While the effects of mand training were similar across children, the effects of tact training differed from one child to another. The variables responsible for these differences are unknown; however, participant characteristics that may have influenced the results include chronological age and the order of training phases within the study. The two children who did not emit any mands following tact training, Olivia and Mackenzie, were also the youngest two participants at the time that tact training was completed and testing began. Olivia was 3 yrs., 2 mos. old and Mackenzie was 2 yrs., 9 mos. old, whereas the other children's ages at the completion of tact training ranged from 3 yrs., 5 mos. to 3 yrs., 7 mos. It seems possible that the older children had more advanced verbal skills that resulted in more effective tact-to-mand transfer. It should be noted that Olivia was also the youngest child tested for tact emergence at the completion of mand training, and the only one for whom tact acquisition was not demonstrated immediately. Mackenzie's participation in the study was unfortunately discontinued before it was possible to observe the effects of mand training on her tact repertoire.

Egan and Barnes-Holmes (2004) reported that mand-tact independence observed in initial testing sessions was overcome when antecedent instructions were modified, but this was not the case for Olivia in the present study. Olivia did not respond correctly on any mand trials following initial tact training, even when mand probes were modified in an attempt to evoke the response forms that had been trained as tacts. It is possible that the modification implemented in the present study was simply not effective, and that a yet more explicit instruction (e.g. "What is the name of the piece you need?") would have evoked correct mands. However, it should be noted the tasks and instructions used in the present study differed from those used by Egan and Barnes-Holmes in several ways; including that in the present study, the stimuli to be manded were not visible to the children.

With respect to the three children who did acquire mands as a result of tact training, Tristan and Emma showed a similar pattern of responding, although Tristan responded correctly on a greater percentage of mand trials than Emma did. Noah exhibited a different pattern, as mands emerged only in the second testing session following tact training. On the first testing trial on which a correct mand occurred (in session 6), Noah was observed to point to and tact the three pieces on the table, following which he successfully manded for the fourth piece when the experimenter asked, "What do you need?" This behavior may have represented a strategy that enabled mand acquisition, not as a direct result of training, but as a result of exposure to the testing conditions. Emma and Tristan, by contrast, emitted correct mands already in the first session following tact training (although Emma responded correctly on only one trial). Emma and Tristan differed from Noah in that by the time they received tact training, they had already received mand training on another assembly task. It is possible that this prior exposure to mand training in some way facilitated mand acquisition during tact training. Consistent with that hypothesis, when Olivia received a second round

of tact training on the cube, after being exposed to mand training on the puzzle, she initially responded correctly on all four mand trials, although the mands did not maintain over subsequent testing sessions. These results appear consistent with studies that have demonstrated transfer following a history of training in both functions under similar conditions (Hall & Sundberg, 1987; Nuzzolo-Gomez & Greer, 2004). Further, the results might be conceptualized as indicative of the type of history proposed by Barnes-Holmes et al. (2000) to result in the emergence of untrained mands and tacts. Future investigations of mand-tact independence might focus on younger children and systematically explore participant variables that may be correlated with the emergence of untrained mands and/or tacts. In particular, it may be important to investigate whether any prerequisite verbal skills or prerequisite training histories are required for transfer between operants. The identification of such skills or training histories would have implications for language assessment and intervention selection.

Some limitations of the present study may be noted. The first concerns the presumed absence of multiple stimulus control in the tact and mand conditions. Training and testing conditions in this study were specifically designed such that the presumed controlling variables for each operant (EOs for mands and S^Ds for tacts) were present only during training and testing of that operant. However, some stimulus generalization may have occurred across conditions due to possible physical similarity between the shape of each piece and the shape of an incomplete assembly task without that piece. For example, the shape of each puzzle piece may have been similar in shape to the "gap" in the puzzle when that piece was missing. It is conceivable that this resemblance caused the sight of the incomplete puzzle on a mand testing trial to evoke a response previously trained as a tact in the presence of the missing piece. On a tact testing trial, similarly, the sight of a puzzle piece might have evoked the response that was already under EO control of the gap in the puzzle. However, if it was the case that multiple control was introduced this way, it does not explain why mand training had a greater effect on the untrained operant than did tact training, and also does not explain why transfer between operants was observed in this study to a greater extent than in Lamarre and Holland's (1985) study in which the presence of the S^D for the tact in the mand condition was more salient and did not require stimulus generalization.

A second potential limitation is that the study was conducted in a relatively uncontrolled environment that contained a number of potentially disruptive stimuli. Noise level varied unsystematically across sessions, and sessions were intermittently interrupted by other children. Variations in the level of disruption may be partially responsible for the variability in responding across testing sessions that was observed for all five children. Therefore, although the first testing session following each training phase perhaps best represents the effects of training alone, that data point could also represent a day on which disruption was unusually high, as a result of which it is important to consider the children's performance across all of the subsequent testing sessions.

Finally, it should be noted that testing was conducted under extinction, and no effort was ever made to maintain trained responses once the training criterion had been reached. Once a mand or a tact repertoire had been trained, it was never again reinforced (except in the case of Olivia, who received tact training on the cube twice). Some of the data obtained in this study may thus be attributable to extinction; such as Noah's poor performance on mand trials when mands had already been trained to criterion, and all of the children's failure to maintain accurate responding over extended periods of time. It is also possible that the emergent repertoire is more susceptible to extinction than the trained repertoire, and that this contributed to the observation that in some cases there was evidence that the untrained repertoire emerged, but performance was poorer than in the trained repertoire or declined over time (Tristan and Emma's performance on mand trials following tact training, and Olivia's performance on mand trials following the second round of tact training).

In conclusion, Skinner's (1957) analysis of verbal behavior suggests that mands and tacts are functionally distinguishable verbal operants, each requiring a unique learning history to be established. However, the analysis does not necessarily imply that one is typically acquired without the other, as a number of conditions could potentially give rise to mand-tact transfer. Additional research on mand-tact in-

dependence in typically developing children is needed to shed light on seemingly discrepant findings in the small existing literature. Future researchers should attempt to isolate the variables that may give rise to mand-tact transfer. Experimental identification of such variables would not only further our understanding of language development from a behavior-analytic perspective, but might also result in the identification of potential language intervention techniques.

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