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ACQUISITION OF SIGN LANGUAGE BY AUTISTIC CHILDREN II: SPONTANEITY AND GENERALIZATION EFFECTS

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Autistic children typically do not use their language repertoire in order to communicate. Six autistic children who exhibited poor communication skills were trained to use their sign repertoire to make spontaneous requests of adults. Training consisted of imitative prompting, fading, and differential reinforcement, and included aspects of incidental teaching. The children displayed an increase in the rate and variety of spontaneous sign requests (Experiment 1). Generalization of spontaneity across adults (Experiments 1 and 2) and settings (Experiment 2) was also observed. We suggest that spontaneity may be facilitated when language is brought under the control of broadly defined stimuli such as adult attention rather than narrowly defined stimuli such as the presence of specific objects or verbal prompting in the form of questions. Finally, response generalization was observed as well (Experiment 1). Specifically, as spontaneity increased, self-stimulatory behavior decreased. This result may be accounted for in terms of reinforcer competition, reinforcer consistency, or discriminative stimulus effects.

DESCRIPTORS: language, sign language, generalization, response generalization, incidental teaching, autistic children

The acquisition of language and communication facility is critical to the social development of young normal children. Unfortunately, many children labeled as autistic show profound deficits in this area. Half of all autistic children are functionally mute (Rutter, 1966). Further, many of these children show only limited gains in spoken language in spite of intensive operant therapy (Mack, Webster, & Gokcen, 1980). Fortunately, speech is not the only modality that children can use. Children who would otherwise remain nonverbal can be taught a variety of sign language skills in lieu of speech (Bonvillian & Nelson, 1976; Carr, 1981, 1982a; Kiernan, 1977; Layton & Baker, 1981; Creedon, Note 1) and this type of training has achieved widespread use nationally (Goodman, Wilson, & Bornstein, 1978; Lloyd, 1980). A review of the research literature on sign training with handicapped children (Carr, 1979) indicated, however, that although most studies reported positive outcomes, and some were data based, almost none involved controlled experimentation. Yet, systematic experimentation is needed to isolate those variables that are critical to the development of signing skills. This need prompted us to undertake a program of research centering on the functional analysis of sign language acquisition.

Our initial studies identified some of the variables necessary for facilitating the acquisition of receptive and expressive labels (Carr, Binkoff,

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Kologinsky, & Eddy, 1978; Carr & Dores, 1981). In spite of our initial success, we found that spontaneous signing was often absent (Carr, 1982b), a situation paralleling that observed in the case of speech (Lovaas, Koegel, Simmons, & Long, 1973). That is, although children may learn many sign labels, they typically do not *use* these labels to communicate spontaneously unless adults ask them questions or otherwise prompt them to sign. Other investigators have also noted that spontaneous signing usually lags far behind label acquisition (Konstantareas, Oxman, & Webster, 1977). In view of these problems, one purpose of the present study was to identify a procedure that would reliably facilitate spontaneous signing.

A second purpose was to assess response generalization effects, that is, changes in behavior other than the targeted language skills. Intensive training in vocal language is typically accompanied by decreases in a number of psychotic behaviors such as self-stimulation (Lovaas et al., 1973). Similar response generalization effects have been observed with respect to sign language training (Konstantareas, Webster, & Oxman, 1979). However, the reports to date have not attempted to demonstrate an explicit functional relationship between increases in spontaneous sign language per se and decreases in psychotic behaviors such as self-stimulation. The present study afforded an opportunity for studying this relationship.

Stimulus generalization poses an additional problem in the area of language training (Carr, 1980). Specifically, one can raise the question (cf. Faw, Reid, Schepis, Fitzgerald, & Welty, 1981) of whether spontaneous signing would transfer to locales outside of the treatment situation (i.e., setting generality) or from the treatment agent to others not initially associated with treatment (i.e., generalization across adults). Setting generality is often difficult to achieve with normal children (Wahler, 1969) and especially difficult with autistic children (Handleman, 1979; Rincover & Koegel, 1975). Further, generalization across adults is seldom achieved without explicit programming (Stokes, Baer, & Jackson, 1974). Given the above difficulties, a third purpose of the present study was to identify variables that could produce generalization of spontaneity across settings and across adults.

EXPERIMENT 1

METHOD

Subjects and Setting

Three males attending a day school program for developmentally disabled children participated. John was 9 years old; Mike, 10; and Bob, 14. All had been diagnosed as autistic or autistic-type by the psychological staff. On the Leiter scale, a nonverbal measure of intelligence, the children received mental age scores as follows: John, 5 yr 1 mo; Mike, 4 yr 9 mo; and Bob, 3 yr 6 mo. The children were selected for this study because they had failed to acquire any functional expressive speech despite repeated attempts at training. Their vocal repertoire was limited to infrequent, meaningless sounds. Receptive speech was restricted to a few common commands (e.g., "Sit down," "Get your lunch box"), particularly if the commands were accompanied by gestures. All the children had participated in previous sign training studies conducted by the authors (Carr et al., 1978; Carr & Dores, 1981) and had repertoires of 25-50 sign labels. However, their teachers complained that the children almost never used their signs spontaneously to make requests. John and Bob displayed high levels of self-stimulatory behavior such as rocking and stereotyped gazing; Mike rarely engaged in such behavior. All children displayed marked social withdrawal from adults and an absence of peer interaction.

Sessions were conducted in a 6.0 × 5.0 m room located adjacent to the regular classrooms and attached to an observation room by means of a one-way mirror. This space was normally used as a recreation room for small group interaction or as an auxiliary language training classroom. Sign label training had frequently taken place in this room and thus each child had a history of reinforcement for correct labeling in that setting.

Procedure

Reinforcer selection. We began by identifying a variety of food, toy, and activity reinforcers for which the child would subsequently be taught to make signed requests. Teaching a child to make requests for reinforcers is generally recognized as an important first step in communication training (Goetz, Schuler, & Sailor, 1979). To accomplish this goal, we used a two-step procedure (cf. Carr, Newsom, & Binkoff, 1980). In step one, the child's teacher was interviewed and a list of 25 potential reinforcers was compiled based on her recommendations. In step two, the food and toy items were arrayed on a desk and the child was given free access to them. Items were chosen for inclusion in the study if the child consumed them (in the case of foods) or played with them (in the case of toys) each time that the array was presented. An activity was chosen for inclusion if the child consistently responded to the activity by laughing or by guiding the adult's hand so as to initiate the activity (e.g., the child might "prompt" the adult to tickle him by placing the adult's hand on his stomach). The above procedures were used to select 10 reinforcers consisting of food items (e.g., juice), toys (e.g., balloons), and activities (e.g., being tickled).

Sign label pretraining. It was necessary to ensure that the children were capable of labeling each of the 10 reinforcer items selected. Otherwise, the possibility existed that a child failed to use signs spontaneously because he did not have the relevant sign labels in his repertoire. Accordingly, each child was pretrained by an adult who was not involved in any of the later stages of the study. In carrying out pretraining, the adult held up each of the food and toy items and asked the child for the label (i.e., signed "What is it?"). In the case of an activity, the adult demonstrated each activity with another child and signed "What am I doing?" Each reinforcer item was presented five times for a total of 50 trials per session. If the child signed correctly, he received the corresponding reinforcer. If the child labeled incorrectly or failed to respond to the adult's request within 5 sec, the child was imitatively prompted to make the correct sign label (i.e., the adult demonstrated the sign to the child). On prompted trials, the child was praised for correct signing but did not receive the reinforcer item. Pretraining was considered complete when the child scored 100% correct (without prompts) on two consecutive sessions. John required 2 sessions to complete pretraining and Mike and Bob required 5 and 16 sessions, respectively. Reliability was assessed during each session by an independent observer who scored the child's response on each trial on a precoded data sheet identical to the one used by the experimenter. Sign label definitions were based on those that appeared in a standard sign language dictionary (Bornstein, Hamilton, Saulnier, & Roy, 1975). The reliability index was the number of agreements divided by the number of agreements plus disagreements. The mean interobserver reliability was 95% across the three children (range: 92% to 98%).

Experimental Design

The experiment proper consisted of two conditions: baseline and reinforce signing, each of which is described below. To evaluate the effects of the intervention, reinforce signing sessions were initiated sequentially following different numbers of baseline sessions for each of the three children. This procedure conformed to a multiple baseline design across subjects (Baer, Wolf, & Risley, 1968). To evaluate further the effects of the intervention on self-stimulatory behavior, a reversal design was superimposed on the multiple baseline for two of the children (i.e., John and Bob). That is, following completion of the initial reinforce signing condition, the baseline condition was reinstated, and following completion of this second baseline, the reinforce signing condition was reinstated.

Baseline. By the end of pretraining, each child had demonstrated that he knew the sign labels for 10 reinforcers. Therefore, the purpose of the baseline was to assess whether a child would *use* those sign labels spontaneously in order to request the reinforcers from an adult. All sessions were 15 min long and were conducted each weekday. During the sessions, a bag (in which food and toy reinforcers were concealed) was present in one corner of the room. The experimenter sat in a chair positioned along one of the walls facing the child so as to make eye contact with him whenever possible. The adult did not initiate any other interactions. During these sessions, the child was free to move about the room. If the child signed for one of the reinforcers (which almost never happened), the adult was instructed to maintain eye contact but not to deliver the reinforcer. In two of the baseline sessions, two generalization experimenters (each conducting one session) replaced the primary experimenter and carried out the procedures just described.

Reinforce signing. Each session in this condition consisted of a training component and a maintenance component. During the training component, spontaneous signing was taught through a combination of prompting, fading, and differential reinforcement. During the maintenance component, spontaneous signing was reinforced but it was never prompted. Throughout the latter component, data were collected in order to assess systematically the effects of the training procedure.

In the *training* component, the child was taught to sign spontaneously in the presence of the adult who had served as primary experimenter during baseline. Training sessions were run once each weekday, and lasted 5 to 10 min. In the first training session, the adult approached the child, looked him in the eye, and presented an imitative prompt for one of the 10 reinforcer items. For example, the adult might demonstrate the sign for "cheese." When the child imitated the sign, he was given a small piece of cheese. Following delivery of the reinforcer, the adult looked the child in the eye again but did not present a prompt. If the child signed "cheese" within 5 sec, he received a piece of cheese; if not, the adult presented a partial imitative prompt. That is, only a portion of the sign was demonstrated. For example, whereas a full imitative prompt consisted of placing the heel of the right hand on the heel of left and making a twisting motion, a partial prompt did not contain the twisting motion. Each child responded correctly to the partial prompts. Training on the sign was considered complete when the child spontaneously initiated the sign (i.e., did not receive prompts) on two consecutive trials. The above procedure was then repeated for each of the remaining nine reinforcers in turn. Training sessions subsequent to the first one were conducted as follows. The adult approached the child, looked him in the eye, and waited for him to sign. Each time the child signed, the adult delivered the relevant reinforcer. However, the adult reinforced only the first two instances of a given sign; additional instances were ignored. These procedural changes were designed to ensure that, as much as possible, a child would have a history of reinforcement for signing that was both self-initiated and varied. If after 5 min, the child had not displayed the signs for each of the 10 reinforcers twice, the adult imitatively prompted him (in the manner described above) to make the signs for the remaining reinforcers. Again, the prompts were faded. Using these procedures, we hoped to transfer stimulus control of the 10 signs from specific imitative prompts to the mere presence of an attending adult.

The *maintenance* component of intervention was conducted like that of the baseline condition except that if the child signed for any of the 10 reinforcer items, he received the reinforcer. Each session was 15 min long. It is worth emphasizing that signs were never prompted in this component of the intervention. During four of these sessions, two generalization experimenters (each conducting two sessions) replaced the primary experimenter and carried out the same procedures as that individual. The purpose of this substitution was to determine if spontaneity would occur in the presence of new adults who had not participated in the training component.

Each session in the reinforce signing condition began with the maintenance component and ended with the training component. Thus, the delay between training in one session and maintenance in the next was 24 hr (72 hr if training occurred on a Friday). The delay period was designed to test the durability of training. Because of the programmed delay, certain procedural changes were necessary in those sessions occurring at the boundary of the different experimental conditions. Specifically, the last session of each of the baseline conditions was extended to include a training component in preparation for the reinforce signing condition that followed on the next day. Also, for John and Bob, the last session of the initial reinforce signing condition did not contain a training component because the second baseline condition was to follow on the next day.

The last four sessions of the (only) reinforce signing condition for Mike, and the last four sessions of the second reinforce signing condition for John and Bob were altered such that each of these sessions was not preceded, 24 hr earlier, by a training component. The purpose of this manipulation was to determine what effects (if any) the discontinuation of the training component would have on spontaneous signing measured during the following day's maintenance component.

Scoring of responses and reliability. During the baseline and the maintenance component of the reinforce signing condition, two responses were recorded: spontaneous signing and self-stimulation. Spontaneity was defined as per Lovaas et al. (1973). That is, a sign was considered spontaneous only if the adult had not prompted or asked questions such as "What do you want?" The only behavior in which the adult was permitted to engage was visual attention to the child. When a sign was considered spontaneous, the observer's next task was to decide which sign had been displayed. To that end, the observers were shown, at the start of each session, the 10 signs that were involved for each child as they appeared in a standard sign language dictionary (Bornstein et al., 1975). A sign was scored as correct if it matched the sign that appeared in the book. Self-stimulation was also defined using the criteria established by Lovaas et al. (1973). The most common forms of self-stimulation recorded were body rocking, stereotyped gazing, hand flapping, and object self-stimulation.

The above behaviors were recorded using a continuous time-sampling procedure with 10-sec intervals; that is, recordings were made for each 10-sec interval within the 15-min session. Each interval could contain an instance of self-stimulation or one or more different signs. However, multiple instances of self-stimulation or multiple instances of the same sign were not recorded as such; they were scored only once per interval. Reliability observers were drawn two at a time from a pool of six undergraduate students. Observers, who were separated from each other by 1.5 m, recorded from behind a one-way mirror that faced the experimental room. Reliability was assessed at least four times per condition and was computed on 24 sessions for John, 29 sessions for Mike, and 34 sessions for Bob. Separate reliabilities were taken for self-stimulatory behavior and spontaneous signing. Observer records were compared on an interval-by-interval basis. For signing, an agreement was scored only if all the signs (or absence thereof) recorded in a given interval by one observer matched all the signs (or absence thereof) recorded in the corresponding interval by the second observer. For self-stimulation, an agreement was scored only if the two observers each recorded an instance of self-stimulation (or absence thereof) in the same interval. The reliability index was the number of agreements divided by the number of agreements plus disagreements. Separate reliabilities were calculated for occurrences and nonoccurrences of the target behaviors. The mean interobserver reliability across the three children for occurrences of spontaneous signing was 84.2% (range: 78.3%-90.5%), and for nonoccurrences, 92.8% (range: 88.8%-95.2%). The reliability for occurrences of self-stimulation was 81.3% (range: 77.6%-84.9%), and for nonoccurrences, 95.8% (range: 94.6%-96.9%).

Results and Discussion

The top half of each of the three frames of Figure 1 shows the percentage of intervals in which a child displayed either spontaneous signing or self-stimulatory behavior during the maintenance component of intervention. (All averaged data are reported in terms of means.) During the initial baseline, John signed 0% of the time; Mike signed a mean of 0.4% of the time, and Bob signed 0.1% on the average. In 30 sessions of baseline (i.e., a total of 7½ hr of recording time) distributed across the three children, there were only five instances of spontaneous signing. The virtual absence of signing confirmed the teachers' classroom observations that these children did not use their sign repertoires spontaneously to make requests. It is unlikely that the low level of signing observed during the initial baseline was simply an extinction effect. A behavior that is undergoing extinction typically shows spontaneous recovery, response variability, a gradual decline in rate, and an extinction burst (Bijou & Baer, 1978; Reynolds, 1968). The initial baseline data of Figure 1 showed clearly that each child exhibited zero percent signing in virtually every session. Thus, there was no evidence of spontaneous recovery across sessions. In addition, Mike and Bob each displayed only a single sign ("chip" for Mike, and "candy" for Bob). There was thus no evidence of sign variability either. Further, in those rare sessions in which signing occurred, the child signed only once or twice and then abruptly stopped. Therefore, the gradual decline in response rate characteristic of extinction was not observed. Finally, the fact that signing ceased so abruptly demonstrated as well that an extinction burst (i.e., a sudden increase in response rate produced when reinforcement for a behavior is first withdrawn) also did not occur. In light of the above findings, the low level of signing that occurred during the initial baseline was most likely a reflection of the general absence of spontaneous signing from each child's language repertoire prior to training.

When the intervention was first introduced, the rate of spontaneous signing increased abruptly. John signed during 70.4% of the intervals on the average; Mike and Bob signed during 57.9% and 85.3% of the intervals, respectively. When the intervention was withdrawn for John and Bob during the second baseline, the rate of spontaneous signing steadily decreased to zero percent. The mean overall rate of signing for this codition was 23.3% for John and 11% for Bob. Finally, when the intervention was reinstated, the rate of signing rose again to 73.4% for John and 83.4% for Bob.

Figure 1 also shows the percentage of intervals in which self-stimulatory behavior occurred for John and Bob. Because Mike rarely displayed self-stimulatory behavior, this behavior was not recorded for him. For the other two children, self-stimulatory behavior was frequent in the initial baseline. John displayed the behavior 57.6% of the time and Bob, 34.6% of the time. When the intervention was in effect, self-stimulation dropped to a mean of 4.4% for John, and 10.2% for Bob. The behavior increased again during the second baseline to 23.3% for John and 65.4% for Bob. Finally, during the second intervention, self-stimulation dropped abruptly once more to 3.3% for John and 9.6% for Bob.

It is clear from Figure 1 that when the rate (i.e., percentage) of signing was high, the rate of self-stimulatory behavior was low, and vice versa. There was a negative correlation between these two behaviors such that the Pearson r was -0.57 for John and -0.96 for Bob. (The Pearson r was computed by pooling the data from the first and second interventions and the second baseline; data from the first baseline were excluded because spontaneous signing was essen-

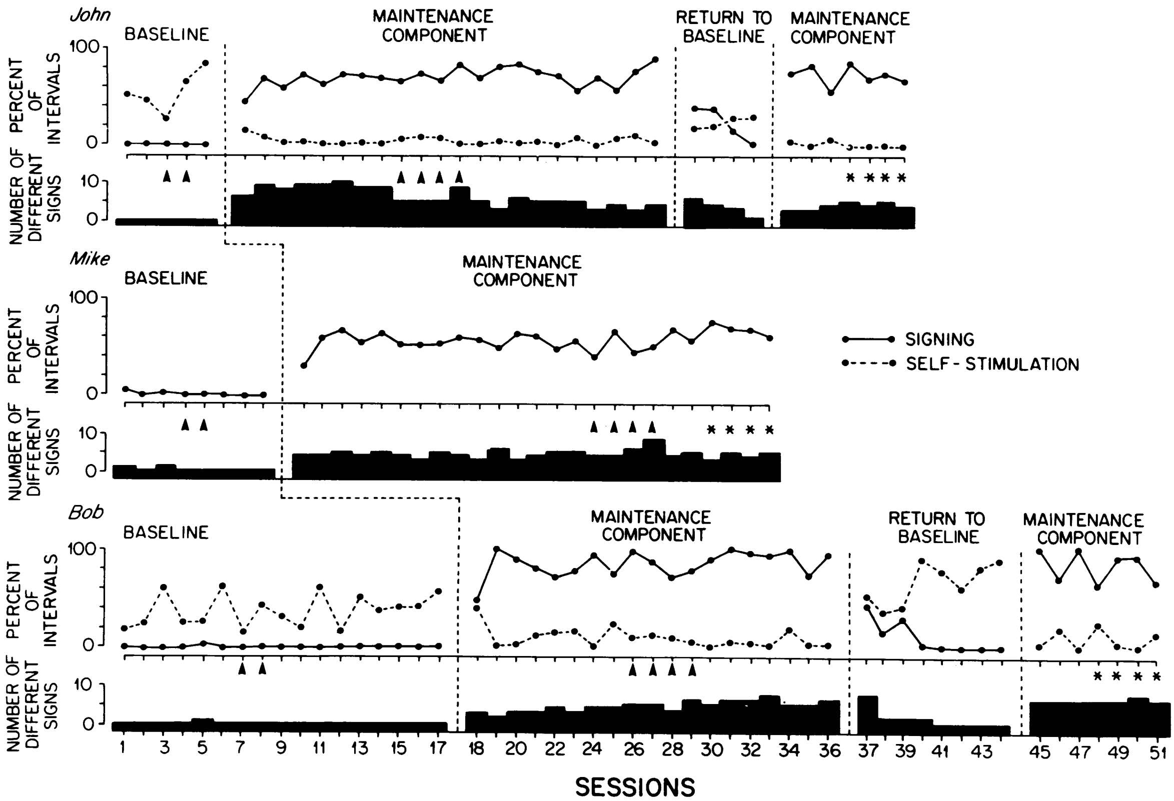

Fig. 1. Percentage of intervals in which each child displayed either spontaneous signing or self-stimulation (top half of each frame), and number of different signs displayed in each session (bottom half of each frame) for the baseline conditions and the maintenance components of the reinforce signing conditions. Arrows beneath the abscissa denote sessions conducted by generalization experimenters. Asterisks denote sessions not preceded by training components.

tially constant at zero percent during this condition and, of course, r is not an appropriate statistic when one of the presumed variates is in fact a constant.)

The bottom half of each of the three frames of Figure 1 shows the number of different signs that the children displayed. That is, these data depict the *variety* of signing, whereas the data already described depict the overall *rate* of signing. During the initial baseline, the mean number of different signs displayed was 0 for John, 0.4 for Mike, and 0.1 for Bob. The maximum possible score was 10, reflecting the fact that there were 10 different reinforcers available that could be requested by signing. When the initial intervention was in effect, the number of different signs exhibited by each child rose dramatically. John displayed a mean of 5.9 signs, and Mike and Bob each showed a mean of 4.5 signs. In the second baseline, the number of signs fell to a mean of 3.5 for John, and 1.6 for Bob. The second intervention resulted in another increase in the number of different signs exhibited. John displayed a mean of 4.0 signs and Bob, 6.1 signs.

The arrows under the abscissa in Figure 1 denote those sessions in the initial baseline and intervention that were conducted by the generalization experimenters. These data directly parallel those collected in comparable sessions by the primary experimenter. That is, the children displayed low rates of signing and high rates of self-stimulation in baseline, and the inverse pattern during intervention. Further, the number of different signs was zero during the baseline but rose substantially during intervention.

In Figure 1, the last four sessions of the intervention for Mike and the second intervention for John and Bob are marked by asterisks to denote that these sessions were not preceded, 24 hr earlier, by a training component. Nonetheless, as can be seen, the data for these sessions are comparable to those generated during other sessions. That is, the rate and number of spontaneous signs were high and the rate of self-stimulatory behavior was low.

Experiment 1 demonstrated that spontaneous signing can be taught through a combination of imitative prompting, fading, and differential reinforcement. Further, spontaneity can be maintained through differential reinforcement of sign use. In the present study, we used sign only rather than total communication (i.e., the simultaneous use of speech and sign) in conversing with the children. Some investigators (e.g., Schaeffer, 1978, 1980) have suggested that total communication may facilitate the development of spontaneous signing and, at a later time, spontaneous speech. Our decision to use only sign with the present sample of children stemmed from earlier observations of this sample (Carr et al., 1978; Carr & Dores, 1981) that suggested these children were unresponsive to speech and sometimes appeared confused when speech was added. Schaeffer's data suggest, however, that unless there are strong indications to the contrary, it is generally prudent to use total communication. At this point, we may simply note the need for researchers to develop systematic procedures to assess the circumstances under which the addition of speech can have a facilitative effect on spontaneity.

The above discussion concerning the role of speech stimuli raises a related question, namely, whether the incidental training procedures described in the present study could also be applied to vocal autistic children in order to facilitate spontaneous speech. To date, the analyses reported in this study (and in Experiment 2 below) have not been extended to speaking children. This extension would seem justifiable, however, particularly in light of the fact that effective sign and speech training procedures often closely parallel one another (Carr, 1981, 1982a).

Returning to the issue of sign use, we can see from Figure 1 that the children displayed high rates of spontaneous signing following intervention. One question that can be raised, however, concerns the degree to which the children were making discriminated versus nondiscriminated requests. This question is an important one because autistic children may sometimes run through their entire (limited) repertoire of language behavior in making requests (i.e., nondiscriminated requesting) rather than making a single request at the outset in order to access a specific item (i.e., discriminated requesting). Our interpretation of the data is that the children's requests were indeed discriminated. We base this interpretation on the patterning of each child's requests. First, if the child had requested a number of salty foods (presumably becoming thirsty in the process), the child would subsequently be more likely to request fluids, not irrelevant (i.e., to his state of deprivation) items such as toys. Second, if the child had been eating for a while during the session or had come to the session just after classroom snacks, he was more likely to begin requesting toys or activities rather than additional food, a discriminated pattern of signing that likely reflects satiation with respect to edibles. Finally, a child's requests would change from day to day. On some days, a child might request a specific toy many times, whereas on other days, he might not request the toy at all. These behavior patterns stand in sharp contrast to the repetitive, stereotyped display of all or part of the sign repertoire, session after session, that characterizes nondiscriminated requesting. Although our observations are consistent with a discriminative interpretation of spontaneous signing, we suggest that the most compelling evidence would consist of a direct experimental test in which a child's mild thirst or hunger, for example, was systematically manipulated. If the child's signs were truly discriminated, we would expect high rates of "drink" signs during thirst manipulations and high rates of "food" signs during hunger manipulations.

From Figure 1, it is also apparent that the rate of spontaneous signing was inversely correlated with the rate of self-stimulation. Because self-stimulation was not itself a target of intervention, the decrease in this behavior following language training represents a response generalization effect. We believe that this effect was not simply the result of physical incompatibility between signing and self-stimulation. These two responses could and did occur at the same time, at least occasionally. For example, the child might be rocking while he signed. Also, the children were observed to sign at one point in an interval and self-stimulate (e.g., hand-flap) at another point in the same interval. Further, there were a number of intervals in which there was no signing and yet the child did not self-stimulate despite the opportunity to do so. The above set of observations suggest that signing and self-stimulation were functionally rather than topographically incompatible (cf. Risley, 1968), a point that is further elaborated on in the General Discussion.

Our intervention not only increased the rate of spontaneous signing, it also produced an increase in the variety of signs displayed. Typically, the language of autistic children is characterized by the perseverative use of a limited number of words or phrases (Cunningham & Dixon, 1961; Wolff & Chess, 1965). Thus, a child may repeat the same request (e.g., "want cookie") over and over, while displaying almost no other language output. In contrast, the children in the present study varied their requests both within and between sessions, a diversity of language use which is closer to that observed in young normal children (Clark & Clark, 1977).

It is clear from Figure 1 that there were sessions in which disparities existed between rate of signing and variety of signing. For example, a child might sign in 80 to 100% of the recording intervals during intervention and yet request only five items. It is conceivable that this pattern reflects a preference hierarchy within the set of identified reinforcers. Ultimately, a situation might develop in which a child began to request one or two items over and over, thereby displaying an ever more restricted repertoire. With this point in mind, we are focusing one aspect of our current research on preventing the development of perseverative signing by arranging contingencies that continuously reinforce maximal sign variation.

Experiment 1 also provided data on the issue of stimulus generalization. Specifically, each child exhibited spontaneous signing when the generalization experimenters were first introduced even though no prompts were given. Thus, generalization across adults was observed. The subsequent reinforcement of signing by the new experimenters maintained high levels of signing accompanied by low levels of self-stimulation, a pattern paralleling that obtained by the primary experimenter.

Finally, maintenance was observed even after the training component of the intervention was discontinued. The data do not allow us to pinpoint the earliest time that one can terminate the training component and still obtain maintenance. However, they do at a minimum demonstrate that during the last four sessions of the experiment, for each child, treatment gains were maintained despite the absence of training in the sessions that preceded these four. An encouraging anecdote is that several weeks after the termination of the study, the classroom teachers informed us that the children were making signed requests for a number of foods and activities including some that were not explicitly taught by us. The possibility that our procedures might produce long-term maintenance and broad spontaneity is an intriguing one that merits further evaluation.

EXPERIMENT 2

This study was conducted to provide a more detailed analysis of stimulus generalization effects. Specifically, generalization of spontaneity across settings and across adults were examined to identify those variables that facilitate these forms of generalization.

METHOD

Subjects

Three males attending the same school as those in Experiment 1 participated. Tom was 10 years old; Andy, 11; and Len, 14. All had been diagnosed as autistic or autistic-type by the school psychologist. On the Leiter scale, Tom received a mental age of 5 yr 11 mo, and Len, 4 yr 8 mo. Andy scored 3 yr 8 mo on the Stanford-Binet. These children had characteristics similar to those of the participants in Experiment 1, with respect to their degree of prior sign training, lack of expressive and receptive speech, social withdrawal from adults, and absence of peer interaction. All had extensive repertoires of self-stimulation including hand regard, body rocking, and stereotyped gazing.

Procedure

Baseline. The purpose of the baseline procedure was to assess whether a child would use either of two sign labels spontaneously in a variety of situations in order to request the reinforcers represented by those labels. Each child was assessed twice in each of five different settings; thus, the basic session consisted of 10 trials. The settings involved were referred to as *primary* settings to distinguish them from other settings (i.e., generalization settings) described below, and the trials were referred to as *primary* trials. Settings were chosen so as to reflect a typical school environment and included a cafeteria area, two auxiliary classrooms, the gymnasium, and a hallway near the gymnasium. The order in which these settings were presented to the child varied from session to session with the constraint that no one setting was presented twice in a row. School policy required that a child not be allowed to move about the building without adult supervision. Therefore, an adult, designated hereafter as a monitor, accompanied the child from setting to setting. Sessions in this condition and the others described below were 25 to 40 min in duration.

The assessment procedure used in the cafeteria setting illustrates the baseline procedure. The monitor led the child to the cafeteria area where the primary experimenter was waiting in a concealed corner of the room. (The term *primary* experimenter is used to distinguish this individual from other adults, referred to as generalization experimenters, described below.) The primary experimenter emerged from the hiding place and approached within 1 m of the child. The experimenter looked the child in the eye and waited 10 sec for him to make a signed request. If no request was made (and this was always the case even though each child had a history of reinforcement for appropriate sign labeling in this and other settings), the experimenter moved on to the next setting while the monitor detained the child in the cafeteria. The procedure just described was repeated twice for each of the five primary settings. In each baseline session, the experimenter noted the child's response on a data card. On reliability sessions, an observer, who remained concealed in the original hiding place from which the experimenter had emerged, recorded the child's response on an identical data card. For any given session, the monitor was drawn from a pool of four adults, and the reliability observer from a pool of eight adults. The primary experimenter was the same person in all sessions.

Reinforce sign 1 (RF sign 1). This condition followed baseline. Sign 1 was designated as pretzel for Tom, cereal for Andy, and candy for Len. The baseline procedure described above was in effect during this condition with one change. If the child did not make sign 1 after

10 sec, or made some other sign, the primary experimenter imitatively prompted sign 1 and then reinforced correct imitation. Over trials, the partial prompting procedure described in Experiment 1 was used to fade the prompt. If the child did make sign 1 within 10 sec, he was given the reinforcer represented by the sign.

Reinforce sign 2 (RF sign 2). This condition followed RF sign 1. Sign 2 was designated as candy for Tom, cheese for Andy, and cookie for Len. The procedure used in this condition was the same as that for RF sign 1 except that only sign 2 was imitatively prompted or reinforced.

Reinforce sign 1 plus sign 2 (RF sign 1 + 2). The purpose of this condition was to see if we could induce each child to use spontaneously both of the signs he had been taught. This condition was conducted in the same manner as the two conditions just described with one difference. On any given trial, both sign 1 and sign 2 were reinforced. When the child made one of the signs, the primary experimenter reinforced that sign and waited an additional 10 sec for the other sign to occur. If the child repeated the same sign again or failed to make any sign, the experimenter imitatively prompted the other sign. Thus, on any given trial, each sign was reinforced once; the order of occurrence of the signs was irrelevant for purposes of reinforcer delivery.

Experimental design. Following the initial baseline, the RF sign 1 and RF sign 2 conditions were alternated with each other twice. The sequence was terminated with the RF sign 1 + 2 condition. The experimental design was thus an ABCBCD with the B and C conditions conforming to a reversal design (Hersen & Barlow, 1976).

Assessment of generalization across settings. For all three children, during the last 1-4 sessions in each condition (after responding had reached asymptote), extra trials were carried out in five new settings, one trial per setting. The purpose of these trials was to assess whether the training procedure, conducted in the primary settings, would result in the transfer of signing to new (i.e., generalization) settings. The five generalization settings were a play area, the art room, the school entrance, the psychological testing room, and a workshop area. To avoid learning effects, we did not reinforce correct signing on generalization trials. The generalization trials were randomly interspersed among the primary trials and in all other respects were conducted in the same manner as the primary trials.

Assessment of generalization across experimenters. After the data for Tom had been collected, we decided to extend the assessment of generalization to see if correct signing would also occur in the presence of new adults. Accordingly, during the last 2-4 sessions in each condition for Andy and Len, an additional five trials were conducted by a new adult in the primary settings. On any given session, the new (i.e., generalization) experimenter was drawn from a pool of eight adults. The total number of trials conducted during these sessions was 20 (i.e., 10 primary trials plus 5 experimenter generalization trials plus 5 setting generalization trials). The experimenter generalization trials were conducted in a manner identical to the setting generalization trials. The one exception occurred during the final RF sign 1 + 2 condition for Len in that Len was reinforced for correct signing on experimenter generalization trials. This procedural change was made after it was determined that Len (unlike Andy) gradually discriminated between primary experimenter trials and generalization experimenter trials. The purpose of the change in procedure was to see if this problem could be eliminated by having the generalization experimenters also reinforce signing.

Scoring of responses and reliability. The method for scoring signs was the same as that used in Experiment 1. That is, correct signs were those that matched the relevant signs listed in the standard dictionary (i.e., Bornstein et al., 1975) and incorrect signs were those that did not match. Prompted responses were also scored as incorrect. Signs were recorded on a trial-by-trial basis on precoded data cards. Reliability was taken on all sessions. An agreement was scored when both observers recorded the presence of a specific sign on a given trial or the absence of signs on the trial. The reliability index was the total number of agreements between the two observers in a given session divided by the total number of trials in the session. Mean interobserver reliability was 98.5%, Tom; 99.8%, Andy; 98.7%, Len; reliability range across the three, 90-100%.

Results and Discussion

The top half of each of the three frames of Figure 2 shows the percentage of trials on which each child correctly displayed sign 1 during the various experimental conditions. The bottom half shows the same data for sign 2. Consider the data for Tom. During baseline, he exhibited zero instances of sign 1 and sign 2. However, during the RF sign 1 condition, sign 1 responding rose to 100% correct and sign 2 responding remained at 0% correct. When the RF sign 2 condition was introduced, sign 2 re-

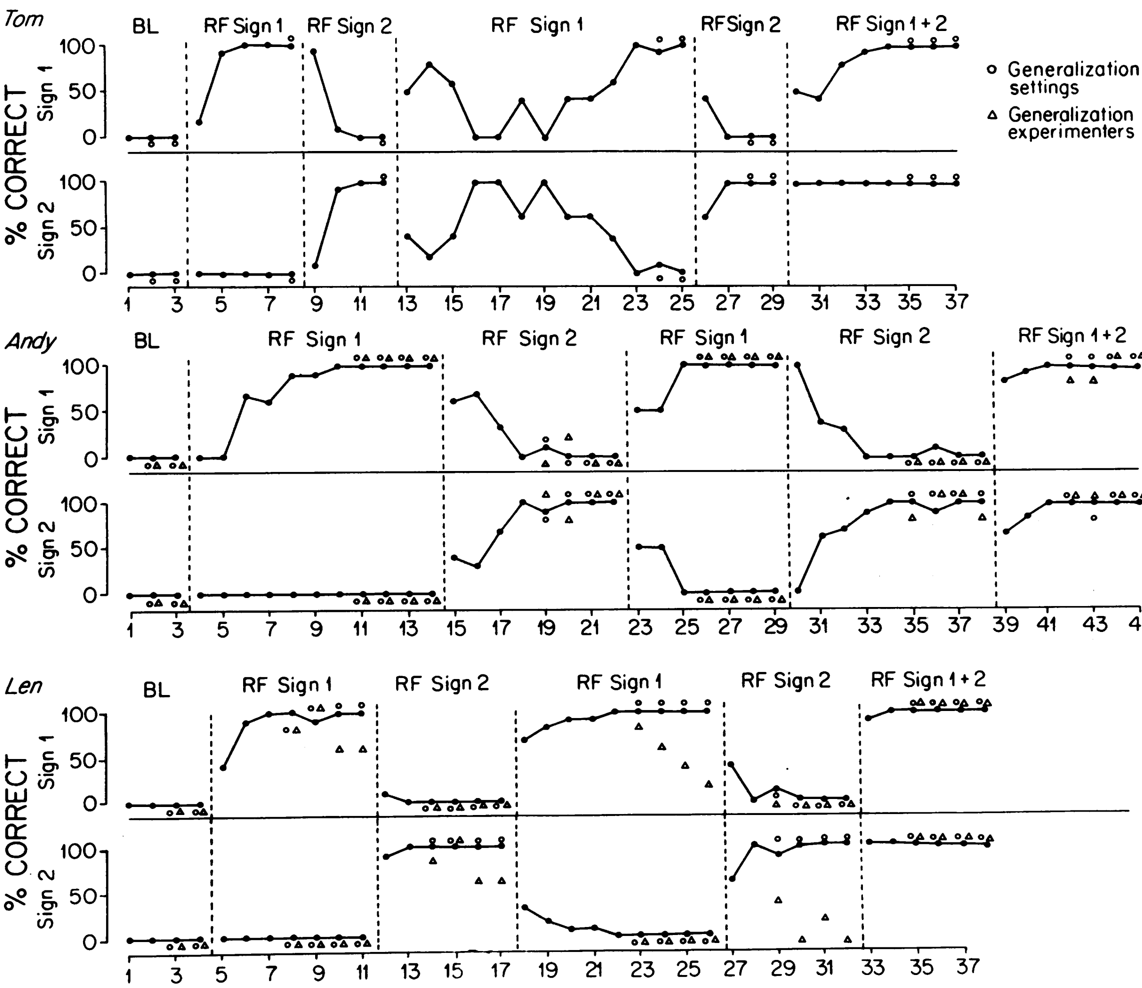

Fig. 2. Percent correct trials for sign 1 (top half of each frame) and for sign 2 (bottom half of each frame) during the RF sign 1, RF sign 2, and RF sign 1 + 2 conditions. Open circles denote responding in generalization settings; open triangles, responding to generalization experimenters.

sponding increased to 100% correct and sign 1 responding declined to 0%. The effects just described were also obtained during the replications of the RF sign 1 and RF sign 2 conditions. The last condition, RF sign 1 + 2, typically resulted in 100% correct responding for both sign 1 and sign 2. All of the above relationships were replicated for Andy and Len.

In Figure 2, the open circles denote each child's responding in the generalization settings. As can be seen, perfect or near perfect generalization was achieved in all conditions for all three children. High levels of correct signing in the primary settings were correlated with high levels of correct signing in the generalization settings.

The open triangles in Figure 2 denote responding in the presence of the generalization experimenters. For Andy, generalization was complete and stable: High levels of correct signing in the presence of the primary experimenter were positively correlated with high levels of correct signing in the presence of the generalization experimenters. For Len, generalization was nearly complete but transient: High levels of correct responding to the generalization experimenters were obtained only during the first one or two generalization sessions for each condition. By the end of each condition, Len exhibited substantially reduced levels of generalization to new experimenters. In fact, Len's data reflected an orderly process of stimulus discrimination: Responding during the second RF sign 1 and RF sign 2 conditions decreased more rapidly and to a lower level than responding in the first instances of those conditions. However, when the new experimenters reinforced correct signing during the RF sign 1 + 2 condition, high levels of correct signing were maintained throughout the entire condition.

Experiment 2 replicated Experiment 1 in demonstrating that spontaneous signing could be taught through a combination of imitative prompting, fading, and differential reinforcement. As was the case in Experiment 1, the high levels of correct responding that occurred at the end of each condition demonstrated that training (i.e., prompting and fading) could eventually be terminated without adverse effects on treatment gains.

It is also worth emphasizing that Experiment 2 involved multiple training settings. In contrast, Experiment 1 involved only a single training setting. Because children are normally expected to exhibit spontaneous language in more than one environment, the use of multiple training settings represents a more naturalistic situation. Hence, the positive results obtained in Experiment 2 support the notion that the procedures outlined may help promote spontaneity in the typical community school setting where multiple instructional settings are the rule.

Experiment 2 also provided a more explicit demonstration of the one-to-one correspondence between the training procedures and spontaneity. Specifically, when the RF sign 1 condition was in effect, only sign 1 usage increased; when the RF sign 2 condition was in effect, only sign 2 usage increased; with the RF sign 1 + 2 condition, both sign 1 and sign 2 usage increased. That is not to say, however, that spontaneity can be established only by explicitly training one sign at at time. Experiment 1 provided a clear demonstration that as many as 10 signs at a time could be involved in successful spontaneity training.

Importantly, Experiment 2 extended Experiment 1 in presenting an analysis of stimulus generalization effects. Thus, setting generality, not measured in Experiment 1, was assessed in Experiment 2. The results clearly indicated that spontaneity generalized to new settings for all three children. Experiment 2 further addressed the issue of generalization across adults. This type of generalization had been assessed briefly in Experiment 1 when new adults were first introduced into the maintenance component. However, Experiment 2 provided a more detailed test of generalization by examining the signing behavior of two children over a substantial number of sessions conducted by new adults. The two children (i.e., Andy and Len) exhibited generalization across adults such that Andy's generalization was stable whereas Len's was transient. Some of the factors responsible for the generalization and maintenance effects observed are delineated in the General Discussion section. A final anecdotal point is that after the study was completed, several teachers informed us that the children were making the signs that we had taught them in settings other than those used for training. Again, this anecdote suggests the need for systematic follow-up in the natural environment, a research activity currently in progress.

GENERAL DISCUSSION

Spontaneous sign use can be promoted through a combination of prompting, fading, and differential reinforcement. This set of intervention variables is effective in helping to produce response generalization, consisting of a decrease in self-stimulatory behavior; and stimulus generalization, consisting of the transfer of spontaneity to new settings and to new adults not involved in the initial training.

As noted above, developmentally disabled children often fail to use their language spontaneously to communicate (Carr, 1982b; Lovaas et al., 1973). Many investigators have attributed this failure to an underlying cognitive impairment that prevents normal social-communicative development (Hermelin & O'Connor, 1970). Although such a viewpoint is consistent with a large body of laboratory data, it does not lend itself readily to the formulation of remedial strategies. It might therefore be more profitable to view the problem from an educational perspective. Specifically, lack of spontaneity could be due, at least partially, to the use of training procedures that act to restrict language display (Carr, 1981). For example, if one teaches a child to request a cookie by holding the cookie in front of the child's face and asking "What do you want?" we should not be surprised that when these particular stimuli are absent, the child fails to make the request. In essence, we are suggesting that some training methods in common use may prevent spontaneity by bringing the child's language repertoire under the control of a few highly specific stimuli. The solution, therefore, would be to structure the teaching situation so as to prevent the occurrence of such narrow stimulus control. To that end, we concealed the specific objects that were the target of request training. In this manner, sign use was made independent of whether particular objects were visible to the child. In addition, we had the adult refrain from asking questions. This ensured that the child's use of signs did not depend on the adult's asking "What do you want?" or "What is this?" Thus, once the imitative prompts for signing were faded, the child's entire sign repertoire came under the control of a more general stimulus: the mere presence of an attending adult (cf. Hart & Risley, 1978). Spontaneous use of a variety of signs would therefore be expected under these conditions and this, it turned out, was the result obtained.

We alluded above to the possibility that some training methods may be correlated with low levels of spontaneity. It is helpful to place this statement in perspective by contrasting two prominent language instruction strategies: discrete-trial teaching and incidental teaching. The discrete-trial strategy (Koegel, Russo, & Rincover, 1977) is adult initiated. The adult selects the specific language targets to be trained in each instructional session. In contrast, the incidental teaching strategy (Hart & Risley, 1974, 1978) is child initiated. Whether or not a teaching episode occurs at all is strictly dependent on the verbal or nonverbal behaviors exhibited by the child and these behaviors typically change from moment to moment. Thus, the specific target to be focused on during each brief teaching episode is a function of the child's behavior. We suggest that the above two strategies each serve a different purpose in facilitating language acquisition in developmentally disabled children. The discrete-trial procedure appears to be most effective in teaching language *forms,* for example, labels (Carr et al., 1978; Lovaas, 1977) but there is no systematic evidence that this procedure reliably produces language *use*. In contrast, the incidental teaching strategy has been demonstrated to be effective in enhancing spontaneous *use* of language, albeit only in mildly handicapped individuals (Hart & Risley, 1974, 1980). The procedures described in Experiment 1 represented an attempt to modify the incidental teaching strategy for use with severely handicapped individuals. Thus, during the maintenance component of that experiment, it was the child rather than the adult who determined, on a moment-to-moment basis, which particular signs would be the focus of differential reinforcement efforts. It is important to bear in mind, however, that each child's sign repertoire had, prior to the current study, been built up through discrete-trial training. Thus, the two teaching strategies are best viewed as complementary rather than antagonistic methods for facilitating language development.

Another measure of the success of language training is whether the skills that are taught are generalized. Our data suggest that generalization of spontaneity across settings and adults (i.e., stimulus generalization) may be the result of two strategies: training sufficient (i.e., multiple) exemplars and programming common stimuli (cf. Stokes & Baer, 1977). In Experiment 2, the use of five different training settings was consistent with the strategy of using multiple exemplars and was correlated with strong setting generality. That is not to say that five settings per se were necessary; in fact, other data (e.g., Griffiths & Craighead, 1972) suggest that generality may be obtained by training in as few as two settings. Moreover, the generalization that was produced cannot be attributed solely to multiple exemplar training because a second strategy was used concurrently: programming common stimuli. The monitors who were present in both the training and generalization situations were always drawn from the same limited pool of adults. Therefore, they functioned as stimuli that were common to all situations including those in which the child was confronted with either a new setting or a new adult. Thus, there is no way in the present study to disentangle the unique contribution made by each of the two strategies. However, the strong setting generality obtained suggests that it might be worthwhile in subsequent research to examine the effects of using more than one generalization strategy at a time and to compare these effects with those obtained when only a single strategy is used. Finally, it appears that generalization across adults can also be produced and that such generalization can be maintained over sessions by having new adults reinforce spontaneous signing. It is important to distinguish between generalization and maintenance (cf. Koegel & Rincover, 1977). All three children in Experiment 1 generalized their signing to new adults as did Andy and Len in Experiment 2. Further, the three children in Experiment 1 maintained their spontaneous signing in the presence of the new adults, most likely because these adults continued to reinforce signing. When new adults did not reinforce signing (Experiment 2), maintenance of generalized signing was inconsistent across children: Andy maintained his signing but Len did not. Previous research (cf. Koegel & Rincover, 1977) suggests that had Andy been exposed to a greater number of sessions of unreinforced signing, he too would eventually have stopped signing to new adults, a further example of failure to maintain (rather than failure to generalize). Moreover, as Len's data (in RF sign 1 + 2) demonstrate, as well as the data from Experiment 1, the most reliable procedure for maintaining generalized responding across new adults is to have these adults reinforce sign requests.

Spontaneous sign language training also produces significant response generalization effects (Experiment 1). A prevalent class of psychotic behavior, self-stimulation, decreases to low levels following training. Risley (1968) speculated that response generalization effects may be due to functional (rather than topographical) incompatibility between different classes of behavior.

The factors responsible for functional incompatibility have not been systematically explored. Our data, as well as those of other investigators, suggest several plausible conceptualizations of the process. One hypothesis concerns reinforcer competition. This hypothesis states that if behavior A produces a more potent reinforcer than behavior B, then A will increase in frequency and B will decrease. Data presented by Rincover, Cook, Peoples, and Packard (1979) showed that when autistic children were trained to play with toys (behavior A), self-stimulation (behavior B) decreased. They suggested that the sensory reinforcers inherent in toy play may have been more potent than those produced by self-stimulation; therefore, the latter decreased and the former increased. Likewise, our results may reflect the fact that the reinforcers produced by sign use (behavior A) were more potent than those inherent in self-stimulation (behavior B), thereby accounting for the decrease in self-stimulation. The hypothesis just outlined could be tested by manipulating the potency of the reinforcers that follow sign use. For example, potency could be decreased or increased by respectively satiating or depriving the child of the reinforcers (e.g., food, toys) involved. One should then see systematic changes in the frequency of self-stimulation.

A second hypothesis assumes that reinforcer consistency may be a determinant of response generalization. This hypothesis states that if behavior A produces more consistent access to a given reinforcer than behavior B, then behavior A will increase and behavior B will decrease. For example, Carr et al. (1980) trained an aggressive boy to sign (behavior A) in order to leave an aversive teaching situation and found that aggression (behavior B) decreased. One interpretation of these findings was that aggressive behavior served as an escape response that was occasionally reinforced by task termination whereas signing served as an escape response that was consistently reinforced by task termination (Carr & Lovaas, 1982). Because signing produced more consistent reinforcement, that behavior increased and aggression decreased. In the present study, one could speculate that signing produces more consistent access to reinforcers than does self-stimulation; therefore, self-stimulation decreases. However, this interpretation is problematic in that signing and self-stimulation likely produce different reinforcers. Thus, reinforcer quality may be confounded with consistency. Nonetheless, in cases in which the reinforcers are equivalent, it should be possible to test the reinforcer consistency hypothesis by manipulating the probability with which the reinforcer follows each of the responses in question. Extrinsic reinforcers are the easiest to manipulate in this fashion. However, even in the case of self-stimulation, in which the reinforcers are presumably intrinsic, it may still be possible to manipulate consistency through the use of procedures that intermittently block or eliminate the sensory reinforcers (cf. Rincover, 1978; Rincover et al., 1979).

A third hypothesis focuses on the stimulus control dimension. This hypothesis states that the introduction of a discriminative stimulus (X) that controls one class of appropriate behavior (A) will result in a decrease in other classes of inappropriate behavior (B). Clearly, this hypothesis is related to the other two in that the discriminative value of a stimulus is determined by variables such as reinforcer potency and consistency. By emphasizing the stimulus dimension, however, we believe that a number of experimental findings can be brought into sharper conceptual focus. For example, Russo, Cataldo, and Cushing (1981) found that establishing adult commands (stimulus X) as discriminative for child compliance (behavior A) was correlated with a decrease in the frequency of oppositional acts (behavior B). Adult commands were initially ineffective in producing compliance, and oppositional acts were frequent. During training, however, compliance to adult commands was consistently followed by potent reinforcers. In other words, with respect to compliance, adult commands now constituted a discriminative rather than a neutral stimulus.

Henceforth, such commands set the occasion for compliance and oppositional behavior therefore diminished. Likewise, in the case of signing, the presence of an attending adult (stimulus X) was not initially discriminative for sign use (behavior A) and self-stimulation (behavior B) was frequent. However, during the intervention phase, sign use consistently produced a variety of preferred reinforcers whenever the adult was in the setting. In other words, with respect to signing, the presence of the attending adult now constituted a discriminative rather than a neutral stimulus. Henceforth, the adult's presence set the occasion for signing, and therefore self-stimulation decreased. The discriminative stimulus hypothesis has heuristic value in suggesting that any set of operations that strengthen the discriminative value of a stimulus will increase the frequency of those behaviors which the stimulus controls while concurrently decreasing the frequency of other behaviors not under control of that stimulus. These operations not only include variables pertaining to reinforcer consistency and potency but also others such as reinforcer delay and reinforcer schedule. The systematic investigation of variables that influence stimulus control can help broaden our understanding of the response generalization effects that frequently accompany language acquisition and thereby contribute to our knowledge of an important facet of child development.

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