

# Functional independence and preference effects on the acquisition of multiply-controlled mands and tacts

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## ABSTRACT

**T**he aim of the present study is to evaluate the effects of mand and tact establishment on collateral response in functionally different conditions among typically developing children.

The influence of both mand and tact trainings on spontaneous utterance emergence was also examined by evaluating the role of preference. Data were collected within A-B-A and A-B-A-B1 multi-schedule across subjects' designs. Six children with typical abilities were trained either to mand or tact the items ranked as highest and lowest in a preference assessment and subsequently tested to see if responses occurred in collateral conditions. Results show that all participants rapidly manded for preferred and neutral stimuli but acquired tact slowly suggesting that, although preference can be considered a strong motivative variable, other contingencies may alter verbal production. The role of stimulus preference and operants independence needs to be further investigated in consideration of the natural changes in its value during the experimental history.

*Key words:* verbal behavior, mand/tact, operant independence, preference.

In the last few decades researches based on Skinner's verbal behavior analysis have brought relevant contribution to the study of language development. Both applied and conceptual research have led to significant benefits for subjects with developmental disabilities and disorders (Arntzen, & Almås, 2002; Baer, & Detrich, 1990; Bourret, Vollmer, and Rapp, 2004; Buckley, & Newchok, 2005; Goldsmith, LeBlanc and Sautter, 2007; Greer, & Ross, 2004; Taylor, Hoch, Potter, Rodriguez, Spinnato, and Kalaigian, 2005; Winborn, Wacker, Richman, Asmus, and Geir, 2002). It is also a fact that human developmental disorders could offer special insight into the genetic, neural and behavioral basis of language by providing a way to study naturalistically what cannot be controlled in the lab (Marcus & Rabagliati, 2006). Skinner's language functional analysis (1957) examines the speaker behavior in relation to the events that influence it (antecedents and consequents), to its topography (verbal, non-verbal, and their interactions), and to its reinforcers. What results is a specific classification of verbal relations or verbal operants. Among the verbal operants, *mand* and *tact* represent two basic aspects of the communicative competence being, together with the *echoic*, the earliest verbal classes to appear (Salzinger, 2008; Schlinger & Blakely, 1994). Mand is a verbal response reinforced by a specific consequence and under the functional control of motivational variables (aversive stimulation or deprivation) and sustained by specific consequences (Skinner, 1957). Due to the special relation between verbal response and reinforcement, a response can be identified as mand only on the basis of the contingencies of reinforcement maintained by the listener or by the verbal community and not only from its topography (Michael, 1993; Schlinger, 1993).

Tact was defined as a verbal operant in which a response is evoked by an object or an event, or by one or more of its features. In the tact, the response specifies a feature of a stimulus and is maintained by generalized reinforcement (Skinner, 1957). Although there is experimental evidence to support Skinner's suggestion of independent acquisition of mand and tact (Arntzen, & Almås, 2002; Carroll, & Hesse, 1987; Goldsmith, LeBlanc and Sautter, 2007; Hall, & Sundberg, 1987; Lamarre, & Holland, 1985; Sautter & LeBlanc, 2006; Savage-Rumbaugh, 1984), the most common verbal training is mainly based on the linguistic assumption that once a child has acquired the "meaning" of a word, he/she is therefore able to use it in functionally different contexts (e.g., Buffington, Krantz, McClannahan, & Poulson, 1998; McGee, Krantz, & McClannahan, 1985). The aim of the present study is to expand upon Skinner's analysis of "impure" verbal operants, and to focus on the extent of their impact on the understanding of factors associated with language development and use (Arntzen & Almås, 2002). Skinner (1957) described an "impure tact" as "a common result of a mixture of controlling relations typical of both tact and mand". An aspect of "pure" tact is the complete absence of verbal stimuli in the stimulating environment. When some verbal stimulation is part of the environment, the ensuing verbal operant would be under multiple control, and thus could be similar to an intraverbal. Intraverbals were defined by Skinner (1957) as verbal responses that lacks point-to-point correspondence with an antecedent verbal stimulus. Thus, if the specific item or event that a child mands is a part of the stimulating environment, such as the presence of a cookie or a toy, then that verbal operant may be further specified as a *mand-tact*, to distinguish it from the pure mand and the pure tact.

It should also be noted that the mand-tact reinforcer is most probably the one specified by the child's response, rather than the eventual accompanying social consequence. In this form of mand, if a child were asked "What do you want?" while a cookie and chip were held before him, the answer "cookie" would be characterized as an *intraverbal-mand-tact* (Frost & Bondi, 2006). The tact-portion of the operant is identified by the controlling relation between the "cookie" itself and the form of the answer. According with Frost and Bondi (2006) in the early stages of functional communication development it is unlikely that a child will generalize, without explicit training, to emit "pure" mand if such combination was used. In another case answering to questions regarding object "names" is a form of a compound operant, the intraverbal-tact. The current study was designed to: a) evaluate the acquisition of mand and tact among a sample of typically developing children together with a manipulation of the stimulus preference; b) assess the spontaneous generalization to collateral conditions.

According to some suggestions about preferred stimuli function (Carr, Nicolson & Higbee, 2000; DeLeon & Iwata, 1996; Hanley, Iwata & Lindberg, 1999; Northup, George, Jones, Broussard & Vollmer, 1996; Piazza, Fisher, Hagopian, Bowman & Toole, 1996), the impact of mand on subsequent response (Buckley & Newchok, 2005), and the influence of motivative operations on the frequency of initiations (Taylor et al, 2005) were evaluated comparing preferred and neutral items. The purpose of the study was to find out if preferred items work as a motivational operation in the mand procedure. Two experiments with different training sequences and multiple stimuli control were carried out to investigate the conditions under which functional independence did or did not occur and to evaluate if specific events, such as the presence of certain prompts or situations, may acquire stimulus control over responding.

## METHOD

*Assessment.* In order to obtain a representative sample for language and communication development an Italian questionnaire was used (Questionario Mac Arthur per la valutazione della comunicazione e del linguaggio nei primi anni di vita, Caselli & Casadio, 1995), consisting of three parts: a) General comprehension. This evaluates the wide-ranging comprehension skills of the child; b) Lexicon. Divided in part C and part D. It assesses both production and comprehension of specific words; c) Actions and gestures. This part evaluates the non-vocal communication skills of the child.

A preference assessment was conducted with each participant to identify the preferred item that would maximize the motivating conditions. The checklist named Valutazione della preferenza dello stimolo (VPS) (Pino, 2004) was developed according to the Child Reinforcement Survey (CRS) (Fantuzzo, Rohrbeck, Hightower and Work, 1991), and the Reinforcement Assessment for Individuals with Severe Disabilities (RAISD) (Fisher, Piazza, Bowman, & Amari, 1996). This questionnaire examines the activities and the things that the child loves or usually receives from parents or caregivers. Parents were provided with a Likert scale (0 to 5), including 45 questions, to specify their predictions regarding their children's preference for 7 categories of stimuli.

*Participants and setting.* The participants were 3 boys and 3 girls, ranging from 16 months to 21 months old. Three children were assigned to each experiment based on their level of verbal behavior development. They were selected following a screening test to determine that they consistently did not demonstrate the behavior to be trained in the experiments. School administrators were informed of the purpose of the study and informed parent consensus was obtained prior to the execution of the study.

The experiments took place in a room containing a small table, two small chairs and teaching materials, such as toys. The subjects received instruction twice per day in a 1:1 setting. An independent observer participated in the data collection with the experimenter.

*Objects-stimuli.* Edibles and preferred items were used as identified by the preference assessment questionnaire. The object-stimuli used in the research were kept in a big bag on the floor near the table next to the experimenter. In both experiments 16 objects-stimuli were used eight of which were favorites and 8 were neutral. Preferred items were kept out of sight during the school day as an Establishing Operation. Michael (1993) defined Establishing Operations as "changes in the environment with alter the effectiveness of any object or event as reinforcement and simultaneously alters the frequency of the behavior followed by the reinforcement" (p. 191). As stated by Pistoljevic, Cahill and Casarini (2010), typically developing kids usually learn spontaneous speech by responding to the natural establishing operations that control human communicative behavior (e.g., lack of social attention when attention is preferred for pure tacts; deprivation or aversive conditions for mands). The stimuli were presented three times for each child in an alternate and random order in mand and tact conditions during experimental phases. A total of 96 trials were obtained for each session, 48 for mand and 48 for tact condition respectively.

*Experimental design.* Both the experiments used a multi-schedule design across subjects, with a multiple baseline to control for maturation (Baer, Wolf & Risley, 1968).

*Verbal behavior intervention and response measurement.* During the intervention the controlling variables for mands and tacts were manipulated.

*Mand training procedure.* Each subject was taught to produce manding behavior, defined as verbal behavior that specifies its reinforcer (Skinner, 1957). First the experimenter showed the object to the child and placed it in a bag remaining near the child, to occasion the establishing operation for mands (Laraway, Snyckersky, Michael & Poling, 2003). If the relevant mand occurred within 5 seconds the experimenter removed the item from the bag and handed it to the child. If the vocal response did not occur, additional prompts were included to increase the likelihood of triggering the verbal operant and to enhance discrimination (see Table 1). After putting away the object the experimenter presented the student with the vocal antecedent "What do you want?". If the subject did not respond within 5 seconds, verbal prompts suggesting the word to label were given or the appropriate verbal model was presented (the item was repeated until the child responded accurately and independently). Correct responses were followed by delivery of the specified reinforcer.

*Collateral tact generalization.* Stimulus control transfer was said to occur if the participant correctly tacted the item taught in the mand condition. Probes for stimulus control transfer were conducted by presenting each participant with the item and the discriminative stimulus "What is it?". The experimenter waited for the answer without giving any verbal suggestion. Following the presentation of the item and the discriminative stimulus each participant had five seconds to answer and the accuracy of the response was recorded. A correct response was defined as the student emitting an appropriate tact within 5 seconds, using the same response form taught in the mand condition and was followed by social reinforcement provided by the experimenter. If the participant did not respond within the five second interval or answered incorrectly, the response was identified as incorrect. Probes for generalization were conducted in non-instructional settings.

*Tact training procedure.* Each subject was taught to verbally produce the name of the object showed by the experimenter. Preferred or neutral stimuli were placed in front the subject and the question “What is this?” was asked. After a 5-second pause to wait for the child to give an answer, verbal prompts suggesting the word to be labeled were given. If the subjects tact response was incorrect, an echoic prompt was provided and the original question was repeated. When the subject answered correctly, the experimenter rewarded him/her with verbal praise, followed by applause. Furthermore, after a couple of responses or when the response was stable, other tasks were presented to provide a break between the different procedures.

- *Collateral mand generalization.* In order to test the collateral mand development (i.e. to understand if the acquisition of the operant has occurred) the experimenter showed the object to the child after carrying out the tact training and following the removal of the object-stimulus. The same objects used during the training phase were presented to the participant in a random order, and the experimenter looked at the child without giving any verbal prompting. The child received a small piece of the named food item or a 20-s access to named nonfood items. The object was then returned to the bag while the child was observing. No corrections were delivered following incorrect responding.

Table 1. Prompt training sequences and relevant contingencies

Condition	Antecedent - Prompt training sequence		Consequence
<i>Mand</i>	MO	Vocal prompt “What do you want?” + echoic	Access to the specific reinforcer
<i>Tact</i>	Sight of item	Sight of item + vocal prompt “What is it?” + echoic	Generalized reinforcement (e.g. praise)

MO Motivational Operation

The responses chosen for each child were words previously not emitted by the subjects, as reported by parents. The child's response needed to satisfy two criteria in order to interrupt the tact and mand trainings: a) Accuracy, which was the 70 % of verbal production for each stimulus and b) Frequency, , two correct answers for each stimulus were required, or 90% of the stimuli (43 correct responses).

*Data recording and analysis.* The experimenter collected data using paper-and-pencil recording. A second independent observer also collected data either simultaneously or by videotape to measure interobserver and interscorer agreement.

## FIRST EXPERIMENT

*Hypotheses.* The experimenters expected that in mand condition verbal responses would be more frequent with preferred stimuli rather than neutral. Therefore, the main hypothesis of the first experiment implies that functional independence among operants does not occur under specific motivational conditions (preference).

*Experimental design.* The study was carried out using a multi-schedule design across subjects (A-B-A). The three phases consisted of baseline (A), mand training (B) and reversal condition (A). The first baseline consisted of eight sessions for subject A, 11 for subject B, and 14 for subject C, respectively.

*Subjects.* A group of 3 subjects was selected averaging 18 months and showing the same level of verbal behavior development according to the Mac Arthur questionnaire scores. Subject A was a 16-month-old girl whose vocabulary was of approximately 40 words (mand or tact), imitate words (echoic), repeated words and

simple phrases overheard in conversation

(echoic). She was able to follow simple commands. Subject B was a 18-month-old boy able to name a number of the objects he was familiar with and his vocabulary was of approximately 90 words. He pointed to an object or picture when it was named for him and answered to such commands as “*Show me your eyes (nose, mouth, hair)*”. Subject C was a 20-month-old boy who recognized names of familiar people, objects, and body parts and pointed to an object or picture when it's named for him (listener skills).

*Procedure.* Before the research began, the experimenter started going gradually to the crèche to allow him to become familiar with the children. The subjects' parents were asked to fill in the VPS scale in order to select the objects-stimuli for each child, and to differentiate them according to the child's preference level. Participants and the experimenter sat in front of each other.

*Baseline.* Baseline measurement was conducted to observe the subjects and their responses after the administration of all neutral and preferred stimuli in both tact and mand relations, with the vocal antecedent “*What is this?*” in the former case, and organizing a motivational operation (MO) in the latter. No introduction of the verbal model or prompts were used.

*Mand training.* Stimuli in mand training are introduced as illustrated in the general methodology section. In tact condition we proceeded as we did in the baseline providing the participants with the vocal antecedent “*What is this?*” without any response prompt. The aim was to establish a comparison between stimuli which had undergone to training and stimuli that had not. During the mand training condition, the subjects were shown with the target item and given 5 seconds to mand for the hidden items under the control of the MO.

If a mand occurred within 5 seconds, the mand was immediately reinforced by giving the subject the item. If a mand did not occur at the end of the 5 second delay the participant was then given the vocal prompting "What do you want?" and/or an echoic (vocal) prompt in the form of the item's name. If the participant then manded under the multiple control of prompts and the MO, the item was delivered. The response met the criterion with mands for the item solely under the control of MO, a second item was subjected to the experimental variables. These procedures were used until all the responses were subjected to the experimental condition for all three subjects. During the mand training condition probes were conducted to test for transfer of function from the mand to the tact repertoire.

*Reversal condition.* In order to evaluate the effect of the training, the procedure was discontinued. The subjects received all the stimuli (preferred, neutral, tact and the mand) in trials identical to the baseline ones.

### **Interobserver agreement**

During the 18 sessions (69% of all total trials) for Subject A (including the baseline sessions), 21 (72%) for Subject B, and 23 sessions (69%) for Subject C, an independent observer recorded data simultaneously but independently from the experimenter, each response as either correct, incorrect, no response, or modeled response. The total IOA score ranged from 90 to 100% (mean 96%).

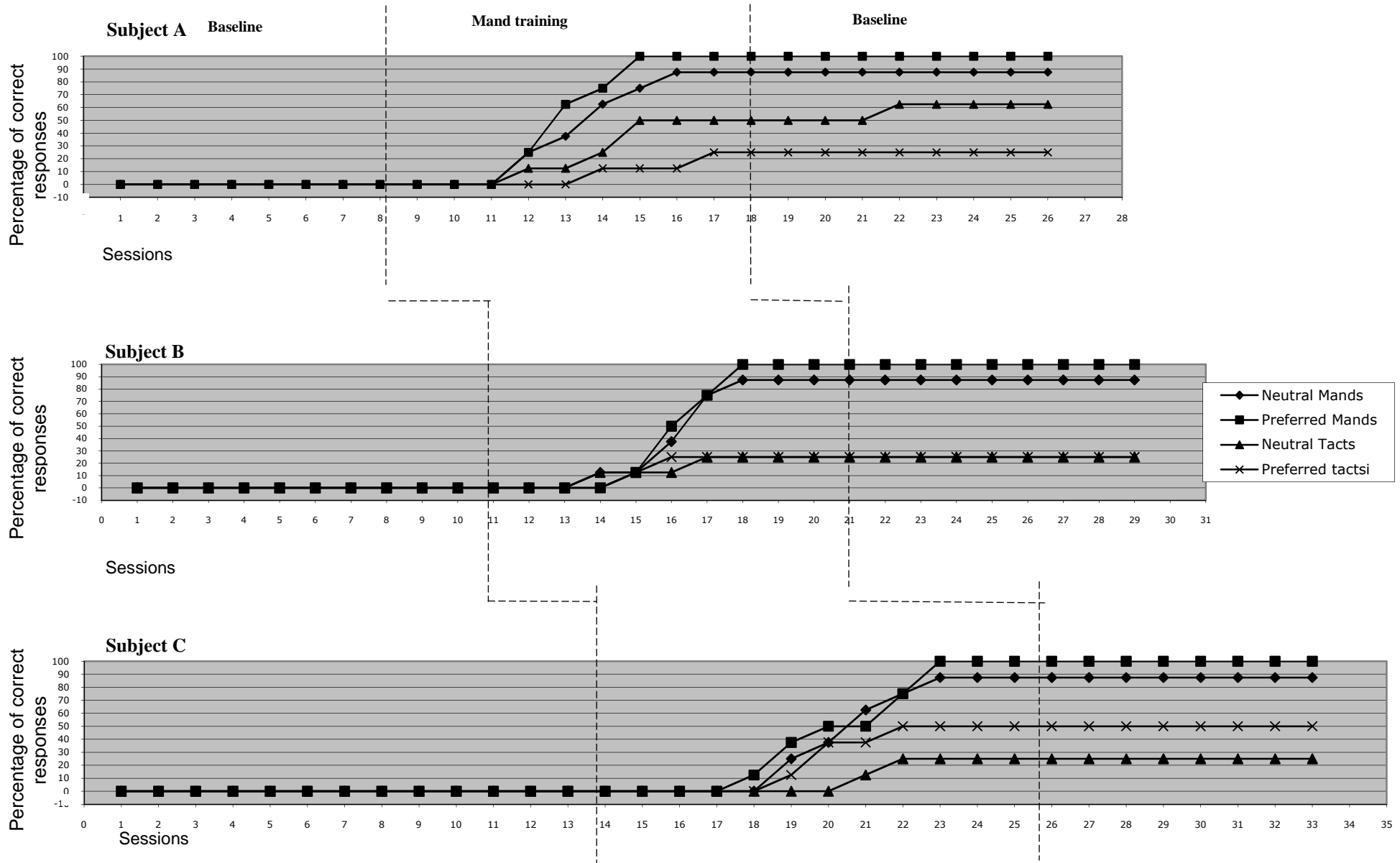
### **Results**

As shown in Figure 1 baseline responding for all three subjects was stable at zero spontaneous mands per session. Following the implementation of prompt and training procedures, manding for all items increased at various frequencies per

session. Data suggested that the mand treatment was effective in producing an increase in MO controlled mands. A variation in the level of manding behavior appeared after the first sessions of mand training. The subjects began to respond after the presentation of the prompts sequence until they stabilized this skill. This clearly supports the effectiveness of the training, particularly with preferred stimuli. Subject A did not respond at all during baseline. However, he engaged in moderate to high levels of responding during mand training, especially with preferred objects. Generalization probes on tact emergence showed an increase in response appearance especially with neutral item. Subject B did not engage in vocal response during both mand and tact baseline. Whereas he rapidly acquired mand responding for both preferred and neutral items. However, levels of response rarely occurred in the corresponding tact control sessions, thus indicating that this response functioned as a mand (levels of responding in the mand test sessions were higher than those in the tact control sessions). Subject C results indicated a high level of response for both stimulus categories. The response reemerged during the tact generalization probes, particularly with preferred items.



**Fig.1 Emission frequency (%) of the target responses in the I Experiment: A-B-A *multielement* across subjects.**



## Discussion

The results of the first experiment suggest that mand contingencies are weakly related to the development of the collateral tact behavior. Only in a few infrequent cases, concerning some objects (classified as preferred for subject C, and neutral for subject A), a spontaneous increase in tact behavior was noticed. These differences, albeit irrelevant, could be explained in terms of the specific value assumed by a given object-stimulus for the subject, beyond the preference/neutrality dichotomy. The performance might have been influenced by other variables connected to the stimuli themselves, thus clarifying how easy/difficulty it is for tact behavior to be acquired for that given object. As far as the second hypothesis is concerned, a similarity was found in the performances for neutral and preferred objects. However, it should be made clear that the preferences expressed by the subjects for different objects varied during the training sessions, meaning that the distinction between preferred and neutral stimuli resulting from the VPS scale probably changed during the experiment, with a consequent non-meaningfulness between the tacting and manding behavior among the preferred and neutral items.

## SECOND EXPERIMENT

*Hypotheses.* The second experiment was designed to control the order effect of the training on verbal operant acquisition. Moreover, the experimenters investigated the functional independence between tact and mand operants and the effect of the manipulation of stimulus preference, as in the first research.

*Experimental design.* A multi-schedule ABAC across subjects design for each category of stimuli was used: Baseline (A), Tact Training (B), back to baseline condition (A), and Mand Training (C).

*Subjects.* The research was carried out on three 17 month old children (Subject A1, Subject B1, Subject C1) selected from an initial group of 10 on the grounds of their age and their level of verbal behavior development. Subject A1 (a 17-month old girl) was able to point to objects or pictures and to recognize names of familiar people, objects, and body parts. She also used 1- to 3-word sentences (mands and/or tacts). Subject B1 (a 18-month old boy) whose vocabulary was of approximately 90 words (mand or tact) and he was able to repeat words overheard in conversation (echoic behavior). He combined words into a short sentence-largely noun-verb combinations (mands and/or tacts). Subject C1 was a 21-month-old boy who recognized names of familiar objects, and body parts and pointed to objects or pictures when named for him (listener skills). He could emit one- to three-word utterances frequently throughout the day (mands and/or tacts).

*Procedure.* As in the previous study, subject and experimenter sat in front of each other. The experimenter took the preferred or neutral objects-stimuli out of the bag and presented them to the subject.

*Baseline (A):* Baseline trials were the same as in the first experiment, but the stimuli were first presented in the tact training and then in the mand training. Participants were given 5 seconds to emit an initial response. If no response occurred, the question for the next randomly selected item was presented. If the child responded within 5 seconds, she/he was vocally reinforced. All correct, non-repeated responses were recorded, and the process went on until all items had been assessed.

*Tact training (B)*: the tact training procedure was applied at this stage. The researcher held up each item and gave the vocal antecedent “What’s this?”. All correct responses resulted in brief vocal praise and progression to the next item. No response within 5 seconds or an incorrect response resulted in an experimenter prompt (e.g. “Say ball”). Echoed responses were praised and the object was shown until the child answered accurately and independently. Training continued until children reached mastery criterion.

*Back to baseline phase (A)*: The same procedure as in the first baseline was repeated for eight sessions.

*Mand training (C)*: Neutral and preferred stimuli were reversed and submitted to a mand training, as described above.

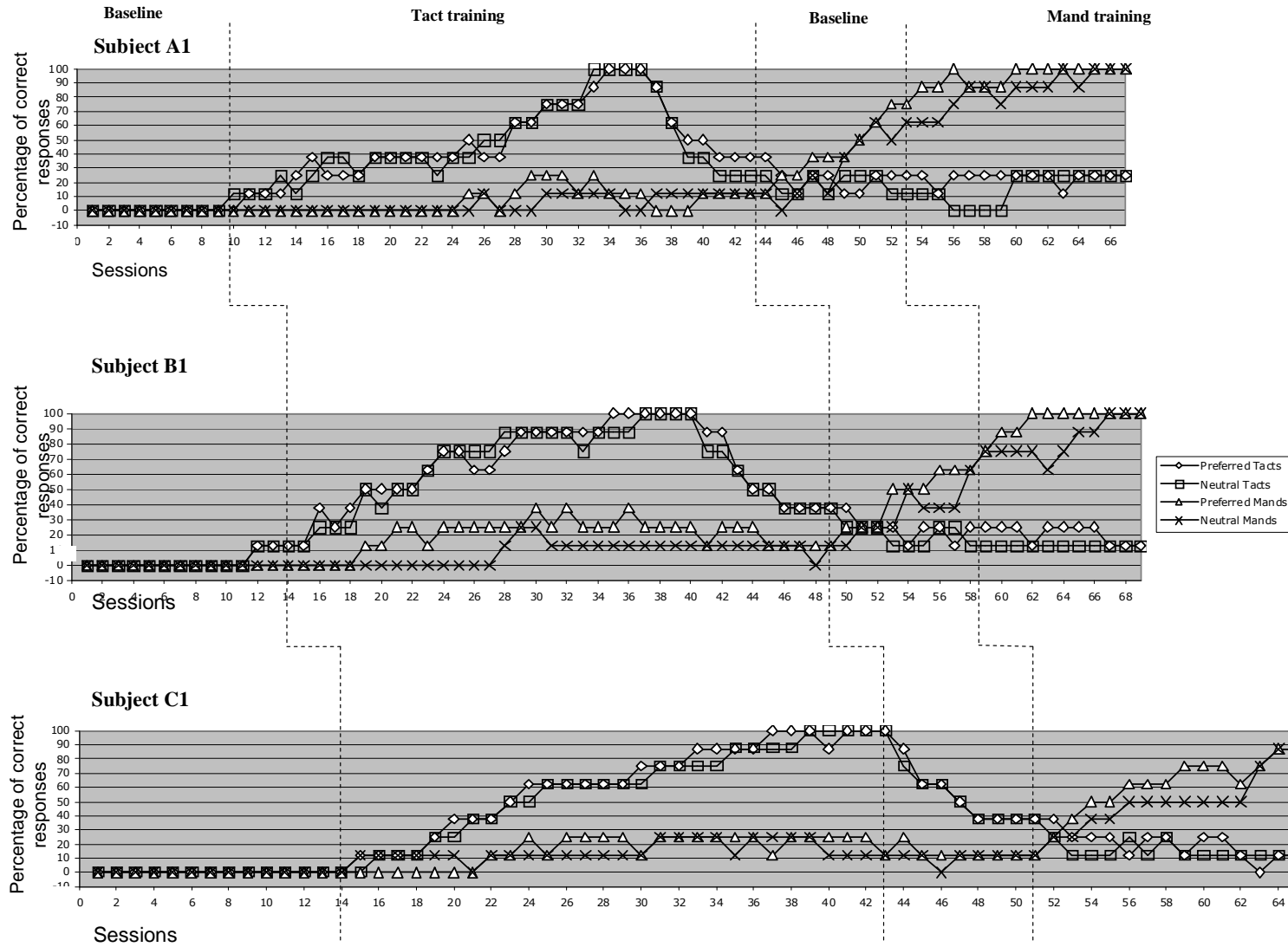
### **Inter-Observer Agreement (Ioa)**

Inter-observer agreement (IOA) was assessed by having a second observer simultaneously but independently collect the experiment’s implementation of assessment and treatment procedures; data were collected during 32 sessions (47% of all total trials) for Subject A1, 37 for Subject B1 (53%) and 33 for Subject C1 (47%), respectively. Agreement percentages were calculated as in the first experiment. All of these measures were consistently above 95% accuracy.

### **Results**

Correct tact and mand responses for each subject are graphically depicted in Figure 2. No correct response occurred during the first baseline trials. In contrast, when training was implemented, Subject A1 responded 100 % correctly after twenty-six teaching sessions for neutral objects and after twenty-seven sessions for preferred items, respectively. While tact responding underwent teaching, spontaneous manding for preferred items began to occur after seventeen sessions. Subject B1 required 26 teaching sessions to acquire 100% of correct tacting for neutral items and 27 teaching sessions for neutral items, respectively. While the tact response underwent teaching, spontaneous manding for preferred objects began to occur after eight teaching sessions. Subject C1 met criteria for recognisability after twenty-three teaching sessions and spontaneous mand for neutral objects began to emerge during the first sessions.

Fig.2 Emission frequency (%) of target responses in the II Experiment: A-B-A-B1 multielement across subjects.



Following mastery of all tacts, second baseline levels of these responses decreased for both categories. Spontaneous manding showed a very low level of responding for both items categories for subject A1. A poor tact response pattern is notable during the second baseline despite a robust repertoire acquired during training. For all three participants stimulus control was not transferred from the tact condition to the mand condition without any teaching. The results for mand training showed poor performance in initial trials, resulting in booster training trials. Although some spontaneous manding did occur for all the three subjects during the second baseline, reliable spontaneous manding only occurred after the implementation of the training procedures. Responding during the last few trials remained invariable also under different preference level.

### Discussion

Consistent variations in the average of correct answers in the various phases were recorded, with a remarkable variation between the tact training (B) and the mand training (C) phases (Fig. 2). When the tact training was introduced, an alteration of the trend with respect to the first baseline was evident in all the subjects. This trend was reversed when the intervention was interrupted (back to baseline condition). When the second phase of treatment was introduced (mand training), a new rise appears in the trend. In terms of latency - the period between the beginning and the end of a condition (e.g., intervention, return to the basic condition) - a delay was observed in the variation of the tacting behavior once the tact training (B) was introduced, and on average 10 more sessions were required to fulfill the criterion in all three subjects. When the mand training was introduced, all the three subjects show a fast variation in the mand responding. Our data showed effectiveness

of both the training phases, since a consistent change in the verbal behavior

before (baseline) and after training is clear. On the contrary, production of tacts and mands, with respect to the preference manipulation, did not show significant differences, thus the effect of stimuli preference in manding was not confirmed. In the mand training trials a variation in the trend for all three subjects was noticed, whereas the number of collateral tact stimuli rapidly decays. No significant differences among preferred and neutral mands was recorded. Anecdotally, preferences to the stimuli can change with time and can depend on idiosyncratic characteristics and environmental variables. Thus, it is likely that the preferences to the stimuli that were identified in the VPS could actually have been modified.

### GENERAL DISCUSSION

The present study provided experimental support to the existing literature on the development of language, and more specifically on the acquisition of multiply-controlled mand and tact. The main difference from previous studies was in the chosen subjects who differ from the representative population employed in pure applied investigations. These experiments were instead based on a population with typical development in order to discover whether the suggestions offered in literature and originally in Skinner's book could be extended to the normal language development of the young (Arntzen & Almås, 2002). Evidence from the present investigation indicates partial interdependence of mands and tacts. Although good acquisition effects were achieved, generalization effects were limited. Our data showed mand training sequence to be more effective in producing an interdependence effect between the operants. It is possible that mand and tact

functions were learned via exposure to the multiply control variables included in these sessions. Thus, it is possible that the vocal response was not controlled by the key variables manipulated in these conditions, such as deprivation. This problem, as Lerman et al. (2005) suggested, might be circumvented by reducing the frequency of these prompts. Thus, although our findings may produce false positives, they could provide information about procedure and functional relations that should assist caregivers in developing effective language interventions for children with developmental disabilities.

However, more researches are needed aiming at collecting further data. The results of our study indicated that mands tend to conserve a stable pattern of acquisition and maintenance, compared with the tact and mand response generated via the presentation of preferred objects-stimuli showed higher results from the neutral ones. The transfer of stimulus control from the mand to the tact condition can be attributed to controlling variables of the tact being present during the mand training condition. The role of preference has to be furthermore investigated, not only as regards individual characteristics, but also as regards the preference evolution during the experiment. In the present research, although the use of a Likert-scale questionnaire was convenient, it did not take in account possible changes in children's preference. Moreover, reinforcer value in human experiments often changes in a few minutes, so preference should have been measured directly and probed intermittently during the study to verify whether or not baseline preferences remained stable. This represented a serious limitation for the present study and should be borne in mind in further investigation. The study of human developmental disorders provides researchers with the opportunity to examine how biological and psychological variability influence verbal behavior

development and verbal operants emission. However, a detailed comparison between particular disorders and typical development could throw essential light on theoretical language development research.

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