Operant Conditioning of Verbal Behavior
of Two Young Speech-deficient Boys

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Although many investigators have applied operant conditioning techniques to the study of verbal behavior (see reviews by Krasner, 1958; K. Salzinger, 1959; Greenspoon, 1962), almost all of them have dealt with the modification of various response classes in verbally fluent adults. Outstanding exceptions are a series of studies by Flanagan, Goldiamond and Azrin (1958, 1959), who produced stuttering in normally fluent subjects and relative fluency in stutterers; a study by Isaacs, Thomas and Goldiamond (1960), who reinstated speech in two acute schizophrenic patients; and a study by Lindsley (1963), who worked with vocalizations assumed to constitute hallucinatory behavior and showed them to be independent of external reinforcement contingencies, except by indirect changes caused by reinforcing non-symptomatic behavior.

As to work with very young children, one study (Salzinger, Suzanne, Salzinger, K., Portnoy, Eickman, Bacon, Deutsch, and Zubin, 1962) showed that it is possible to condition speech rate of normal five and six year old children in much the same way as one can condition behavior in lower organisms. Furthermore, other studies (Long, Hammad, May, and Campbell, 1958) showed the effectiveness of operant conditioning techniques on non-verbal behavior in normal children. Ferster and DeMyer (1961, 1962) demonstrated the efficacy of operant conditioning of non-verbal responses in getting autistic children to interact effectively with their environment.

Our present work stems from an interest in determining how effectively operant conditioning techniques can be employed to instate speech in children who have either none or very little at the beginning of the experiments. The study of such children not only presents the opportunity to evaluate another technique of behavior therapy but also should put us into the position of tracing the process of acquisition of language in children in whom a pathological process has forced the slow-down of the natural acquisition, thus providing the opportunity for more detailed observation. The advantage of studying the speech process of children in pathology has already been demonstrated in a study by Lenneberg (1962). While it is too early for us to comment on whether, for example, children acquire discrete responses and then chain them as opposed to acquiring a set of rules, it might be well to point out that a topological description of the language learning process will eventually provide the necessary data for evaluating such theories of language acquisition as those espoused by Miller, Galanter and Pribram (1960), who base their notions largely on Chomsky's (1957) description of syntax, or by Braine (1963) who has begun to collect data in experimental situations for his theory. In any case, our efforts in this paper will be directed toward the description of some of the procedures we employed to modify the verbal behavior of two young children.
Subjects

1. The first child (C-1) was born full-term to a mother who has been described as emotionally disturbed, perhaps psychotic, but at any rate rejecting, and neither parent wanted C-1 returned home after hospitalization. C-1's younger, twin siblings were described as physically sound but emotionally unresponsive.

The parents reported noticing the first symptoms of disturbance when C-1 was 18 months old. These were hyperactivity, lack of speech development, and occasional trembling and convulsions. When C-1 was 3 years and 1 month old he was admitted to an acute-care hospital, where he was treated as physically well but severely hyperactive, although not purposefully destructive, and was either confined to a netted crib or tied in a wheel chair during his six-month stay there. The psychologist's report gave an I.Q. of 32 with basic performance at the 11-month level, discounting verbalization. Estimated social maturity was 16 months.

At the age of 3 years and 7 months, he was released directly to the psychiatric hospital at which we saw him. His admitting diagnosis was psychosis due to unknown or hereditary cause but associated with organic change, with other disease of the brain or nervous system. This was subsequently changed to, mental deficiency and chronic brain syndrome, without psychosis or mental disorder. Skull films and electroencephalogram were normal. It was noted that he had an awkward gait and sometimes bumped into things, but his physical examination was otherwise negative. His coordination and agility in climbing and other activities seemed normal.

We began our work with C-1 two months after his admission. At that time he was still hyperactive, but, according to the ward staff, less so than at the time of his admission. He was subject to sudden tantrums or fits, during which times he might scream, hit his head with his hands, beat his head on the wall or floor, or roll on the floor. He resisted being handled at these times and was not distractable. At other times he was easily approachable and seemed to enjoy being held and talked to. He paid little attention to the other children on the ward, all of whom were older than he.

His vocal behavior consisted of a variety of vowel and consonant sounds plus a wide array of whines, screams, grunts and other sounds which varied enormously in pitch, intensity and duration. There were no recognizable words and none had ever been reported for him except by his father, who claimed to have heard "cookie" used appropriately at home a few times. Neither did he appear to use any sound consistently in a given situation. He did not imitate, either on demand or spontaneously. He could respond promptly and appropriately to many simple commands, such as to come when called, and to pick something up.

A few final points are that he could partially dress himself, that he could feed himself, and that he had not been bladder or bowel trained and would occasionally play with his feces.

We worked with C-1 for a period of nine months in nearly daily sessions. At the end of this time he was sent to an institution for mental defectives. The psychiatrist's report upon his discharge from the psychiatric hospital noted
that organic involvement had been confirmed by observation and by drug reaction, since C-1's hyperactivity had been refractory to or aggravated by a variety of drugs which had been tried for short periods.

2. The parents of the second child (C-2) were born abroad and came to the United States about two or three years prior to his birth. The pregnancy was planned at the father's insistence that it would be good for his wife to have a child to care for, although she did not especially want a child. Her pregnancy was medically uncomplicated, but she reported nervousness and attacks of hysteria.

The parents have both been described as exhibiting emotional disturbance and inability to meet C-2's needs and demands for attention. They beat the child and locked him in his room for long periods, frequently from early evening to noon the following day. They do not appear to want him returned home. The case record notes that C-2's lack of speech development, end destructive, negativistic behavior, seem related to family patterns: his isolation from human contact and the lack of communication between the parents. It should be added that the parents speak German, Hebrew and English, and may have spoken mostly German at home. The child did have English-speaking baby sitters.

C-2's mother had done reading in the area of mental retardation and was convinced her son was retarded. She felt that speech was extremely important and that it had been unfortunate for her that she herself had been late in developing speech as a child. She appears to have made a great issue of this at home and showed particular concern, for example, over getting C-2 to call her "mama".

The parents eventually consulted a hospital service and at the age of 3 years and 10 months he was referred to the psychiatric hospital at which we have been seeing him. His diagnosis is primary behavior disorder. The outstanding presenting symptom was lack of speech, and some hyperactivity was noted. An electroencephalogram obtained during natural sleep was within normal limits, and his physical examination was negative. His general motor coordination was excellent and his manual dexterity outstanding. The psychologist who saw C-2 shortly before his admission estimated him to be of at least normal intelligence, but this is merely an impression, since adequate testing was not then possible.

We began seeing C-2 about two months after his admission. In contrast to C-1, he was reported to be emotionally responsive, even affectionate with the regular ward personnel, but he appeared only moderately more concerned with the other children on the ward than had C-1. However, in marked contrast to C-1, he showed fear of all strangers, although it was reported to us that at the time of his admission such fear was confined to women only. He would back away and even show panic if strangers attempted to come closer to him than ten feet or so. Thus, considerable conditioning was necessary before it was even possible to get him to the experimental room. He was also subject to occasional very sudden tantrums involving screaming and head-banging on the wall or floor. These often seemed related to his being prevented from doing something. At these times he usually responded quickly to being picked up and talked to.

His verbal behavior was free of the babbling and animal-like sounds typical of C-1 and, when we first saw him, was almost exclusively limited to the word
"no," always used appropriately -- for example, when we attempted to approach
him. Although he then spoke only rarely in our presence, his active vocabulary
(as reported by, among others, the social worker who has seen him regularly since
his admission) already included other words. The most frequent of these was
"key," which he used to request keys to play with or to indicate that he wanted
a door opened. His articulation ranged from fairly good to very poor. He
could respond promptly and appropriately to a wider variety and greater com-
plexity of commands, such as to go and get an object and bring it back, than
could C-1.

Like C-1, he could partially dress himself and could feed himself and had
not been bladder or bowel trained and would occasionally play with his feces.
It should be noted that he reportedly urinated and had bowel movements on the
floor while he was locked in his room at home.

C-2 is still hospitalized at the time of this writing, about ten months
after his admission, and we are continuing experimentation with him on a nearly
daily schedule. He has begun to leave the hospital to attend a nursery school
for normal children, although the nurse or attendant who takes him must remain
there with him.

Finally, it is interesting that Ferster (1961) has elaborated a hypothetical
history very much like C-2's which might be expected to produce a child who has
symptoms quite similar to his.

Procedures for C-1

The work with C-1 can be divided into two broad types of sessions: 195
sessions in which pre-determined procedures or strict reinforcement (SF) con-
tingencies were primarily in operation (these will be called experimental
sessions, abbreviated EXP), and 61 special sessions in which the experimenter
(E) used a variety of techniques to introduce words into C-1's repertoire and
to attempt to gain stimulus control over various verbal and non-verbal responses,
whose emission was then reinforced.

EXP 1-2. Establishing E as a source of SF by following C-1's sounds with
praise and a variety of edible SF's (candy, peanuts, spoonfuls of soda, etc.).

EXP 3-82, Fixed ratio (FR) SF for sounds. FR increased from 1:1 to 37:1
by EXP 76. The different kinds of SF's (candy, etc.) were varied freely within
sessions, although mostly candy was used in later sessions. Beginning with
EXP 21, E spoke the name of each particular SF as it was given to the child
but did not say anything else, e.g., he said "candy" when presenting it.

Certain sounds, such as spitting noises or animal-like screams, were never
reinforced, since we judged that they would have no utility is the eventual
production of words, and since they often accompanied wild or otherwise objection-
able behavior. C-1 often produced extended continuous vocalizations punctuated
by one or more stress. While we began by reinforcing discrete sounds only, some
sessions consisted almost entirely of these extended vocalizations (see Salzinger,
1962 for a discussion of the problem of the unit) and therefore, the SF contingency
through EXP 15 was frequently based on number of
stresses rather than number of discrete sounds, to maximize the number of $S^r$'s which could be given in each session. In subsequent sessions, C-1 began to produce short discrete sounds predominantly.

EXP 83-104. FR continued and increased to 50:1, with the additional contingency that words or close approximations to words were reinforced with E's repetition and delivery of candy whenever they occurred (FR = 1:1).

EXP 105-113, $S^r$ (candy and repetition) given only for words or close approximations to words (FR = 1:1).

Table 1 summarizes the $S^r$ contingencies for EXP 3-113. In general the sessions follow one another on consecutive days, weekends included, the few exceptions being primarily due to occasional physical illness and extreme sleepiness or irritability. The missing entries in the EXP column correspond to sessions in which variations in the basic procedures described above, or quite different procedures, were tried. There is not enough space here to describe them and we will simply say that they were discontinued for a variety of reasons, among them practical difficulties, such as lack of adequate apparatus, or the apparent need to do an enormous amount of pretraining or response shaping before the particular behavior in question could be adequately dealt with.

The changes in FR were based on E's judgment, which took into account factors other than C-1's vocal behavior per se. If the child were very irritable, for example, or seemed uncomfortable due to a bad cold, E would not increase the FR unless these factors were counteracted by a very high vocalization rate early in the session. However, the decision to decrease the FR was made almost exclusively as a result of very long periods of silence. As Table 1 shows, these decreases or reversals were confined to the lower FR values and never occurred after FR = 10:1 had been established in EXP 49-55.

The maximum session length for EXP 3-113 was 60 minutes. Most of the sessions were about 40 to 50 minutes long, and those that were much shorter were terminated because of the occurrence of a violent tantrum or some other event requiring immediate attention.

EXP 114-142. Discrimination training. A book and several stuffed animals, with which C-1 had frequently played and which were appropriate to the few recognizable words C-1 could by this time utter spontaneously, were selected to become discriminative stimuli ($S^D$'s) in the presence of which the words were reinforced and in whose absence ($S^A$ periods) no $S^r$ was given. It should be emphasized that the objects chosen as $S^D$'s did not initially exert any discriminative control over the words.

EXP 114-142 always began and ended with an $S^D$ period and consisted of three
or five periods in all, alternating $S^D$ and $S^A$. The initial $S^D$ period was 10 minutes, and subsequent $S^D$ and $S^A$ periods were 5 or 10 minutes at different points in the series of sessions. Thus total session length ranged from 20 to 50 minutes.

**EXP 143-178.** The presence or absence of the $S^D$'s were made contingent on C-1's behavior rather than on arbitrary time periods, thus themselves being used as secondary reinforcements. The $S^D$'s were first presented with C-1's first word and their duration in the experimental room was timed from 0 again for each subsequent word emitted. They were removed from the room if no word was emitted within 3 minutes, in which case they were immediately returned upon the next emission of a word. Thus the minimal requirement for the child's keeping the toys in the experimental room was the emission of one word every 3 minutes. For EXP 170-178 the critical interval was reduced to 2 minutes.

The $S^F$ for EXP 144-178 consisted of candy, repetition of the given word, and handing C-1 the appropriate object if he were not already touching it.

**EXP 179-195.** C-1 was required to pick up one of 4 toys and bring it to E upon verbal command. The toys were a book, a "big" and a "little" stuffed dog, and a stuffed teddy bear. In the earlier sessions of this procedure, E requested one toy a pre-determined number of times (usually 5) and then switched immediately to another toy if C-1 did not comply. In later sessions, E insisted on one toy until C-1 brought it, or, if several minutes passed without the child at least attempting to select a toy from the group, E handed him the appropriate one, returned to his place across the room and asked C-1 to bring it to him. If C-1 had taken a particularly long time to approach the toys or pick one up, and then hesitated again, E reinforced his behavior to that point and added another command with the statement, "That's right. Now bring the __________ over here." If C-1 picked up the wrong toy, E said, "No, that's your __________. I want you to bring me the _____________."

When the child finally completed carrying out the instruction, he was praised, given candy, and allowed to play freely for 2 or 3 minutes, at the end of which time E took the toy, replaced it with the others and resumed the procedure by asking C-1 to bring another toy.

Before the special sessions are described, some general comments are in order on the conduct of the experimental sessions.

Although C-1 invariably accompanied us willingly to the experimental room, he was extremely active once we got inside, walking or running around, climbing on the radiator or the few pieces of furniture present, and sometimes trying to leave. The method of dealing with this behavior was begun in the very early sessions and consisted simply in delivering the edible $S^F$'s in once part of the room only. The candies or spoonfuls of soda were put into a cup standing on a table in the corner of the room, or, if C-1 had removed the cup, candies were dropped onto the table itself. The child learned to spend increasing amounts of time near the table and often climbed up and sat on it for long periods.

The door of the room was never locked, and C-1 was allowed to open it and leave the room if he persisted in the attempt after E stood in front of the door to block his way. On those occasions when he did not return of his own accord
in a minute or two (during which time E remained in the room), E was usually able to bring him back easily with a minimum of talking and handling. It soon became possible to discourage attempts to leave simply by E's putting his hand on the door.

There were two other noteworthy exceptions to the rule that physical contact with the child and talking to him during the experimental sessions were to be rigorously avoided except as they constituted part of the planned SF contingency. The first exception concerns toilet training and will be discussed below since it raises a procedural question of some importance. The second exception concerns the occurrence of tantrums, during which it was sometimes necessary to hold the child to prevent his injuring himself and to talk to him in order to calm him down rapidly enough to allow continuation of the session. Such behavior on E's part was kept to a minimum, and C-1's tantrums, as in the case of Ferster and D'Amato's (1961, 1962) autistic children decreased in frequency and severity, rarely occurring in later sessions except for a temporary increase in frequency when the SD's were removed from the room during the discrimination procedure.

The special sessions were instituted following EXP 93. In EXP 83, as stated above, we introduced the contingency that words or close approximations would be reinforced on FR 1:1, in addition to the higher ratio in effect for other vocalizations. However, C-1's operant level for words was actually 0 in some sessions. The special sessions were set up to elicit words by presenting a variety of stimuli and to reinforce imitation whenever possible, and thereby to increase through generalization the frequency of occurrence of words during the experimental sessions.

The procedure involved talking to the child most of the time, using short simple sentences and frequent repetition of the words appropriate to his activity at the moment, and freely encouraging him to repeat the names of the objects to which his attention seemed directed. Three activities were introduced into most of these sessions: drawing with crayons, pointing to pictures in a book, and playing with some stuffed animals (the book and the animals were those later introduced as SD's during discrimination conditioning). The child's attention was gained by a variety of means, most frequently through repeating words (mostly nouns) in short rhythmic sequences while tapping along lightly on C-1's hand. E often held the child in his lap at these times.

Thus C-1 was exposed to a relatively small vocabulary very frequently repeated and associated with a limited range of objects and behaviors. E reinforced, with candy, repetition, praise, and often by hugging the child, any approximation to naming or imitation, even, at first, if no actual vocalization were produced. For example, C-1 would sometimes watch E's lips quite intently and make deliberate lip and mouth movements of his own, often seemingly made with great effort. In later sessions the SF was made contingent on the production of any vocalization at these times, and, eventually, on the production of a vocalization having some vowel or consonant element in common with either the word E was repeating or the name of an object C-1 pointed to or picked up.

Since no quantitative data from these special sessions will be presented, no further detailed description of procedures will be given. It can be stated as a general principle that, while the particular behavior dealt with was often unspecified in advance of a given session and in some aspects varied greatly
among sessions, the SF contingencies were made increasingly strict in the manner already described for C-1's vocalizations but applied as well to non-vocal behavior (length of time spent at one activity, for example).

The maximum length of the special sessions was about 30 minutes. The 61 such sessions were interspersed at fairly regular intervals with the experimental sessions after EXP 93. One session of each type sometimes occurred on the same day, but never two of the same type.

Finally, a few words about the experimenters. There were five E's in all for the experimental sessions, three of whom were primarily responsible for the early sessions, and two of whom conducted nearly all the experimental sessions after EXP 30 and all but a few of the special sessions. Two E's were present during nearly all sessions up to EXP 93, with one monitoring the tape recorder but otherwise being a silent observer, except in very early sessions where C-1 required some mild physical restraint to prevent injury to himself or the equipment. With rare exceptions, only one E took part in the special sessions.

Sessions of both types were tape recorded.

**Procedures for C-2**

The initial problem with C-2 was getting him to the experimental room without upsetting him to the point where no experimentation would be possible. Unlike C-1, he would back away from approaches by anyone other than regular ward personnel, and would cry and appear fearful simply at mention of the idea that we take him off the ward.

We began by visiting the ward once or twice a day, talking to C-2 but not approaching closer than he appeared willing to tolerate without interrupting his activity. Eventually he would approach us long enough to take a piece of candy, for which he received much praise as well. Gradually, he began to respond to the suggestion of leaving the ward with a verbal "no" but no particular signs of distress, then he would allow us to pick him up for brief periods, then to carry him about if we did not approach the exit from the ward. Each successive stage was reinforced with candy and praise, and the candy was generally accompanied by E's talking about leaving the ward.

The next step was to have one of the regular ward staff accompany us to the experimental room where pieces of candy had been conspicuously placed. It was soon possible for E alone to get the child to the room by reinforcing every few steps with candy. After this, it was possible for E to carry C-2 to the room, for while the child often cried when this was done, he had ceased to put up physical resistance. He was taken to the room, where he quickly calmed down long enough to eat the candy and was reinforced in addition by being allowed to leave freely and return to the ward. Thus we were able temporarily to use the very behavior we wished to reduce (leaving the experimental room) as a reinforcer for the behavior we wished to strengthen (remaining in the room). By the end of about four weeks, C-2 would stay in the room with E for periods up to an hour in length, climbing immediately onto the table and beginning to play with his toys.
The sessions at this time were basically the same as the special sessions described above for C-1. The major difference concerned the relative ease of establishing a criterion for the reinforcement of words. C-2 already showed verbal as opposed to merely vocal behavior, although it was emitted very infrequently—that is, his small output consisted almost entirely of words, which were generally recognizable in spite of very poor articulation, and which were clearly under discriminative control. Therefore, our first aim was to use reinforcement to increase the frequency of word emission.

The special sessions were terminated after about a month, and the following experimental procedure was then instituted. C-2 was brought into the room and allowed to play freely with a number of toys, books, and miscellaneous objects. E remained silent until C-2 uttered a word, phrase, or sentence, at which time E responded with an utterance as close as possible to the length of the original and as exact a repetition as seemed appropriate. Thus, if the child pointed to a book and said "book," E repeated the word but if the child said "Gimme ice cream," E would say "I can't give you ice cream" or if C-2 persisted, "no ice cream." If the child made such a response as clearly pointing to a picture of a blue car while saying "red car," E made the correction and called it a "blue car." If C-2's utterance was a request which could reasonably be carried out, E complied as he gave the verbal Sf. Thus, if C-2 dropped an object off the table and asked E to "pick it up," E would do so as he said "I'll pick it up." However, if C-2 attempted to make a game of this by deliberately dropping things, E would respond with, "No, I won't pick it up." Candy was given only when C-2 specifically asked for it, and further requests were denied if he accumulated several pieces without eating them. If E could not understand all or part of any utterance, he made the best guess he could using whatever vocal or non-verbal cues were available. This was generally easy, since C-2's verbalizations typically concerned objects in the immediate environment and were frequently accompanied by responses such as pointing. Such vocalizations as humming or imitations of noises made by various toys were never reinforced. The response had to consist of at least one actual word.

EXP 1-2. The 60-minute session was divided into 2 types of alternating 15-minute periods: one type, as described immediately above, where E's speech served as the Sf by being made contingent on C-2's speech, and the other like that of the special sessions, where E spoke at a fairly constant rate throughout, making remarks relevant to the child's activity at a given moment. E attempted to interest the child in several of the same toys in each period of the second type, so that there would be considerable overlap among these periods in the content of E's speech. EXP 1 began with a 15-minute period of the first (speech contingency) type, EXP 2 began with the other type.

In EXP 1, at the beginning of the first period of the new procedure, C-2 reacted as he did when being punished or reprimanded on the ward, that is, he stopped playing, became very still and appeared to be on the verge of crying. E told him that he was a good boy and that he could go right on playing. The child immediately smiled and resumed play, and no such incident recurred.

EXP 3-4. The speech-contingency procedure was in effect for the entire session. After about 40 minutes on each day, C-2 lay down on the table where he was playing, watched E for several minutes, and then appeared about to fall asleep. E, without speaking, sat the child up and pushed the toys closer to him. In EXP 3, C-2 lay down again and E terminated the session after several more minutes. In EXP 4, however, the child remained awake, and the session
continued for the planned 60 minutes.

EXP 5-13. The speech-contingency procedure was in effect for the entire 60
minutes.

EXP 14. Same as EXP 1-2.

EXP 15-19. C-2 was reinforced only for requesting whatever object E
held in his hand. A sentence, such as "Gimme __________", not simply naming
the object, was required. Sp included E's giving the child candy and the object
as well as the verbal Sp.

EXP 20-31. Here the procedure was changed completely and C-2 was reinforced
only for imitating E's verbalization. These were generally names of objects or
pictures in a book, and included an article or adjective of size or color in
addition to the noun. The Sp was candy and praise and several minutes of free
play following completion of a series of imitations (e.g., all the pictures on
one page, or all the parts of a toy).

EXP 32-56. Conditioning of color names and their discriminative control.
Briefly, 5 color names were established in C-2's vocabulary and brought under
the control of the appropriate Sp's. Various non-verbal responses were also
brought under the discriminative control of color stimuli. Since analysis of
these data is still in progress, detailed description of the procedure will be
reserved for a later paper.

Results and Discussion

Response unit

For both children, the unit of measurement of amount of vocal or verbal
behavior is the number of seconds of vocalization time per one minute of clock
time (for discussion of this unit of measurement, see Salzinger, K., 1962;
Salzinger, K., Portnoy, and Feldman, 1964; Salzinger, Suzanne, Salzinger, K.,
Portnoy, Eckman, Bacon, Deutsch, and Zubin, 1962). Analysis was done from tape
recordings. The observer released a switch whenever the child vocalized and
depressed it during silences, thereby starting and stopping a chronoscope
accurate to .01 sec. Readings were taken once per minute. Typical inter-observer
reliability for 2 well-practiced observers, and intra-observer reliability for
one of them are shown separately over 20 min. of session time in Fig. 1.

Insert Fig. 1 about here

For C-1 all vocalization was cumulated which was acceptable under the de-
definition of the Sp contingency for EXP 3-104 (see Procedure for C-1). For
C-2, the definition for purposes of analysis was the same as for C-1, even though
the Sp contingency during conditioning had been based on words only.
Results for C-1

Cumulative seconds of vocalization are presented for the first 20 minutes of EXP 5, 9 and 33 (see Fig. 2A), 57, 64 and 83 (see Fig. 2B). These sessions were originally selected for analysis because they are free of such contaminating variables as physical illness or medication and relatively free of interruptions. Subsequent analysis of additional sessions from this FR procedure confirmed the general result: an overall increase in rate with increasing FR. The long near-plateau in EXP 5 was a feature of very early sessions only.

Insert Figs. 2A and 2B about here

Thus operant conditioning accomplished our basic aim of increasing a large class of responses to the point where selective reinforcement could be attempted. However, we obtained another result whose implications are at least as important from the point of view of behavior control, and that is, the essentially complete elimination of certain objectionable behavior which was not reinforced and which was incompatible with other, reinforced behavior. C-1's miscellaneous animal-like sounds were eliminated outside of the experimental sessions as well as within them because we never reinforced them and they were incompatible with behavior whose emission was reinforced. Similarly, his hyperactivity was controlled simply by making SP's available in only a restricted area of the experimental room. As Ferster and DeMyer (1961) comment with regard to the decrease of tantrums and atavistic behavior in their conditioning sessions, such decreases suggest that the behavior may have been at least partly socially maintained and may be displaced through establishing the potency of other behavior.

In EXP 83-104, the relatively high, steady vocalization rate continued to be maintained, but the additional contingency of FR =1:1 for words produced no clear evidence for conditioning. The rate of word emission remained extremely low, with only a few very small temporary increases in some sessions. In EXP 105-113, SP only for word emission again failed to produce conditioning in the sense of a regular and substantial increase within sessions or across successive sessions. However, while the rate of word emission remained generally low, it was higher than formerly, with all sessions in this group containing at least a few words. This may be a generalized effect from the special sessions, where we had been reinforcing imitation of words and where praise and physical contact with the child, in addition to candy, may have constituted a more effective reinforcer for word emission than simply repeating the word and giving candy as we did in EXP 83-113. An analysis, now in progress, of the phoneme distributions of C-1's vocalizations is expected to give us a more precise picture of the results of selective reinforcement of approximations to words.

The discrimination training in its several variations in EXP 114-178 was unsuccessful, the only notable consequence of the procedure being a temporary increase in emotional behavior when the SD's were removed.

The procedure in EXP 179-195 was successful in the sense that C-1 was soon making only very rare errors in selecting the correct toy. The problem was in getting him to respond at all, with only 2 or 3 complete responses executed in some sessions. Thus, while he had learned to respond correctly to the verbal SD's,
such $S^D$'s remained weak in their power simply to increase amount of responding. It may be that the $S^r$ was not sufficiently powerful to increase and sustain discrimination behavior, while at the same time the aversive consequences of responding incorrectly (this prolonged the task by requiring correction and thus also postponed the free play interval) combined with the mild effectiveness of the positive $S^r$ to permit the conditioning of occasional correct responses.

Results for C-2

One observation made during the special sessions with C-2 was that social reinforcers (E's talking and smiling, etc.) appeared to have become very powerful, whereas the candy was often treated as just another toy and often remained un eaten at the end of the session. This suggested that E's speech alone could be used as a reinforcer and furthermore that the 'value' of each $S^r$ might be made contingent on C-2's behavior simply by having the amount of speech in each $S^r$ correspond to the amount of speech in the response. In EXP 1-2, the effectiveness of this $S^r$ was confirmed by direct comparison of contrasting 15-minute periods (see Procedure for C-2). The 4 speech-contingency periods (2 each in EXP 1 and 2) show a continuous increase in percent of time C-2 spent vocalizing (6.7, 10.8, 15.5, and 17.5 percent), while vocalization in the alternate periods where E's speech was not contingent on C-2's speech, does not increase regularly nor reach as high a rate (9.7, 7.9, 9.7, and 15.4 percent). In the alternate periods, which were conducted like the special sessions, a check on the timing of E's speech showed a steady rate in all 4 periods and about 35 percent of each period was occupied by his speech; thus about 50 percent of each of these periods was silence, and it can not be argued that C-2's speech would have increased more in these periods if E had not monopolized the speaking time.

Cumulative seconds of vocalization are presented for the first 20 minutes of EXP 3, 5 and 6 (see Fig. 3A), and 7, 11 and 13 (see Fig. 3B). Except for EXP 3, which began at a relatively high rate but concluded with the child nearly asleep (as explained under Procedure), the trend is for an increase in rate.

The percentages of time spent in vocalization for the 20-minute periods shown are 16.2, 4.9, 9.5, 17.5, 18.6, 14.6. The corresponding numbers of $S^P$'s are 56, 64, 78, 114, 80, and 67. It is necessary to remember that the number of $S^P$'s is contingent not on total vocalization or on number of words, but on number of utterances comprised of words. Thus, there was an increase in such utterances from EXP 3 to EXP 5 in spite of the drop in total vocalization. At the same time, the decrease in number of $S^P$'s from a maximum (for the sessions analyzed so far) of 114 may well have been accompanied by an increase in the length of each utterance if, in fact, longer $S^P$'s were really more powerful $S^P$'s as hypothesized. A detailed analysis, including word counts and study of the lengths of response units, is now in progress to clarify these relationships.
As for the remaining sessions there is no doubt that C-2 learned both the asking and the imitation responses very quickly. In EXP 32-56, while the errors have not been examined in detail, we can state that long after C-2 could respond correctly to the color names as $S^D$'s and could use the names spontaneously without error, he still made many errors in naming colors on demand, and did not reach the criterion of 2 successive errorless series on the naming task until the last session of the group. We plan further experimentation to determine whether this represents a general deficit in this child's language ability.

One of the striking features of C-2's language development has been the broadening of its range along lines not required by our specific $S^T$ contingencies. We said earlier that we hoped this study would allow us to observe the acquisition of language in "slow motion." The detailed observation performed by Braine (1963b) on very young children's speech can, in fact, be done under more controlled conditions in a hospital setting. One of the interesting phenomena which we have been able to observe is the acquisition of the very complicated series of intersresponse relations which are commonly referred to as grammar. How does a child learn, as C-2 has learned, from having uttered and being reinforced for saying "gimme car" that one can also say "gimme tape"? C-2 has even generalized further along the same line, in a perfectly logical, albeit grammatically unacceptable, extension of the "gimme ____________" frame, to such utterances as "gimme pick it up" (where someone else is to perform the action).

This is in extreme contrast to the behavior of C-1, who generalized only to the extent of emitting outside the experimental situation the responses conditioned within it. He never acquired a single word other than those we conditioned by reinforcing successive approximations; these numbered only about 25, among which all but 4 or 5 remained very infrequent and difficult to understand.

It is interesting that in Ferster and DeMyer's (1961) study, the autistic child with less speech and a generally narrower range of behavior also responded far less quickly to attempts at gaining stimulus control over his behavior, and in general food and candy reinforcements maintained his experimental performance; the child with more speech responded quickly to the $S^D$'s, and non-food $S^T$'s proved very effective. These differences parallel those between C-1 (who had at one time been diagnosed as autistic) and C-2 in our study, in spite of differences in age, diagnosis, the responses involved, etc. There may prove to be a very general relevance for Ferster and DeMyer's comment that, "The differences between the 2 children are closely related to the amount of speech present, probably because the verbal repertoire, by itself, represents a large potential of control by the environment" (1961, p. 342).

Also, we must strongly emphasize that while our work with C-1 represents the only sustained and systematic attempt at changing his behavior during his hospitalization, except for his care on the ward, the same is not at all true for C-2. In particular, a social worker has been seeing him on a nearly daily basis since his admission. While her work has generally not concentrated so intensively as ours on preselected and quite restricted classes of responses, many of her procedures are easily fitted into an operant conditioning paradigm.

Final comments

One of our basic problems has been to work with response classes which would
teach us something about the application of operant conditioning to the instatement of verbal behavior and which would at the same time benefit the children.

One example should make this point clear. With C-2, the major aim of the procedure in EXP 32-54 was to locate and examine specific difficulties in language learning by studying the acquisition of a restricted class of verbal responses. Usual experimental practice would dictate the use of materials such as nonsense figures and nonsense names, rather than pegs and color names, thus minimizing the effects of differential pre-experimental reinforcement histories and concurrent extra-experimental reinforcement contingencies. But the control to be gained by using such materials must be weighed against two factors: (1) the possible adverse consequences to a child whose speech is minimal and not easily understandable to begin with, of returning to the ward and attempting verbal communication with the staff and children by using nonsense words, and (2) the loss of the opportunity, in the case of a child who may learn slowly or who is available for a limited time, to condition responses which might also be reinforced outside of the experimental situation and which could generalize to other members of the response class which could themselves be reinforced.

In fact, since C-2 was as a matter of course continually surrounded by stimuli appropriate to the use of color names, generalization quickly took place, and he not only used the conditioned responses outside the experimental situation but learned other color names in addition. As well as we could determine, he had nearly ceased to make errors in color naming on the ward at the same time he achieved the criterion of 2 successive errorless series in the experimental situation.

Another general problem concerns the extent to which we interrupted the planned procedure to deal with the occurrence of behavior secondary to our purpose but of great importance for the child. The principal example of this involves toilet training of C-1. Close observation often made it possible to predict from his behavior that he needed to be taken to the bathroom. Since these behavioral signals (all non-verbal, e.g., pulling at his pants) were not obvious enough to be effective routinely on the ward, we decided to deal with them specifically by strengthening them through reinforcement.

Thus, during a session, we responded to such behavior by interrupting the procedure, taking the child to the bathroom, and reinforcing him by praising and hugging him if he went to the toilet or returning to the experimental room with as little talking and handling as possible if he did not. If C-1 wet or soiled himself during a session, we continued the procedure without interruption unless he became very upset. Since the child invariably showed some degree of distress if he became wet or soiled, a response which resulted in his being taken to the bathroom at the appropriate time was effectively an avoidance response as well as one leading to direct positive SR.

This program -- in conjunction with the cooperation of the ward personnel, who took C-2 to the bathroom at regular intervals, showed great approval if he used the toilet, and minimized the positive reinforcing events (talking, playing, etc.) connected with changing his wet or soiled clothes -- resulted in great improvement. He even began occasionally to demand the attention of a nurse or attendant when he needed to be taken. The original response never became simply a means of escape from the experimental situation, mainly because we rarely permitted more than one such interruption in a session and therefore far more SR
was available by remaining in the situation. In fact, such interruptions became less frequent in later sessions because the child had learned to use the toilet more frequently at other times.

Briefly, we can mention another use of the same technique, although involving very different behavior, with C-2. This child, if he became very insistent about wanting a particular toy or object which could be quickly obtained, and if he expressed this desire by a clear verbal response, was sometimes permitted to leave with E and bring it back to the room. Rather than using this more and more frequently as a means of escaping the experiment, the child learned to make such requests before the session began and his demands for such interruptions eventually ceased almost completely. At the same time, this procedure contributed to the fact that C-2 has learned to request objects rather than simply name objects present in the immediate environment.

A third general issue to be discussed here concerns the relationship of our work to other relatively long-term applications of operant conditioning. Ferster and DeMyer (1961, 1962), working with autistic children in an automatically controlled environment in which simple free operant motor responses produced machine-delivered SF, showed that reinforcement could be used to develop and sustain various aspects of these children's behavioral repertoires. While they make clear that their work was not aimed at therapy or rehabilitation, they add that rehabilitation "would have to be carried out through the manipulation of social contingencies and the development of performances with which the child would interact with other individuals" (Ferster and DeMyer, 1961, p. 344). In fact, DeMyer and Ferster (mimeo) report successful use of social reinforcers to teach new social behavior to autistic and symbiotic children, and while they did not treat these results quantitatively, their techniques appear to have proved effective with a wide range of behaviors, including verbal behavior. Our work in the special sessions was in many ways similar to the work they describe.

We would point out in this regard that, no matter how simple the response in question, the mere fact that positive reinforcement is delivered by another person rather than by a machine, may be of great importance in the case of a child for whom other individuals have become SD's primarily for socially unacceptable responses or for whom they have never in any significant way become SD's at all. In our work, C-2 presents the example of a child whose history prior to hospitalization provided relatively little opportunity for the establishment of other individuals as SD's for speech. Nevertheless, by pairing E's speech with stimuli already possessing positive reinforcement properties (candy, toys, etc.), E's speech itself was made to acquire strong, secondary reinforcement properties for C-2's behavior, and at the same time other individuals have clearly become SD's for the emission of the conditioned verbal responses. If the fundamental distinguishing characteristic of verbal behavior is its reinforcement through the mediation of another person (Skinner, 1957), this emphasizes the particular relevance of another person as the source of positive reinforcement in conditioning speech in children who have lost it or never attained it.

Verbal behavior -- because it is subject to the kind of basic behavioral analyses Ferster and DeMyer (1961) present for non-verbal behavior and in addition plays such a crucial role in the development of social control (Ferster, 1961) -- would seem to provide a valuable opportunity for studying the ways in which the experimental manipulation of relatively simple responses is related to the
therapeutic manipulation of more complex behavior by the same techniques. The grouping of children in terms of their performance in the strictly controlled experimental environment might even provide a means of evaluating the effects of such therapy. It would at least provide a basis for comparisons now meaningless because of inexactness of diagnostic labels. Such basic data might ultimately prove far more valuable than the current diagnostic categories in deciding how best to apply the techniques of operant conditioning to the treatment of a given individual.

Summary

Operant conditioning techniques were applied to the vocal and verbal behavior of 2 young hospitalized boys, one having no speech and the other very little. With the first child, it was possible to condition vocalization rate and to shape a small vocabulary by reinforcing successive approximations to words, but not to gain discriminative control over word emission. With the second child, it was possible to use a social reinforcer to condition speech and to gain discriminative control over a variety of responses.

We discussed some uses of reinforcement to control broad aspects of these children's behavior concurrent with the experimental manipulation of the responses with which we were primarily concerned. We considered issues related to the generalization of conditioned behavior from the experimental to the extra-experimental environment. Our results were discussed with particular reference to Ferster and DeNoyer's behavioral studies of autistic children. The parallels between their findings and ours, evident in spite of large differences in the responses and the children involved, suggest that the techniques for controlling operant behavior may cut across present diagnostic categories and play a valuable part in the assessment and treatment of many types of children.
References


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*Experiential Sessions 3 through 113.*

Reinforcement Contingencies For

**Table I**
Fig. 1. Reliability for timing of vocalization from tape recordings. Left part of figure shows typical agreement between 2 well-practiced observers, for cumulative vocalization in the first 20 minutes of EXP 61 with C-1. Right shows typical intra-observer reliability for one of the observers for the first 20 minutes of EXP 6 with C-2.
Fig. 2A. Cumulative seconds of vocalization for the first 20 minutes of EXP 5, 9, and 33 for C-1. Fixed-ratio reinforcement schedules are indicated at the points where they went into effect.

Fig. 2B. Cumulative seconds of vocalization for the first 20 minutes of EXP 57, 64, and 83 for C-1. Fixed-ratio reinforcement schedules are indicated at the points where they went into effect.
Fig. 3A. Cumulative seconds of vocalization for the first 20 minutes of EXP 3, 5, and 6 for C-2.

Fig. 3B. Cumulative seconds of vocalization for the first 20 minutes of EXP 7, 11, and 13 for C-2.