

THE ROLE OF VERBAL BEHAVIOR IN HUMAN LEARNING:  
III. INSTRUCTIONAL EFFECTS IN CHILDREN

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Lever pressing of children from three age groups (2½ to 4, 5 to 6½, and 7½ to 9 years) could produce reinforcers according to a fixed-interval 40-s schedule: (1) Some were instructed to respond at a high rate, others at a low rate, and (2) they were subsequently taught to provide their own spoken self-instructions consonant with the earlier, experimenter-supplied instructions. All subjects who received high-rate instructions responded at a steady, high rate, which was maintained following self-instructional training. The effects of low-rate instructions were directly related to the age of the children. The two older groups produced low-rate patterns, with the oldest children responding at very low rates; effects were least noticeable in the youngest age group. Following self-instructional training, all three groups showed adult-like low-rate behavior and the oldest children showed an improved ability to estimate the interval length. The results provide further evidence of the importance of language as a determinant of human behavior.

*Key words:* verbal behavior, instructions, self-instructions, developmental differences, fixed interval, postreinforcement pause, response rate, lever press, children

When human adults perform on fixed-interval (FI) schedules of reinforcement, they typically respond in one of two ways, neither of which resembles the pause-respond or "scalped" pattern characteristic of animals: Their behavior shows either a constant *high-rate* pattern with little or no postreinforcement pausing (Baron, Kaufman, & Stauber, 1969; Buskist, Miller, & Bennett, 1980; Lippman & Meyer, 1967; Weiner, 1962, 1969, 1970) or a *low-rate* pattern in which, for the most part, only one response is made per interval just after reinforcement becomes available (Buskist, Bennett, & Miller, 1981; Buskist et al., 1980; Lippman & Meyer, 1967; Weiner, 1964). In a recent study by Lowe, Beasty, and Bentall (1983), however, 2 infant subjects performed on FI schedules and showed scalped patterns of responding very similar to those obtained from animal subjects (cf. Ferster & Skinner, 1957; Richelle & Lejeune, 1979; Zeiler, 1977). The performance of the infant subjects also varied with the

schedule parameter in a manner consistent with the animal data. (Although in biological terms humans are animals, the term "animal" is used in the papers in this series to refer exclusively to nonhuman species.)

In a subsequent study, Bentall, Lowe, and Beasty (1985) investigated the FI performance of subjects ranging from 7 months to 9 years of age. Again, infant subjects showed animal-like performance, whereas subjects of 5 years or older produced either the low-rate or the high-rate patterns characteristic of human adults. Subjects in an intermediate 2½ to 4-year-old group produced neither adult-like nor animal-like patterns of responding, but a highly variable, uneven pattern that showed elements of both forms of responding. These studies lend support to the hypothesis that the development of verbal repertoires greatly alters human operant performance, and that this accounts for many of the differences found between animal and human learning (cf. Lowe, 1979, 1983). These findings are also consistent with research into the development of verbal self-regulatory skills in children, which suggests that the capacity to "regulate" behavior by means of speech is not well developed before the third or fourth year of life (Fuson, 1979; Luria, 1981; Vygotsky, 1962).

Several studies have shown instructions to be an important determinant of operant be-

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Table 1

Age in years and months, of individual subjects in each of the experimental conditions (F = female, M = male).

Group	Conditions					
	Low-rate instructions			High-rate instructions		
	Sub- ject	Sex	Age	Sub- ject	Sex	Age
7½-9 years	BN	F	9.0	HW	F	8.1
	CR	F	7.8	MP	M	8.2
	GL	M	8.0	LR	M	8.2
5-6½ years	CH	F	5.7	BP	M	6.1
	TH	M	6.2	TL	F	5.7
	GD	M	5.6	JS	F	5.4
2½-4 years	GH	F	4.0	ES	F	3.3
	JA	M	3.5	CA	F	3.2
	KE	M	2.10	AN	M	3.4

havior in both human adults and children (Baron et al., 1969; Buskist et al., 1981; Catania, Matthews, & Shimoff, 1982; Holland, 1958; Kaufman, Baron, & Kopp, 1966; Lippman & Meyer, 1967; Lovaas, 1961, 1964; Weiner, 1970). According to Vygotsky (1978), a child's performance under the instructional control of an adult may be an indicator of future behavioral development, and he used the term "zone of next development" to denote the range of activities that a child is able to carry out if given instructions, but otherwise cannot. Vygotsky's account suggests that if a child's verbal self-regulatory skills are in the process of developing, though not yet fully acquired, then appropriate instructions to the child may produce a performance that is characteristic of older children or adults. A principal aim of the present experiment was to test this prediction and to investigate how instructions affect the operant performance of children of different ages.

The present study also investigated how training children of different ages to "self-instruct" affects their performance on schedules of reinforcement. The work of Meichenbaum and others on self-instructional training suggests that a child's self-directed speech may come to affect related nonverbal behavior (Meichenbaum, 1977; Meyers & Craighead, 1984; Yussen, 1985).

With respect to performance on FI schedules, the relevant instructions to employ were those most likely to produce either the high-rate or the low-rate patterns of responding

observed in human adults. Such instructions, of necessity, would have to be phrased in such a way as to be comprehensible to the child. Verbal reports of subjects in the experiment carried out by Bentall et al. (1985) provided clues as to how appropriate instructions might be phrased. For example, when questioned about the availability of reinforcement, one of the older children who produced the low-rate pattern reported that the puppet figure who delivered the reinforcer to him "went to sleep" for a short while after making his appearance. On the other hand, one of the older children who showed the high-rate pattern reported that she had to "press as fast as possible" during the interval.

## METHOD

### Subjects

The subjects in the experiment were in three age groups corresponding to the three oldest age groups used by Bentall et al. (1985); each group consisted of 3 boys and 3 girls. Those of Group 1 were between 7½ and 9 years of age, with a mean of 8 years 2 months at the beginning of the experiment. The children of Group 2 were between 5 and 6½ years of age with a mean of 5 years 8 months. The children in Group 3 were between 2½ and 4 years of age, with a mean of 3 years 4 months. The ages of individual subjects at the beginning of the study are given in Table 1.

The subjects were recruited from a local school and a local nursery group. Half the children in each age group were randomly assigned to the *low-rate condition*, in which they received low-rate instruction followed by training in self-instruction, and half were assigned to the *high-rate condition* with analogous high-rate instructional and self-instructional interventions. There was one constraint on the randomization procedure, namely, that there be either 2 girls and 1 boy or 2 boys and 1 girl in each condition at each age range.

### Apparatus

The experiment was conducted in the psychology laboratories at the University in a room that had been decorated with posters of cartoon characters. The apparatus was identical to that employed by Bentall et al. (1985) with children over the age of 2½ years. The children sat at a table in front of a large

wooden screen near the center of which was mounted a vertical column of 10 colored lights that could be illuminated in sequence from bottom to top, the entire sequence taking 8 s. To one side of the column of lights there was a translucent acrylic screen (28 by 20 cm) on which slides could be back-projected. The slides used were in story sequences and depicted cartoon characters such as Winnie the Pooh, Donald Duck, and The Lone Ranger. Slide projection was accompanied by pop music played on a tape-recorder behind the screen. On the other side of the column of lights was mounted a black plastic tube through which snack items could be dropped by a glove puppet, "Sooty," into a tray on the table; "Sooty" was operated by the experimenter who remained out of sight behind the screen. A lever was mounted on a small console in the middle of the table and could be operated by a force of 6.7 N, producing an audible click. The experiment was controlled by, and data were recorded on, an Apple II® microcomputer situated behind the wooden screen.

#### *Procedure*

After familiarizing a child with the experimental room, the experimenter set up an FI 40-s schedule on the computer and sat by the subject's side. On this schedule the first response occurring 40 s or more after the previous reinforcement, was reinforced.

*Instructions.* In the case of children in the low-rate condition, the experimenter then said, "Watch what happens when I press this lever," pressed the lever, and received a reinforcer. When at least 40 s had again elapsed, he suggested to the child that he or she press the lever. When the child pressed the lever, reinforcement occurred. The experimenter then said, "Now try again." Because a reinforcer had just been delivered, the child's second response invariably was not reinforced. The experimenter explained this in the following manner: "Look, nothing happened. Sooty didn't come to see you. That's because, after he came to see you he had a rest and went to sleep. You mustn't press the lever when he's asleep as that'll wake him and he doesn't like that. You must wait until he's awake. . . . Do you think he's awake yet? . . . I think he's awake. You can press now." The experimenter then talked the subject through the next response in a similar fashion. After

this, he told the child he would be going behind the screen and that he/she would have to do everything without the experimenter's help. For the next five intervals, the experimenter called, "Not yet, Sooty's still asleep," if the subject pressed too early, and "Do you think Sooty's awake now?" if the subject was more than 10 s late. No further instructions were given.

The high-rate subjects were instructed in a similar manner except, in their case, the subjects were told that the reason Sooty failed to appear was that he was lazy, and that they had to press the lever many times to make sure he woke up. During the first five intervals after the experimenter went behind the screen, the subject was prompted to press faster if he stopped responding. This happened on only two occasions.

Subsequent sessions for subjects in both conditions were begun by reminding the subjects of their instructions. This was done by asking them, "What do you have to do to make Sooty come and see you?" In all cases the subjects were able to state some version of the contingency that had previously been described to them and it never was necessary to give additional instructions.

The instructed subjects were exposed to the FI 40-s schedule for five sessions during which, by inspection of the cumulative records, it was ascertained that the performances of all of the subjects had stabilized. Indeed, in most cases (but see Figure 2) the pattern of behavior altered little from the first session onwards. Each session typically lasted for approximately 10 to 15 min and was terminated when the experimenter judged the child to be tired or to require a rest from the task. Sessions were usually carried out daily, on weekdays only, although in some cases two sessions were conducted with a subject in one day; when this happened, there was an interval of 4 to 5 hr between sessions.

*Self-instructional training.* Having completed the *instructions* phase, the children began the self-instruction training sessions. In the first training session, the subjects in the high-rate condition were all taught by modeling and explicit instruction to say "Faster, faster," while pressing the lever. In the case of all subjects in the two oldest groups, 7½ to 9- and 5 to 6½-year-olds, and 1 child (GH) in the youngest group, the subjects were then

tested on the FI schedule. The other 2 children in the youngest group, however, seemed to find the self-instruction task aversive; it was only after two additional training sessions and much encouragement that they self-instructed consistently.

In their initial sessions of the low-rate self-instruction condition, the children in the two oldest groups were told to count aloud to 40 or 50 (with the number assigned on the basis of the individual subject's counting speed) before pressing the lever. This was sufficient to produce overt counting during additional sessions on the reinforcement schedule alone. Unfortunately, none of the children in the 2½ to 4-year-old group had sufficient counting skills to allow them to perform the self-instructional task that was mastered easily by the older subjects, and when asked to count, they all seemed to find the procedure highly aversive. Having failed to teach these subjects the counting strategy, it was decided to teach them to "sing-and-press." This began with a "sing-song" period during which the experimenter prompted the child to sing various nursery rhymes. Each subject was then taught to sing a particular song before pressing the lever. This was done by a combination of shaping (with praise as the reinforcer), modeling, and explicit instruction. When the subjects appeared to have learned the strategy, which took a number of sessions, the experimenter withdrew behind the screen, leaving the child to respond alone for the remaining sessions.

Following self-instructional training, each child was exposed to the FI 40-s schedule for three sessions, with no further interventions from the experimenter. In the case of all subjects, performance was stable across the three sessions and there was no change in patterning from the first to the third session. Most sessions were tape recorded.

## RESULTS

Figure 1 shows individual cumulative records from the first session of performance on the FI 40-s schedule for subjects in the 7½ to 9- and 5 to 6½-year-old groups. This shows that even in the first intervals of the first session the effects of instructions were considerable. All subjects in the high-rate condition responded at high rates throughout the inter-

val; those in the low-rate condition responded only once or twice in each interval. These patterns of responding changed very little in subsequent sessions.

The cumulative records in Figure 2 show the development of performance of the 2½ to 4-year-old children over the first two sessions on the FI schedule. Again, there were marked differences between the performance of subjects in the high-rate and those in low-rate conditions and these differences were present at the beginning of the first session. By the end of the second session, however, the behavior, particularly of low-rate subjects, had altered. All 3 subjects given high-rate instructions continued to respond at high rates or, as in the case of Subject GH, even increased their rate of responding. By the end of the second session, the low response rates shown by subjects in the low-rate condition had given way to higher rates of responding, this being particularly true for Subjects CA and AN, although rates were still considerably lower than for subjects in the high-rate condition. This departure from the low-rate pattern occurred in spite of the children's reporting that they knew they had to wait after reinforcement and their obvious attempts to wait before responding on the manipulandum (see below).

The final form of responding on the FI 40-s schedule for the children in the 7½ to 9-year-old group is shown in Figure 3, which presents cumulative records obtained from the final session in both the instruction and self-instruction phases of the experiment. (In the case of this and subsequent figures, it should be noted that the cumulative records that were obtained from the final session of the self-instructional condition are representative of performance on the first through the third session, inasmuch as patterning was stable throughout.) For comparison purposes, and to show how children who received no instructions about the reinforcement conditions performed on this schedule, the figure also contains equivalent cumulative records of 3 children of the same age, taken from the study by Bentall et al. (1985); these records show the two characteristic patterns of FI responding, high-rate and low-rate, found in human adults.

Thus, all subjects in this age group who were given the high-rate instruction showed the high-rate pattern; all those given the low-

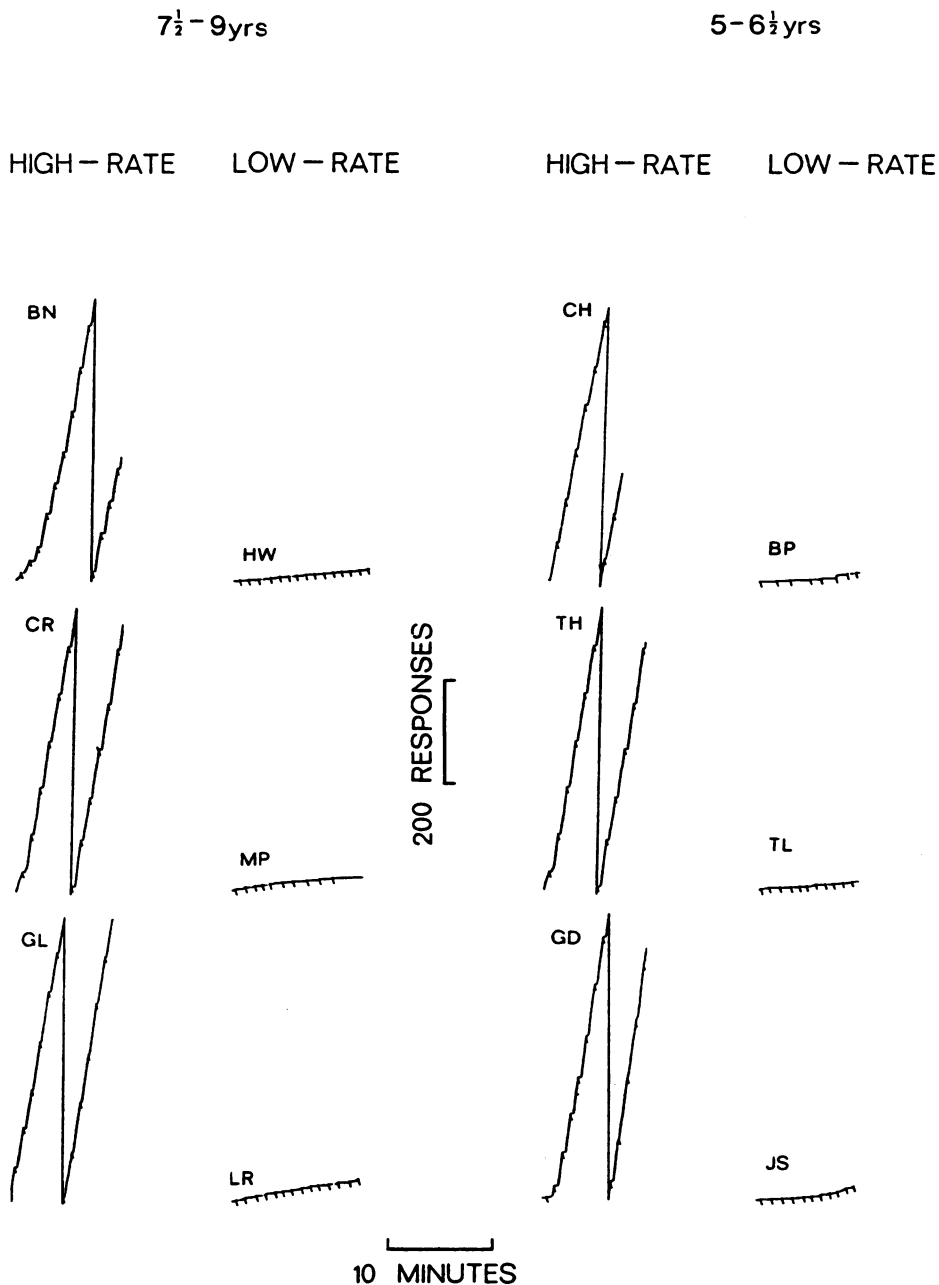


Fig. 1. Cumulative records of lever-press responding for  $7\frac{1}{2}$  to 9- and 5 to  $6\frac{1}{2}$ -year-old subjects in the high-rate and low-rate conditions, from the first session on an FI 40-s schedule. In the case of this and subsequent figures, each cumulative record portrays an entire session.

rate instruction showed the low-rate pattern. The records show that there was little difference between behavior during instruction and self-instruction phases. This is particularly true for the children in the high-rate condi-

tion, who were probably responding as fast as they could in the instructions phase. However, in the case of the low-rate subjects, all 3 children considerably overestimated the interval length in the instructions phase; the effect of

2½-4yrs

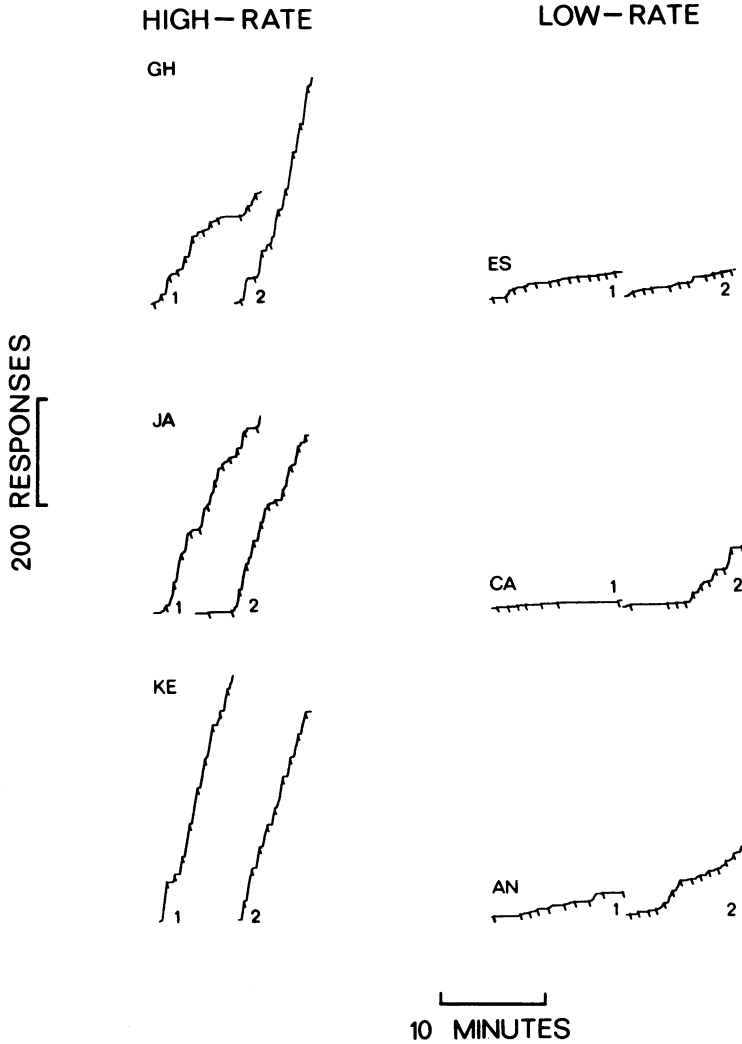


Fig. 2. Cumulative records of responding for the 2½ to 4-year-old children from the first two sessions on an FI 40-s schedule. The number adjacent to each record indicates the session from which it was obtained.

the self-instructions was to increase the frequency of responding such that responses typically occurred just after the end of the interval (see also Figure 6).

Figure 4 shows cumulative records for the 5 to 6½-year-olds. The three comparison records, taken from Bentall et al. (1985), were produced by 3 children of similar age on the same schedule of reinforcement but who had received no experimental instructions; all 3 showed the low-rate pattern.

The effects of instructions and self-instruction on the performance of 5 to 6½-year-olds were very similar to those reported for children in the oldest group, with the form of response patterning being determined by the form of instructions. One difference between these and the older children, however, was in the low-rate condition, where the effect of instructions did not result in the 5 to 6½-year-olds greatly overestimating the interval length; as a consequence, there was little difference

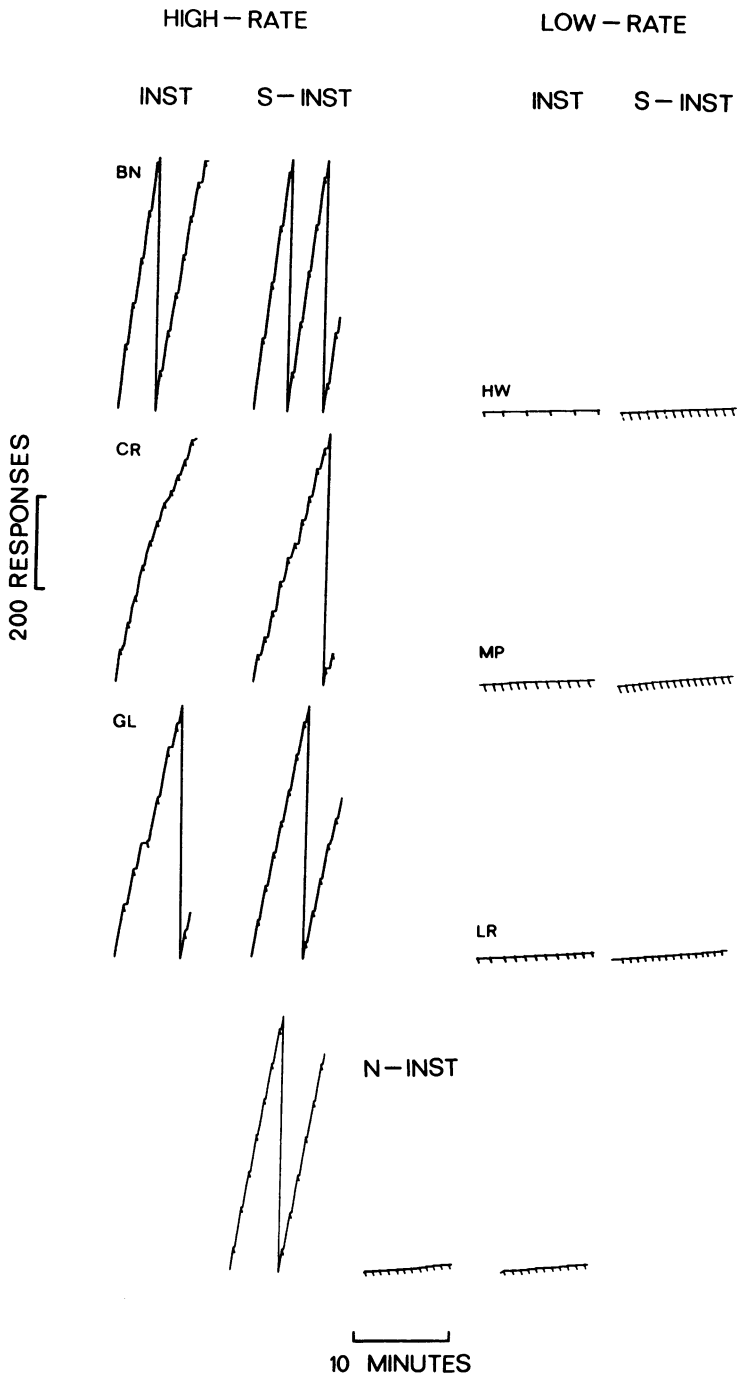


Fig. 3. Cumulative records of responding for each child in the 7½ to 9-year-old group on an FI 40-s schedule, during the fifth session following instructions (INST) and during the third session following subsequent self-instructional training (S-INST). Also shown are records from three 7½ to 9-year-old children who performed on the same schedule but without instructions (N-INST), from Bentall et al. (1985). All records are from the final session on each experimental condition.

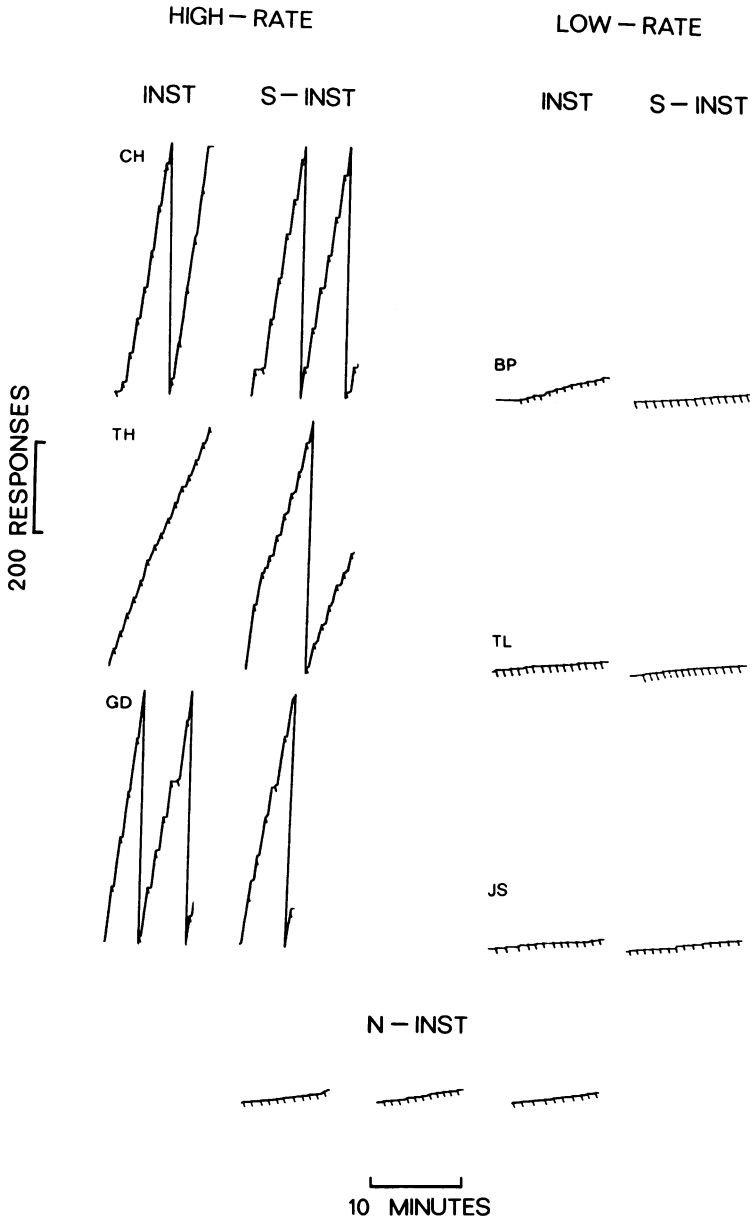


Fig. 4. Cumulative records of responding for each child in the 5 to 6½-year-old group. Also shown are records from three 5 to 6½-year-old children who performed on the same schedule but without instructions (N-INST), from Bentall et al. (1985). All records are from the final session on each experimental condition.

between the performance of these subjects during the instruction and self-instruction phases.

Cumulative records for children in the 2½ to 4-year-old group are presented in Figure 5, which also shows comparison data from noninstructed subjects of similar age (from Bentall et al., 1985). These comparison rec-

ords display response patterning typical of that obtained from children of this age on FI schedules, which is very different from the performance of the older children. Responding is variable from one interval to the next and there are elements of both animal- and human adult-like FI behavior in the records. The high-rate instructions produced a high-



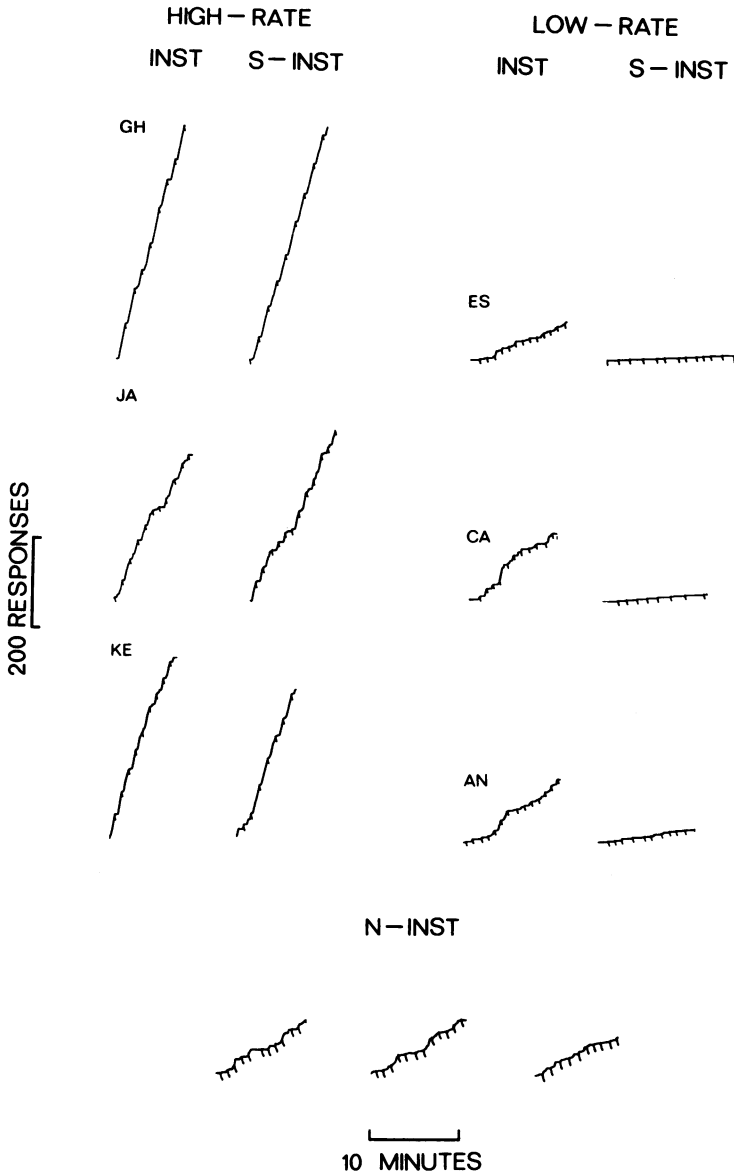


Fig. 5. Cumulative records of responding for each of the children in the 2½ to 4-year-old group. Also shown are records from three 2½ to 4-year-old children who performed on the same schedule but without instructions (N-INST), from Bentall et al. (1985). All records are from the final session on each experimental condition.

rate pattern in each of these 3 youngest subjects and this pattern persisted in the self-instruction phase. This form of responding was very different from that observed in noninstructed subjects of similar age and in the children given the low-rate instructions. There was little if any difference between the behavior of children given instructions in the low-rate condition and the behavior of the

noninstructed children of the same age, reported by Bentall et al. (1985). In contrast, the addition of the special self-instruction strategy, "sing-and-press," developed specifically for these children, resulted in a constant low-rate performance similar to that of older children. Thus, despite the ineffectiveness of instructions alone, the effect of self-instructions was to produce behavior that, at least in

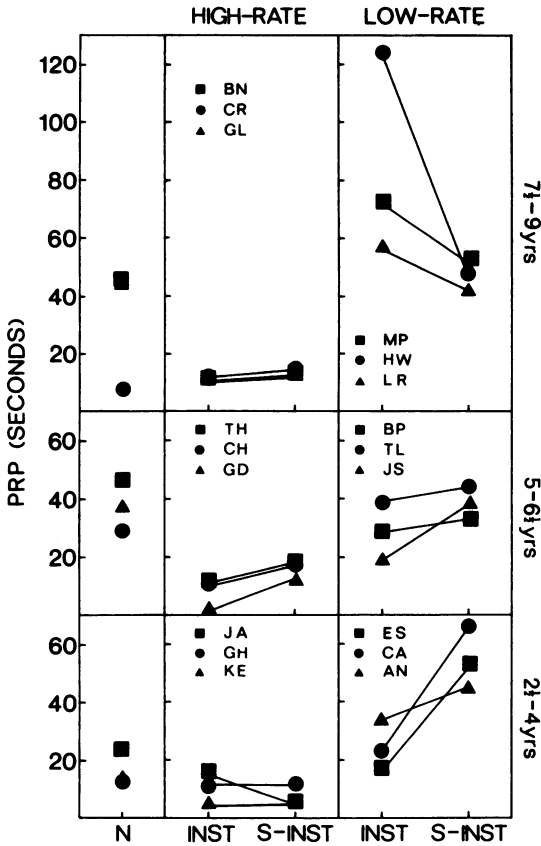


Fig. 6. Mean duration of postreinforcement pause (PRP) for children in instructions (INST) and self-instruction (S-INST) conditions. Also shown (N) are data for children who received no instructions (from Bentall et al., 1985). Data are from the last three sessions of the instruction and no-instruction conditions and from all three sessions of the self-instruction condition; performance was stable across the three sessions of each condition.

general characteristics, was similar to that produced by adults but that was markedly different from that produced by uninstructed children of the same age.

Apart from their lever pressing, the other behavior, both verbal and nonverbal, of the 2½ to 4-year-old children in the low-rate condition was different from that of the other subjects. The overt speech of those in the older groups was largely confined to repetition of the taught self-instructions, and this was also true of the youngest group in the high-rate condition who tended to concentrate on pressing the lever as fast as possible. On the other hand, those 2½ to 4-year-old children who were in the low-rate instruction condition

emitted by far the greatest amount of incidental verbal behavior, some of it in an apparent attempt to wait out the interval before responding. For example, following reinforcement, Subject ES sometimes placed her hands together, as if in prayer, and rocked from side to side saying "Tick-tock, tick-tock" in imitation of a clock. This apparent attempt to mediate the interval was unsuccessful, however, because she increasingly spent less and less time in rocking, until it only lasted for a few seconds, before she would break off and press the lever. She would also call "Now. Now. Now." or "Yes. Yes. Yes." in time with lever pressing even though no reinforcer was forthcoming. Similarly, Subject CA would call out "Sooty's awake" before responding. Verbal behavior of this type usually would occur at the end of a short period of waiting and at the beginning of a burst of responding. In addition to these task-related verbalizations, these 2 subjects also emitted a variety of vocalizations including singing, laughing, squealing, and other remarks addressed to the glove-puppet or to nobody in particular. The third subject in this group was generally much less talkative than the other 2 and emitted much less verbal behavior in the course of the experiment. All 3 children in the low-rate group, however, unlike the other children, spent a great deal of time running and walking around the room and exploring different areas.

An overall picture of how responding was affected by instructions and self-instruction is provided by Figure 6, which shows the average duration of the postreinforcement pause (i.e., the time from reinforcement to the first response in the next interval) for each subject. Data from noninstructed subjects, from Bentall et al. (1985), have also been included for comparison. Taking first their performance in the instructions phase, pause durations were longer in the low-rate than in the high-rate condition and this effect was strongest in the older children. An effect of self-instructional training was to decrease the pause duration of the 7½ to 9-year-olds in the low-rate condition to a value that more closely approximated the 40-s FI requirement. Self-instruction also resulted in a closer approximation of postreinforcement pause to schedule value in the 5 to 6½-year-olds, although in this case the pauses increased in duration. There also were substantial increases in pause length for all 3

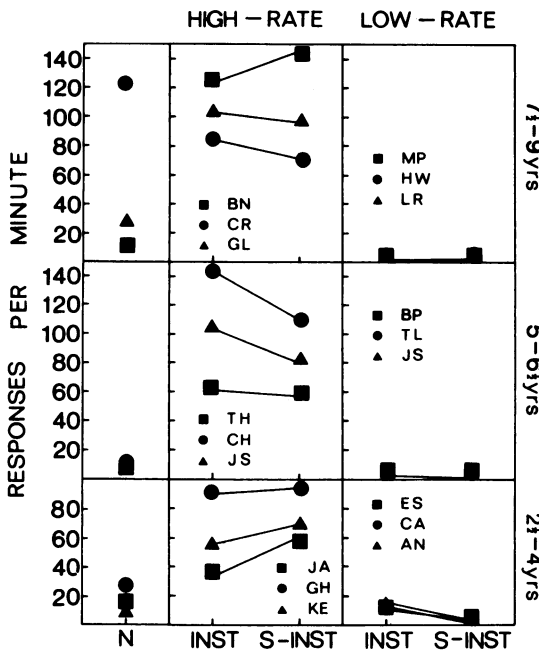


Fig. 7. Overall rates of responding for children in instructions (INST) and self-instruction (S-INST) conditions. Also shown are data for children who received no instructions (from Bentall et al., 1985). Data are from the last three sessions of the instruction and no-instruction conditions and from all three sessions of the self-instruction condition.

youngest subjects in the low-rate condition. However, in the case of the 2½ to 4-year-old children in the high-rate condition, self-instruction had comparatively little effect on responding because, perhaps, pause duration was already very short for all subjects.

The very marked effects of instructions on overall rates of responding are shown in Figure 7; comparison data from Bentall et al. (1985) have also been included. In every case response rates were higher for subjects given high-rate instructions than for those given low-rate instructions; this was true at all age levels. Self-instructions did not appear to have any consistent effect on the performance of subjects in the high-rate condition, although there is some evidence of a decline in the response rate of the 5 to 6½-year-olds after self-instructional training.

To show the effects of self-instructions on the response rate of subjects in the low-rate groups, it is necessary to rescale the right-hand column of Figure 7. Thus, Figure 8 shows consistent effects within each age group,

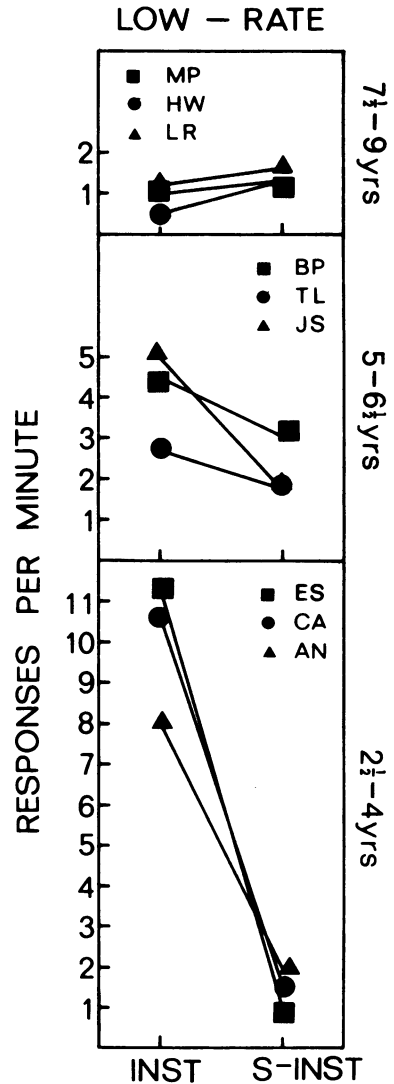


Fig. 8. Overall rates of responding for children given low-rate instructions and self-instructions, rescaled data from Figure 7.

though the direction of effect varied across groups. Self-instructional effects were greater in the 2½ to 4-year-olds, reducing response rates considerably. Following self-instructional training, there was also a consistent, though less marked, reduction in the response rates of the 5 to 6½-year-olds but an increase in the rate of responding of the 7½ to 9-year-old children. These relationships mirror those shown in Figure 6 for postreinforcement pause.

## DISCUSSION

The children aged 5 years and upwards in the present experiment, unlike animal subjects, did not show a pause-respond or scalloped pattern of responding on the FI schedule. This is entirely consistent with the findings of other studies, which have shown that above the age of 5 years human FI performance bears little resemblance to that of animals and is most frequently characterized by either the low-rate or the high-rate response patterns (Bentall et al., 1985; DeCasper & Zeiler, 1972; Long, Hammack, May, & Campbell, 1958; Zeiler & Kelley, 1969). The present experiment, however, showed that which of these two patterns an individual child exhibited was dependent upon which form of experimental instructions he or she had received. The effects of instructions were very marked and, although these instructions were only briefly presented at the beginning of the first session, their effects persisted for the duration of the instruction condition which, in the case of most subjects, took from 5 to 7 days to complete.

Perhaps the most interesting findings came from the 2½ to 4-year-old groups. The earlier study, by Bentall et al. (1985), had shown that children in this age range do not show either of the two patterns that characterize the performance of older children and adults. The present results, however, show that high-rate instructions, given briefly in the course of the first session, were sufficient to produce the high-rate pattern in all 3 children and, again, these effects were maintained over the 5 to 7 days of the instruction condition. It would appear then that a simple verbal instruction, modeled on the verbal behavior emitted spontaneously by older children, may be sufficient to transform the pattern of operant behavior to the adult mode. This clearly exemplifies Vygotsky's (1978) concept of the "zone of next development," which recognizes the fact that although a child may have not yet reached a given behavioral stage (i.e., acquired a particular behavioral repertoire—in this case, adult-like patterns of schedule performance), he or she may do so if given appropriate instructions by an adult. The present results are also consistent with those of Bem (1967), who taught self-regulatory behavior to 3-year-old children and found that subsequent performance on a lever-pressing task resembled that of older children.

The 2½ to 4-year-old children who were provided with the low-rate instructions gave every indication in the early stages of the study that they tried to comply with the instructions but could not refrain from responding; consequently, there was no evidence that instructions affected their lever pressing in this condition. The "sing-and-press" self-instructional strategy that was then introduced did produce the low-rate pattern but it is important to note that none of the older children in this or previous studies spontaneously emitted verbal behavior of this type. The low-rate schedule pattern that subsequently emerged could be a simple response chain (i.e., sing-respond) and, therefore, it should not be concluded that these children's singing bore the same functional relation to lever pressing as did the verbal behavior of the older children.

The results obtained from the youngest children, and in particular their difficulties observed in the low-rate condition, are consistent with the findings of Luria (1959, 1961, 1981), who argued that verbal self-control skills normally do not develop fully until after the third and fourth years of life. According to his account, success in manipulating a child's self-regulatory activity before this age will depend upon the nature of the instructions and how they are integrated into the child's existing verbal repertoire. For example, in a study he reported in 1959, children were told to press a rubber bulb upon seeing a red light with the spoken instruction "Press"; when a blue light was presented they were told "Don't press." It was found that 3-year-olds responded in the presence of the red light but also that there was considerable responding when the blue light was on. Only children aged 4 and upwards could master the task. Other studies reported by Luria (1961) have also shown the ineffectiveness of instructions in enabling young children to inhibit, as opposed to initiate, behavior. On the basis of such evidence, Luria (1981) has proposed that for the 3-year-old, words are in the main "sympractical" (i.e., tied to particular acts), having an impellent function; thus the word "press," even though embodied within the instruction "Don't press," frequently results in an increase rather than a reduction in responding. The verbal processes that govern the planning and withholding of behavior develop later than the more direct stimulus

properties of words, which, typically, serve only to initiate behavior.

Another way of viewing the low-rate condition of the present experiment, particularly inasmuch as the children were instructed to "wait" during the fixed interval, is as a form of "delay-of-gratification" task in which subjects are required to wait, in this case 40 s, before responding to produce the reinforcer. In a number of studies, Mischel and his colleagues (Mischel, 1981; Mischel, Ebbesen, & Zeiss, 1972) have found that, in comparison to older children, those aged 5 years and younger have considerable difficulty in withholding behavior until a delay has elapsed. Also, they reported that during the delay many of these younger children seek to create distractions from the task and engage in varied verbal and nonverbal behavior, resembling in many respects the behavior of the children (particularly Subjects ES and CA) in the low-rate condition of the present study. Moreover, in a review of the literature on delay of gratification, Mischel (1981) reported that close observation of the actions and verbalizations made by children while they were waiting suggested that those who waited effectively were simultaneously engaged in complex self-instructions and covert behavior. Clearly, until children have acquired the skill of framing verbal descriptions of the contingencies, and rules for responding, their performance on delay tasks should differ markedly from children in whom these skills are already established. This evidence is consistent with the present findings and with those of Luria and Vygotsky.

The present study shows that verbal behavior can have powerful effects on the schedule performance of young children and can, almost immediately, transform the performance of 2½ to 4-year-olds so that it resembles that of older children and adults. The experiment thus represents a further test of the hypothesis that verbal behavior is an important factor in the transition from the animal-like operant behavior of human infants to the patterns characteristic of adult humans (Lowe, 1979; see also Skinner, 1984, p. 576). Of course, the present study cannot of itself "prove" that it is verbal repertoires, as opposed to other maturational or "cognitive" variables, that play the central transforming role. Rarely in the history of science has it

ever been the case that issues of such import have been resolved by a single experiment (Kuhn, 1970). But taken in concert with the other studies in this series, the work of Vygotsky and Luria, and the expanding literature on interactions between verbal and nonverbal operant behavior (e.g., Catania et al., 1982; Lowe & Horne, 1985; Lowe, Horne, & Higson, in press; Matthews, Catania, & Shimoff, 1985; Vaughan, 1985; Wearden & Shimp, 1985), the present study adds further weight to the case for the language hypothesis.

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