JOURNAL OF APPLIED BEHAVIOR ANALYSIS 2002, **35,** 375–389 NUMBER 4 (WINTER 2002)

EFFECTS OF STRATEGIC VERSUS TACTICAL INSTRUCTIONS ON ADAPTATION TO CHANGING CONTINGENCIES IN CHILDREN WITH ADHD

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This study examined the effects of two types of instructions on the academic responding of 4 children with attention deficit hyperactivity disorder. Tactical instructions specified how to distribute responding between two concurrently available sets of math problems associated with different variable-interval schedules of reinforcement. Strategic instructions provided a strategy to determine the best way to distribute responding. Instruction conditions were counterbalanced in an ABAB/BABA reversal design nested within a multiple baseline across participants design. Experimental sessions consisted of a learning session in which participants were provided with one type of instruction, followed by a test session in which no instruction was provided. The schedules of reinforcement were subsequently reversed during test sessions. When learning and test schedules were identical, the responding of all 4 participants closely matched the reinforcement schedules. When tactical instructions were provided and schedules were subsequently changed, responding often remained under the control of the instructions. When strategic instructions were provided, responding more quickly adapted to the changed contingencies. Analysis of postsession verbal reports indicated correspondence between the participants' verbal descriptions (whether accurate or inaccurate) and their nonverbal patterns of responding.

DESCRIPTORS: verbally controlled behavior, rules, attention deficit hyperactivity disorder, concurrent schedules, instructions

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Individuals with attention deficit hyperactivity disorder (ADHD) demonstrate difficulties both with following rules and with adapting to changing contingencies (Hupp & Reitman, 1999; Kollins, Lane, & Shapiro, 1997). In fact, Barkley (1998) hypothesized that poor rule governance may be a primary characteristic of children diagnosed with ADHD. Relatedly, these children often have problems with planning and adhering to goal-directed behavior, with describing past behavior, and with response flexibility (Barkley, 1998). These problems are often manifested in high levels of maladaptive behavior in the home and school and in social maladjustment and academic underachievement (DuPaul & Stoner, 1994). To date, almost no research has been conducted on verbal governance with children diagnosed with ADHD. More research is needed to deter-

This research was supported by a field-initiated research grant (H324C99083) from the U.S. Department of Education, Office of Special Education Programs and by the Vance Cotter Scholarship and Flescher Fellowship from the Ohio State University. The opinions expressed herein do not necessarily reflect the position or policy of the U.S. Department of Education. This research was part of a dissertation submitted by the first author in partial fulfillment of the requirements for the degree of PhD in the Special Education Program at the Ohio State University. We gratefully acknowledge the assistance of Sayaka Endo, Lorraine Stachler, and Sara Ernsbarger in conducting this study. We also thank Dorothea Lerman and the reviewers, whose thorough and helpful critique strengthened the manuscript.

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mine how instructions and contingencies affect the behavior patterns of these children so that more effective treatment options can be developed.

Behavior analysis has contributed a conceptual framework and experimental methodology for furthering understanding of how rules or instructions come to control behavior and their effects on subsequent responding. Skinner (1969) defined a rule as a description of a behavioral contingency or, more formally, as a contingency-specifying stimulus (CSS). Since Skinner's conceptual analysis, behavior analysts have categorized human operant behavior into two dichotomous categories, contingency-controlled behavior (CCB) and verbally controlled behavior (VCB). CCB is behavior that is established and controlled through direct contact with contingencies that operate in the environment (Catania, Shimoff, & Matthews, 1989), whereas VCB is defined as "A higher order class in which . . . self- or other-generated verbal behavior changes the likelihood of subsequent verbal and nonverbal behavior" (Catania & Shimoff, 1998, p. 98).

For a generalized instruction-following repertoire to develop, there must be a history of correspondence between instructions and the contingencies they describe. Once VCB is established, instructions are a ubiquitous and efficient means of influencing behavior. However, VCB may be less sensitive to changes in environmental contingencies than CCB is (Catania et al., 1989). Michael and Bernstein (1991), for example, compared shaped and instructed performance of children on a match-to-sample task. Children who were first provided with instructions acquired the task more quickly than the children who acquired it through contingency shaping. Yet, the performance of the former group took longer to adapt to new contingencies than did that of the latter group. One reason may be that compliance with specific instructions limits the variability of responding and thereby the extent to which the behavior contacts, and can be affected by (is sensitive to), altered nonverbal contingencies.

Joyce and Chase (1990) examined the role of instructions in affecting the relation between the variability of responding and its sensitivity to changing contingencies. Six college students were given either explicit or limited instructions to establish responding (button pressing) on a fixed-ratio (FR) 40 schedule. An unsignaled change to a fixed-interval (FI) 10-s schedule was implemented after stable responding was obtained across three experimental sessions. When no participants demonstrated responding that was sensitive to the changed schedules, they were instructed to respond variably and to notice how the computer was awarding points. The participants were then exposed to the previous schedules. The results indicated that the strategic instruction effectively increased the variability of responding of 5 participants, and all 6 participants showed response sensitivity to the unsignaled change.

In addition to instructions from others, the verbal behavior of individuals themselves can affect responding. Horne and Lowe (1993) examined the effects of verbal behavior on performance under concurrent schedules (i.e., choice responding). They conducted six experiments with adult subjects on responding under a series of multiple concurrent variable-interval (VI) schedules. Following each experimental session, the participants completed a questionnaire. The questionnaire was used to determine if the participants could describe the order of contingencies in effect and to determine if the participants had developed any performance rules. These data were compared to the participants' key presses during the sessions.

The results indicated that responding of less than half of the participants matched the concurrent reinforcement schedules. Most participants showed either undifferentiated responding, undermatching, overmatching, or bias. In each case, however, the different forms of responding closely corresponded to the participant's performance rule. Although this type of analysis cannot determine causality, the results suggest that an individual's verbal behavior plays an important role in influencing his or her nonverbal behavior.

The above findings have derived from basic research with arbitrary responses (e.g., button pressing), and most investigations of VCB have used typical adults as subjects (e.g., Catania, Matthews, & Shimoff, 1982; Galizio, 1979; Joyce & Chase, 1990; Matthews, Catania, & Shimoff, 1985; Shimoff, Matthews, & Catania, 1986; Wulfert, Greenway, Farkas, Hayes, & Dougher, 1986). Research on VCB has important implications for understanding the relation between instruction following and the development of behavior disorders, which are to a large extent diagnosed on the basis of poor rule governance. However, there have been few investigations of how instructions operate to influence the behavior of children with maladaptive behavior patterns (Hupp & Reitman, 1999; Reitman & Gross, 1996).

In the present investigation, therefore, we examined the effects of two types of instructions on response patterns during an academic task with a population of students who typically do not respond well to rules (i.e., children with ADHD). Tactical instructions specified an exact pattern of responding to obtain the most reinforcers with the schedule in effect. Strategic instructions specified a strategy by which the participants could determine the most advantageous pattern of responding. The first purpose of the study was to determine the effects of tactical versus strategic instructions on the allocation of responding between two academic tasks associated with concurrent schedules of reinforcement. Second, we investigated the history effects of tactical versus strategic instructions on schedule sensitivity when no instructions were provided and the contingencies changed or remained the same. Third, we examined the extent to which the participants' verbal behavior corresponded to the schedules in effect and to their nonverbal performance.

METHOD

Participants and Setting

Participants were 4 boys, each 10 years old, who met the diagnostic criteria for ADHD according to the *Diagnostic and Statistical Manual of Mental Disorders* (4th ed.; American Psychiatric Association, 1994). All of the participants attended a large urban area public elementary school and had been suspended from school or removed from the classroom for rule violations in the past school year. Only 1 participant (Greg) had been prescribed medication; he received 5 mg of methylphenidate at 12:00 p.m. each school day. The study was conducted in a vacant hallway of the school with only the experimenters and the student present.

Apparatus and Stimuli

The experimental task was conducted on a Dell computer (Inspiron® 3800 or 5000c) using a software program identical to one described by Neef, Bicard, and Endo (2001). The computer program was equipped to record the number of points obtained, the number of problems attempted, the number of problems completed accurately and inaccurately, and the cumulative time spent completing problems for each problem set. The computer program included a subroutine to calibrate the accuracy of the data collected, and recalibration was conducted at 1-month intervals.

The program provided a menu from which the experimenter selected math problems (e.g., levels of addition, subtraction, and multiplication) and VI schedules of reinforcement for task completion. Five to seven 3-min assessment sessions were conducted prior to the experiment to determine the type of problems the participants would be completing. During each session, the computer presented problems of the same level of difficulty and the same VI schedule for each problem set (i.e., VI 60 s). Problems varied in level of difficulty across each session (e.g., a session of single-digit addition, followed by a session of double-digit addition). Sets of problems that the participant could complete with an overall accuracy of 90% to 100% and at a rate of 10 to 30 problems per minute were chosen for the experimental sessions. Math problems chosen were single-digit multiplication facts 1 to 9 (i.e., 1 × 1 to 9 × 9) for Lenny and Bill and double-digit subtraction without regrouping for Kevin and Greg. For Kevin, these problems were changed to single-digit multiplication facts 1 to 6 on Session 31 at his request. Kevin wanted to change the problems because he was doing multiplication in his math class. The change in math problems did not produce any noticeable change in the session data.

During experimental sessions, two different-colored problems (one from each set selected from the menu) appeared on the left (Set 1) and right (Set 2) side of the monitor (choice screen). The choice screen displayed the cumulative number of reinforcers (points) obtained from each problem set under the respective problem. Once the student selected a math problem by pointing and clicking with a mouse, only the selected problem appeared on the screen along with a small clock that showed how much time was left to complete the problem. The problem remained on the screen until the participant entered the correct answer from the keyboard or the preset time of 30 s elapsed. After a correct response, or if the time ran out before the participant entered the correct answer, the choice screen appeared with two new problems. Following an incorrect response, the words "try again" appeared on the screen, and the computer presented the same problem with the clock reset. Differential auditory stimuli signaled reinforcer delivery for Set 1 and Set 2 problems. Problems completed correctly (initially or upon re-presentation following an error) were reinforced on a VI schedule as described below. Problems continued to be presented in this manner for the duration of the session.

Procedure

One to two sessions were conducted per day, 3 to 5 days per week. Each session included a 10-min contingency learning (CL) session (presented to the participants as a "practice session") during which participants were provided with an instruction for earning points while they responded to the two sets of math problems. This was immediately followed by a 5-min contingency test (CT) session during which no instructions were provided and each point earned was worth 10 cents. Money was chosen as the reinforcer (available only during contingency test sessions) to insure uniform quality of reinforcement and to control for satiation across experimental conditions.

Contingency Learning Sessions

Tactical contingency-specifying stimuli (TCSS). Before beginning each session, the experimenter read the following instruction to each participant:

> You are going to play a game on this computer where you can win points for working on two sets of math problems. Each point you win will be worth 10 cents. The computer will show you how many points you have won for each set. Before we begin the game, I want you to practice so you can win the most money when you play. The best way to win the most points is for you to spend about [number] seconds

> on Set 1 problems, and then about [number] seconds on Set 2 problems, switching back and forth. The clock at the bottom of the screen is set at 30 seconds; this will help you keep track of time you spend on each set. Tell me the best way to win the most points.

Strategic contingency-specifying stimuli (SCSS). Before beginning each session, the experimenter read the following instructions to each participant:

> You are going to play a game on this computer where you can win points for working on two sets of math problems. Each point you win will be worth 10 cents. The computer will show you how many points you have won for each set. Before we begin the game, I want you to practice so you can win the most money when you play. Sometimes you will need to spend more time on Set 1 than on Set 2, and sometimes you will need to spend more time on Set 2 than on Set 1. The best strategy is to try a few problems from each set until you notice how the computer is giving you points. Then spend the most time on the side that is giving you the most points. The clock at the bottom of the screen is set at 30 seconds; this will help you to keep track of time you spend on each set. Tell me the best way to win the most points.

After reading either type of instructions, the experimenter asked the participant to repeat the instructions. If the participant did not state key elements of the specified instructions, the experimenter repeated them. If the participant continued to ask questions or attempted to evoke information at any time, the experimenter repeated the instructions regarding the best way to respond and asked the participant to begin or to keep working.

Contingency Test Sessions

Same. The experimenter programmed the same schedules of reinforcement and math problems as in the CL session. Before each session, the experimenter read minimal instructions to each participant: "Now we will begin the game. Each point you win is worth 10 cents. It is up to you to figure out the best way to win the most points. Tell me what you are supposed to do." If the participant continued to ask questions, the experimenter repeated the instructions and asked the participant to begin. At the conclusion of each CT session, the experimenter thanked the participant and delivered the money earned. This condition was terminated when sensitivity estimates averaged 0.5 or greater across three consecutive CT sessions and responding across those three sessions differed by no more than 20 problems. For example, a condition would be changed if a values were 0.67, 0.48, and 0.73 (average = 0.63) and the number of problems completed were 45, 58, and 51 across three consecutive sessions.

Reversed. The procedure was identical to the same condition, except that there was an unsignaled reversal in the concurrent schedules of reinforcement. Similarly, the reversed condition was terminated when responding either approximated the relative rate of reinforcement under the reversed schedules or remained stable (a difference in responding of no more than 20 problems) across three consecutive CT sessions. For example, the conditions would be changed if sensitivity estimates were −0.55, −0.71, and −0.63 and the number of problems completed during those sessions were 35, 41, and 28.

Each time we changed the instructional conditions (e.g., from tactical to strategic) we also changed the concurrent schedules in effect (e.g., from VI 90 VI 60 to VI 15 VI 30). The goal of each change was to have the participant learn to match his responding to the relative rate of reinforcement of the new set of concurrent schedules and to see whether he adapted to the unsignaled reversal better with strategic instructions than with tactical instructions.

Postsession Verbal Reports

At the end of each CT session, the experimenter asked the participant, "Tell me the best way to win the most points." The experimenter recorded the participant's response on a data sheet.

Experimental Design

The design used for this study was an ABAB/BABA counterbalanced reversal design. Lenny and Greg first responded under TCSS conditions, and Kevin and Bill first responded under SCSS conditions. A prior SCSS condition had been conducted with Greg, but he rapidly alternated between problems, resulting in undifferentiated responding (data are not included). Kevin received a second exposure to the TCSS conditions, but those data could not be analyzed because he failed to obtain reinforcement on one alternative during many sessions.

The concurrent schedules were initially VI 90 s and VI 60 s for TCSS conditions and VI 15 s and VI 30 s for SCSS conditions during both CL and CT sessions. If responding appeared to be sensitive to the schedules, the CT schedules were reversed to VI 60 s VI 90 s for TCSS conditions and to VI 30 s VI 15 s for SCSS conditions. After obtaining stable responding (as described above), instructional conditions were changed and new schedules were programmed. Participants who were first exposed to TCSS conditions received SCSS and responded under concurrent VI 15-s VI 30-s schedules. Participants who were first exposed to SCSS received TCSS and responded under concurrent VI 90-s VI 60-s schedules. If responding appeared to be sensitive, the schedules were changed as described above during CT sessions.

TCSS and SCSS conditions were replicated in this manner with different schedules of reinforcement (VI 60 s VI 15 s for TCSS conditions and VI 30 s VI 90 s for SCSS conditions). The exception was Greg, who was exposed to VI 15-s VI 30-s schedules during the final SCSS condition (replicating the schedules during his first exposure to SCSS under which he had demonstrated undifferentiated responding).

Data Analysis

Nonverbal responding. According to matching theory, schedule sensitivity occurs when the relative frequency of responding (B) is equal to the relative frequency of reinforcement (R) (Pierce & Epling, 1999). Baum's (1974) generalized matching equation is expressed as

$$\log(B_1/B_2) = a \log(R_1/R_2),$$

where B_1 is the frequency of responding to Alternative 1 (i.e., Set 1 problems), B_2 is the frequency of responding to Alternative 2 (i.e., Set 2 problems), a is the sensitivity parameter, R_1 is the frequency of reinforcement for Alternative 1, and R_2 is the frequency of reinforcement for Alternative 2. A sensitivity parameter that approximates zero indicates undifferentiated responding and thus could be considered insensitive responding. Values in either direction toward 1.0 or -1.0 indicate greater sensitivity (1.0 = perfect matching, -1.0 = perfect undermatching). Values over 1.0 or under -1.0 indicate proportionally more responding to the alternative associated with either the richer or leaner schedule.

To assess sensitivity, Baum's (1974) equation was converted to

$$a = \log(B_1/B_2)/\log(R_1/R_2).$$

If sensitivity estimates were greater than 1.0 or less than -1.0, the data were recalculated—that is, $a = \log(R_1/R_2)/\log(B_1/B_2)$—to provide a clearer estimate of sensitivity. For example, if the original equation yielded a sensitivity estimate of 2 (i.e., the participant allocated two times more responding to the richer schedule in relation to reinforcement), the recalculation would yield a sensitivity estimate of 0.5. Complete session data for each participant can be obtained from the authors.

Verbal behavior. The participant's response to the question, "What is the best way to win the most points?" was recorded verbatim. The type of response given was then categorized as an accurate, inaccurate, or no rule. An accurate rule was recorded if the participant described time-based responding in relation to the contingencies in effect (e.g., "To spend more time on Set 1 problems than Set 2 problems"). An inaccurate rule was recorded if the rule was not an accurate time-based response (e.g., "To do as many problems as I can on Set 1"). No rule was recorded if the participant said, "I don't know." These descriptive data were analyzed according to the percentage of occurrence of each type of rule within each condition.

Nonverbal–verbal correspondence. A contingency space analysis was used to investigate nonverbal–verbal correspondence (Matthews, Shimoff, & Catania, 1987). A contingency space analysis is a set of conditional probabilities described as the interaction between $p(y/x_1)$ and $p(y/x_0)$, where p is probability, y is nonverbal responding, x_1 is an accurate verbal description of responding, and x_0 is an inaccurate description of responding. The participant's verbal description was compared to the computer-generated data for the number of problems completed and time allocation from each set at the end of the session. Positive do–say correspondence was recorded if the participant's verbal description closely approximated his nonverbal responding over the entire session. For example, if the participant said, "Spend about 60 seconds on Set 1 and then switch to Set 2 for 15 seconds and switch back and forth," and time allocation showed an approximate 1:4 ratio, positive correspondence was recorded (even if the description was not an accurate depiction of the reinforcement schedules). Negative do–say correspondence was recorded if the participant's verbal description did not reflect his nonverbal responding during the session (e.g., if the participant gave the verbal description above but time allocation showed a 2:3 ratio). Recordings were converted to ordinal data in which positive correspondence equaled 1 and negative correspondence equaled 0. Data closely approximating 1 indicate high correspondence and data at .5 or below indicate low correspondence.

Procedural Integrity and Interobserver Agreement

To obtain procedural integrity data for instruction conditions, a second trained observer simultaneously and independently completed an identical data sheet on 18% of the sessions across conditions and participants. Point-by-point interobserver agreement was 100%. For the reinforcement schedules, the experimenter reviewed the computer-programmed data for 100% of sessions across conditions and participants. Point-by-point agreement was 100%.

At the conclusion of the study, the experimenter reviewed the computer-generated data for responding and schedules of reinforcement for 100% of the sessions across conditions and participants and compared these to the data that had been entered. Point-by-point agreement was 100% for each participant across conditions.

Secondary observers also were trained to record verbal responses and to tact each type of description with 100% accuracy across three training sessions. On 18% of the sessions across conditions and participants, the second observer simultaneously and independently recorded the participant's response and reviewed the computer-generated data for nonverbal responding. Point-by-point agreement on transcription was 94% or greater for each participant. Agreements for description categories occurred if the two observers scored the same category of description (accurate, inaccurate, or no description). Point-by-point agreement was 100% for all participants with the exception of one disagreement for Kevin. A second observer scored correspondence data during 18% of the sessions across participants. An agreement was scored if the two observers recorded the same type of nonverbal–verbal correspondence. Point-by-point agreement was 100% across participants.

RESULTS

Figure 1 depicts schedule sensitivity estimates (*a*) for all participants. Table 1 shows rule occurrence percentages and probability of nonverbal–verbal correspondence across participants. For ease of comparison, results for sensitivity estimates are described by condition, independent of the counterbalanced order of presentation across participants. Nonverbal–verbal correspondence within these conditions is described to provide a context for interpretation of the possible effects of participant descriptions on performance.

TCSS. Results were similar for both the initial (concurrent VI 90-s VI 60-s schedules) and replicated (concurrent VI 60-s VI 15-s schedules) TCSS conditions. When CL and CT schedules were identical, all 4 participants' responding during test sessions showed a moderate to high level of schedule sensitivity. Mean sensitivity estimates for the last three CT sessions during the first and second TCSS conditions were 0.63 and 0.80 for Lenny, 0.60 and 0.55 for Greg, 0.77 for Kevin, and 0.79 and 0.74 for Bill (sensitivity estimates for the second TCSS condition could not be determined for Kevin because he failed to obtain any reinforcement for problems associated with the leaner schedule during several sessions). All of the participants provided an accurate description during all sessions of this phase with a high probability of nonverbal–verbal correspondence (.7 for Kevin and Bill, .8 for Greg, and 1 for Lenny during the first TCSS condition; 1 for Bill, Greg, and Lenny during the second TCSS condition).

When CL and CT schedules were reversed following the initial exposure to TCSS, Lenny, Kevin, and Bill continued to emit the same response patterns as when the schedules were identical. CL *a* values remained relatively high and stable, whereas CT *a* values dropped. Mean sensitivity estimates for the final three CT sessions were −0.64 for Lenny, −0.71 for Kevin, and −0.94 for Bill. Greg's responding during CL conditions deteriorated. Responding during CT sessions was variable. However, by the final three sessions, CL sensitivity estimates averaged 0.26, and CT *a* values stabilized at a low level ($M = -0.96$). Although Greg continued to respond in the same manner and to provide the same rule as in previous CT sessions (which no longer described the schedules), he often complained that he thought the computer was broken and that he did not want to practice. This may explain his deteriorating response patterns during CL sessions and indicates the influence of the previous instructions on his responding. All participants provided an inaccurate description on 100% of the sessions with a high probability of correspondence (1 for Brad, Lenny, and Kevin and .8 for Bill and Greg). This suggests a high level of control by the instruction.

When CL and CT schedules were reversed (in the second exposure), responding during CL sessions again showed clear differentiation from responding during CT sessions. CL sensitivity estimates were relatively

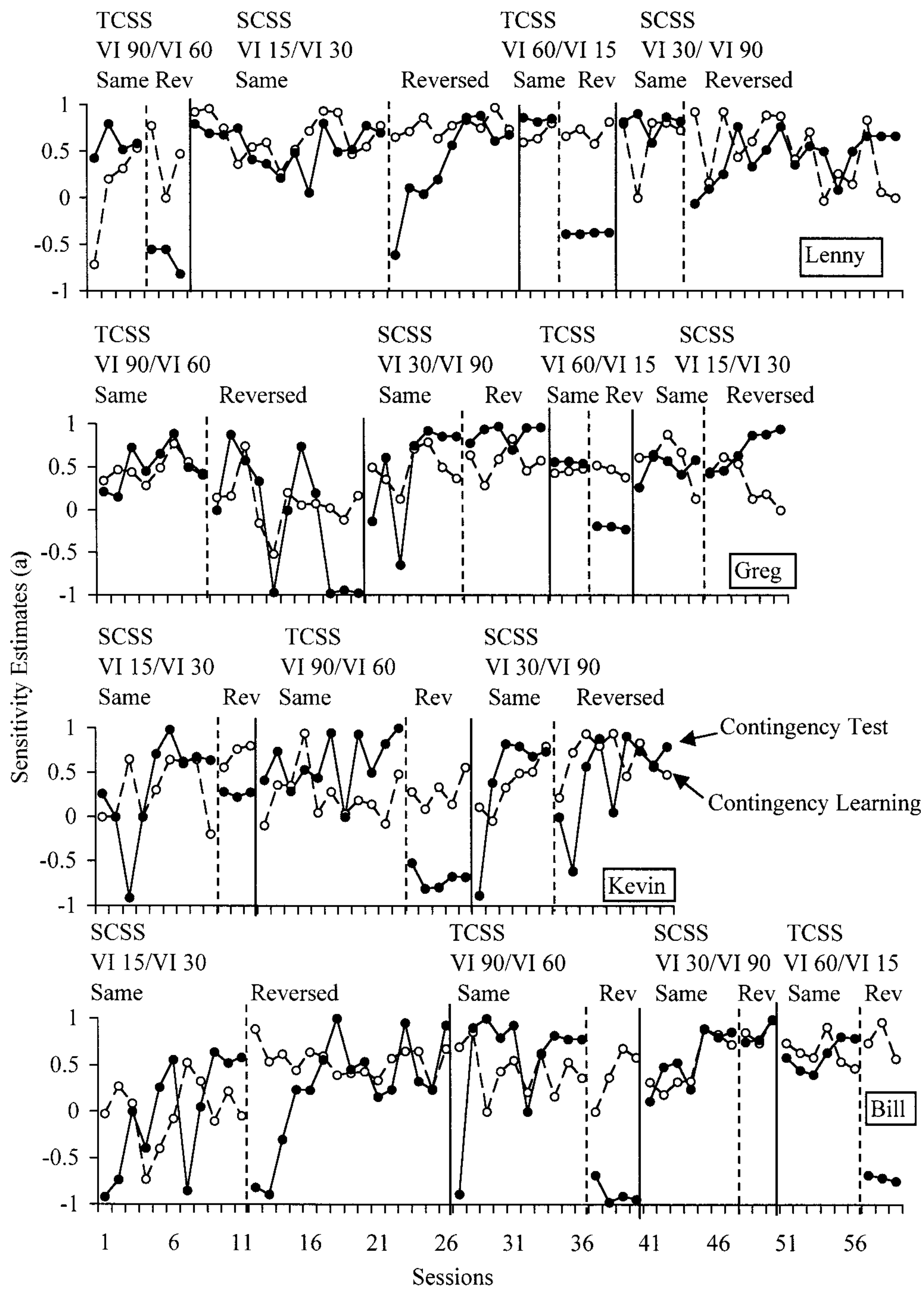

Figure 1. Reinforcement schedule sensitivity estimates (*a*) for Lenny, Greg, Kevin, and Bill during same and reversed schedule phases across tactical contingency-specifying stimuli (TCSS) and strategic contingency-specifying stimuli (SCSS) conditions. Open circles denote responding during 10-min contingency learning sessions (CL). Closed circles denote responding during 5-min contingency test sessions (CT). Variable-interval (VI) schedules are in seconds.

Table 1
The Percentage of Occurrence of Rules (%) and the Probability of Nonverbal–Verbal Correspondence (P of C) for Each Participant Across Experimental Conditions

		Condition							
		TCSS		SCSS		TCSS		SCSS	
Student	Rule	Same	Reversed	Same	Reversed	Same	Reversed	Same	Reversed
Lenny	Accurate								
	%	100	0	85	89	100	0	100	100
	P of C	1		.9	.6	1		1	.8
	Inaccurate								
	%	0	100	15	11	0	100	0	0
	P of C		1	1	1		1		
Greg	Accurate								
	%	100	0	100	100	100	0	100	100
	P of C	.8		.9	1	1		1	1
	Inaccurate								
	%	0	100	0	0	0	100	0	0
	P of C		.8				1		
Kevin	Accurate								
	%	100	0	70	100			84	100
	P of C	.7		.7	.7			1	.6
	Inaccurate								
	%	0	100	30	0			16	0
	P of C		.8	.7				0	
Bill	Accurate								
	%	100	0	27	80	100	0	100	67
	P of C	.7		.6	.7	1		1	1
	Inaccurate								
	%	0	100	73	20	0	100	0	33
	P of C		1	1	1		1		1

Note. "Same" indicates that CL and CT schedules were identical; "Reversed" indicates that CL and CT schedules were reversed.

high and stable, whereas *a* values during CT sessions dropped. None of the participants substantially changed response patterns to conform to the change in schedules; CT *a* values for the final three sessions averaged −0.37 for Lenny, −0.20 for Greg, and −0.71 for Bill. In addition, all the participants provided an inaccurate description on 100% of the sessions with a probability of correspondence of 1, suggesting a high level of verbal control.

SCSS. When CL and CT schedules were identical during both the first (concurrent VI 15-s VI 30-s schedules) and second (concurrent VI 30-s VI 90-s schedules) SCSS conditions, responding during test sessions came under the control of the schedules. Mean sensitivity estimates for the last three CT sessions for Greg, Lenny, and Kevin were 0.52 and 0.87, 0.66 and 0.75, and 0.63 and 0.73, respectively. Bill's responding during the first exposure showed high variability but stabilized by the final three sessions (M = 0.58). During the second exposure, his responding showed much less variability, with sensitivity estimates averaging 0.84 for the last three sessions.

Bill's verbal behavior data showed similar levels of variability in the first exposure. He provided an accurate description on 27% of the sessions and an inaccurate description on 73% of the sessions, with a probability of correspondence of 1. Lenny, Greg, and Kevin provided accurate descriptions on 85%, 100%, and 70% of the sessions, respectively, with a high probability of correspondence (.9 for Lenny, 1.0 for Greg, and .7 for Kevin) during the first exposure. In the replication condition, with the exception of one session for Kevin, all of the participants gave an accurate description on 100% of the sessions with a high probability of correspondence (1.0).

When CL and CT schedules were reversed in the first exposure, transition effects were evident for the first three to five test sessions for Lenny and Bill. CL sensitivity estimates were relatively high and stable, whereas CT *a* values dropped. However, each of the participants changed response patterns to conform to the change in schedules. Sensitivity estimates for the final three CT sessions averaged 0.67 for Lenny. Bill's responding again showed a high level of variability, but he did change response patterns; sensitivity estimates during the final three CT sessions averaged 0.26. Bill and Lenny gave accurate descriptions on 80% and 85% of the sessions (probability of correspondence = .7 and .6), respectively.

Greg's and Kevin's data showed little or no transition effects; that is, response patterns changed with the change in schedules. For Greg, CT *a* values averaged 0.67 for the final three sessions. For Kevin, *a* values averaged 0.58 for the three sessions in this condition. In addition, Greg and Kevin provided an accurate description on 100% of the sessions with a high probability of correspondence (.7 for Bill and 1.0 for Greg). Overall, the data from this phase suggest a high level of verbal control and schedule sensitivity for all participants.

When CL and CT schedules were reversed in the second exposure, Greg and Bill immediately changed response patterns (*M* sensitivity estimates = 0.87 for Greg and 0.83 for Bill). Lenny's and Kevin's responding during CT conditions showed clear transition effects for the first few sessions; however, by the final three sessions, *a* values averaged 0.66 for Lenny and 0.70 for Kevin.

With the exception of Bill, all of the participants provided an accurate description on 100% of the sessions with a high probability of correspondence (.8 for Lenny, .9 for Greg, and .6 for Kevin). Bill provided an accurate description on 97% of the sessions with a probability of correspondence of 1.0. These data suggest a high level of multiple control by the verbal and nonverbal contingencies.

DISCUSSION

Barkley (1998) predicted that children with ADHD would have difficulty following rules, especially those that specify time as a variable. These results do not support his predictions. However, the results do suggest differential effects of the type of instructions used to establish instructional control. Tactical instructions established behavior that was insensitive to changes in obtained reinforcement compared to strategic instructions. This was shown for the 4 participants in the first exposure and 3 participants in the second exposure. Thus, for Lenny, Greg, and, Bill, schedule-insensitive responding during both TCSS conditions was consistent with the results of much of the research on verbal governance (Catania et al., 1982, 1989; Hayes, Brownstein, Haas, & Greenway, 1986; Joyce & Chase, 1990; LeFrancois, Chase, & Joyce, 1988; Matthews et al., 1985; Shimoff et al., 1986; Wulfert et al., 1994).

One possible explanation is that a history of reinforcement for compliance with tactical instructions produced a pattern of responding that was unavailable for shaping by the subsequent change in schedules. A history of reinforcement for compliance with strategic instructions, on the other hand, promoted variability in responding that permitted more salient contact with, and discrimination of, changed contingencies (e.g., Joyce & Chase, 1990).

One implication, therefore, is that tactical instructions should be used during acquisition when strong rule control is desirable (e.g., "Don't talk to strangers," "Only cross the street when the light says 'walk' ") because they increase the probability that a response will persist even when contingencies in the natural environment are inconsistent. For example, research on teaching safety skills to children (e.g., Poche, Yoder, & Miltenberger, 1988), promoting classroom management (e.g., Barrish, Saunders, & Wolf, 1969), and recruiting teacher praise (e.g., Alber, Heward, & Hippler, 1999) has used tactical instructions. When successful performance requires sensitivity to changing reinforcement contingencies (such as those involving social interactions or frequent transitions), direct contingency shaping or strategic instructions may be most advantageous.

The participants in this study generally demonstrated verbal–nonverbal correspondence similar to participants in previous basic research (Catania et al., 1982; Horne & Lowe, 1993; Matthews et al., 1985). These results indirectly support applied research findings on the efficacy of correspondence training for teaching a verbally controlled repertoire to children with ADHD (e.g., Bryant & Budd, 1982; Huff & DuPaul, 1998; Paniagua, 1992; Shapiro, DuPaul, & Bradley-King, 1998). The results are also consistent with Horne and Lowe (1993), and suggest that a rule developed by an individual can have an important effect on his or her subsequent behavior even when the rule is not necessarily an accurate description of environmental contingencies. Therefore, it may be that the sensitivity of human behavior to contingencies is dependent upon the sensitivity of verbal behavior to the contingencies (Catania et al., 1989).

The study suggests several directions for future research. First, the study evaluated performance on an educationally relevant analogue task. As a bridge investigation, the goal was to determine the extent to which behavioral phenomena observed in basic research would operate in a similar manner with meaningful behaviors in a clinically relevant population under controlled conditions (Fisher & Mazur, 1997; Neef & Peterson, in press). The results suggest that further investigation with other target behaviors in the natural classroom environment is warranted. For example, patterns of behavior established through tactical or specific instructions might be examined in a classroom situation during natural transitions to other activities, environments, or teachers, when contingencies may change. In addition, the extent to which medication interacts with or affects sensitivity of behavior to strategic versus tactical instructions should be examined, given research suggesting the benefits of medication for core symptoms of ADHD (Multimodal Treatment Study Group, 1999; Murray & Kollins, 2000). Previous research has demonstrated interactive effects between methylphenidate and environmental variables in children with ADHD (Northup et al., 1997, 1999).

A comparison group also is needed in future research to determine the extent to which findings would differ for children without ADHD. Kollins et al. (1997), for example, used a concurrent-schedules arrangement to evaluate the extent to which the performance of children with and without ADHD was sensitive to changes in schedule parameters. Although conclusions were somewhat limited by few exposures to reinforcement schedules and low sensitivity estimates for all of the participants, the results suggested that the responding of children with ADHD was less sensitive to changes in reinforcement schedules than was the responding of children without that diagnosis. Therefore, a replication and extension of the present study with typically performing students may show differences in the extent of verbal control correlated with ADHD status.

Finally, basic research has suggested other variables that affect sensitivity of behavior to changing contingencies, such as the interaction of history and degree of correspondence between instructions and contingencies (Hackenberg & Joker, 1994), the use of punishment contingencies (Galizio, 1979), and delay of reinforcement (Lattal, 1984). Additional bridge studies are needed to examine these relations in socially relevant contexts.

The present study differed methodologically from basic studies in a number of ways. First, a limitation is that sessions were brief relative to those in most basic investigations of choice (Davison & McCarthy, 1988). On a number of occasions, Lenny and Kevin failed to obtain reinforcement for one alternative during test conditions. The use of longer test conditions may have increased the likelihood of contacting reinforcement and, thus, decreased the time needed to obtain stable responding.

Second, a changeover delay is often used to minimize switching between response options in basic studies. We did not use a changeover delay because it rarely occurs outside the laboratory (Pierce & Epling, 1999), and we sought to examine performance under conditions that might have analogues in the natural environment. However, use of this procedure may be indicated to induce sensitive responding by minimizing the type of high-rate switching exhibited by Greg in the initial exposure to strategic rule conditions.

Third, in basic studies, conditions typically continue until steady-state responding is obtained over a number of sessions. A limitation of this study is that we were unable to obtain steady-state responding over several CT sessions because of time constraints. A replication in which a more stringent stability criterion is used may yield different results.

However, as a refinement to basic research, we included all session data in our analysis instead of only steady-state responding to show possible transition effects when the schedules were reversed. In addition, we used a within-subject design to examine sensitivity to changing schedules as a function of instructional history rather than a between-groups comparison that is more typical of basic research on verbal governance. Madden, Chase, and Joyce (1998) suggested that within-subject comparisons offer a more precise and experimentally valid measurement of sensitivity.

The results of this study represent an initial step in the investigation of how instructions and contingencies affect the behavioral patterns of children with ADHD. The limitations notwithstanding, the results support the application of principles and procedures derived from basic research (i.e., the study of verbal governance and the matching law) to address questions of educational and clinical relevance. Basic research has contributed vital information on the effects of instructions and contingencies on behavior. Our investigation represents a preliminary but promising extension that may lead to more effective interventions for children with ADHD.

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Received August 1, 2001
Final acceptance August 12, 2002
Action Editor, Dorothea Lerman

STUDY QUESTIONS

1. How are contingency-controlled behavior (CCB) and verbally controlled behavior (VCB) different? Provide an example of each.

2. Describe one advantage and one disadvantage of establishing behavior under verbal control.

3. What was the difference between tactical and strategic instructions?

4. Briefly describe the basic experimental task.

5. What were the purposes of the contingency learning (CL) and contigency test (CT) sessions, and how did these sessions differ?

6. Summarize the results obtained during the CL and CT sessions following both instructional conditions.

7. To what extent did participants' verbal description of contingencies correspond with (a) their patterns of responding and (b) the actual contingencies in effect?

8. Under what conditions would it be desirable to establish behavior through the use of rules rather than contact with contingencies?

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