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FIXED-INTERVAL RESPONDING DURING HUMAN COMPUTER-INTERACTIVE PROBLEM SOLVING

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Experiment 1 was designed to investigate student patterns of responding during fixed-interval (FI) 30-s reinforcement. During the experiment, students were able to respond to multiplication problems by typing answers on the keyboard. Correct answers/min were calculated by the computer program and automatically recorded on disk. Following the experiment, students were questioned regarding what they believed to be the best way to earn the money while working problems. Outcomes from the first experiment showed that only one of the five students was dominated by a pause-respond pattern of temporal disparity. This student provided a verbal rule that accurately described the contingencies associated with FI reinforcement. The other four students in this experiment responded at relatively constant rates in the majority of their intervals and provided verbal descriptions of contingencies suggesting that reinforcement became available only after the completion of a number or a changing number of problems. Experiment 2 replicated the preparations of Experiment 1; however, prior to initiated computer-interactive problem solving, the two subjects were shown the *accurate rule* generated by the subject in Experiment 1 who had exhibited pause-respond performance. Response patterns produced by these subjects showed conspicuous and consistent patterns of pause-respond throughout all intervals of FI 30-s reinforcement. Experiment 3 was conducted to further assess the possibility that scalloping (or some other pattern) might emerge over an extended series of sessions. Outcomes confirmed that performance patterns did not change significantly over sessions. Moreover, the subjects' verbal description of programmed contingencies conformed to the pattern of responding they produced. Outcomes are discussed in terms of self-generated and socially mediated rule-following.

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Fixed-interval (FI) schedules deliver reinforcement contingent upon the occurrence of the first target behavior after a specific amount of time has elapsed (Ferster & Skinner, 1957). During such contingencies, response rates among nonverbal organisms usually begin at low levels and gradually accelerate positively (Dews, 1978). Following reinforcement, rates subside and then reaccelerate as time approaches the moment at which reinforcement becomes available again. This pattern of initial slow responding that builds to an asymptote and immediately decays following each reinforcement often appears as a series of cupped curves, or "scallops," when graphed cumulatively. In fact, scalloping has become something of an archetype representing the unique patterns of responding that emerge under the influence of specifically scheduled consequences. To the extent that various individuals (and species) demonstrate scalloping during FI reinforcement, their performances may be identified as being conspicuously "sensitive" to the effects of scheduled consequences.

Catania (1992) points out that such responding varies as a function of the *relative* rather than *specific* time within a FI schedule. He notes that if an organism's performance attains half its asymptote within 40 s of a 100-s FI, it will probably reach half its terminal rate in 20 s during a 50-s FI. Catania offers a human analogue in which a student might increasingly glance at his/her watch as time elapses during a lecture. Under such conditions, reinforcement might be inferred as the student finally seeing the moment at which he or she can vacate the classroom. He adds that glancing at the timepiece does not make the watch run faster; nevertheless, many students may find themselves acting as if that were the case. The above analogue begs the question as to whether the hypothesized student is "aware" of his/her accelerated rate of watch glancing under such conditions. Is such behavior under verbal or schedule control? Another question emanating from this analogue is whether the student's academic or other forms of complex behavior might approximate a pattern of scalloped responding during FI reinforcement. Indeed, it has been observed that patterns of newly enacted legislation appear scalloped as bill passing becomes increasingly accelerated near the end of each congressional session (Weisberg & Waldrop, 1972). Moreover, other schedules have generated substantial continuity in performance patterns between humans and nonhumans. For example, consistent with the behavior of a wide range of species, Baxter and Schlinger (1990) found that children demonstrated comparatively higher rates of responding during random-ratio (RR) and lower performance rates during random-interval (RI) schedules (cf. Ninness, Shore, & Ninness, 1999). Furthermore, continuity has been noted in the response patterns emitted by preverbal children (Weisberg & Fink, 1966).

On balance, numerous studies have failed to demonstrate that human performances are predictable under the influence of scheduled consequences. Even many of the early experimental analysis of human behavior challenged the assumption of continuity between humans and nonverbal organisms (e.g., Lippman & Meyer, 1967; cf. DeCasper & Zeiler, 1972). Indeed, human performances often appear conspicuously insensitive to scheduled consequences (e.g., Lowe & Horne, 1996; Ninness & Ninness, 1998, 1999; Rosenfarb, Newland, Brannon, & Howey, 1992; Weiner, 1970). Generally, cumulative records of children above the age of 4 years showed either continuous fast rates of responding or extremely low rates with just a few responses being emitted at the close of every fixed interreinforcement interval (Lowe, 1979). In fact, most of the research during the last 40 years seems to conclude that as humans mature, they usually exhibit diminished sensitivity to scheduled consequences.

This discontinuity in schedule sensitivity has been attributed to the human acquisition of verbal repertoires. For example, Lippman and Meyer (1967) reported that when given nonspecific directions during FI schedules, subjects who generated rules suggesting that reinforcement was time dependent responded more slowly than those who developed verbal rules indicating that reinforcement depended on a number of responses. Similarly, Lowe, Harzem, and Bagshaw (1978) found that under proper testing conditions, which included a digital clock, human behavior on fixed-interval schedules resembled that of other species. This behavior was not found in humans who were tested in a binary clock condition. Their study also suggested that in order to reduce the subject-produced cues, for instance, counting must be minimized and behavior must be brought under the control of outside temporal cues. All subjects reported that the number of points received was related to the passage of time, and only those subjects in the binary group reported counting to measure time. Subsequently, Lowe, Beasty, and Bentall (1983) found that infants' behavior on FI schedules, unlike that of older children and adults, was very similar to the behavior of animals. This supported Lowe's 1979 suggestion that the large difference in schedule performance between older humans and animals is due to verbal behavior. Bentall, Lowe, and Beasty (1985) provided further support for these results when they tested children in four different age groups, ranging from infant to age nine. Again, only the infants tested similar to animals. Bentall and Lowe's (1987) study of children who were prompted to respond at different rates also supported this conclusion.

Another obstacle in unraveling whether humans exhibit the FI scallop is discrepancies among the definitions. Madden, Chase, and Joyce (1998) submit that some of the discrepancies between human and nonhuman behavior may be a function of conflicting definitions of the term sensitivity. They suggested using a within-subject definition of schedule sensitivity and separately describing the extent to which interspecies replications (effects of scheduled consequences across species) are demonstrated.

Hyten and Madden (1993) discussed the inherent difficulties in identifying exactly what constituted a scallop. Moreover, they illustrated how the dilemma with the loose descriptions used to summarize large numbers of diverse response patterns has led to inaccurate characterizations of data. As an alternative they proposed an interval-by-interval classification system indexed by patterns into the following six categories:

1. Scallop - Postreinforcement pause followed by a gradual acceleration in responding to a terminal rate at the end of the interval.

2. Break-run - Postreinforcement pause followed by an abrupt transition to a terminal rate at the end of the interval.
3. Terminal Minimum - Extended pausing until the very end of the interval when only a few responses occur.
4. Constant Rate (low, moderate, high) - A constant response rate throughout the interval.
5. Other Discernible - Any identifiable and repeated pattern not fitting into the above categories. The research should define the characteristics of any pattern in this category, labeling or naming each distinct pattern.
6. Unclassifiable - Erratic response patterns with a form not repeated in several intervals. (p. 492).

Hyten and Madden further noted that, in records that present particularly subtle discriminations between scallop and break-run, "Perhaps we should abandon the classification of scallop altogether, and refer to any pattern with a substantial postreinforcement pause followed by high rate terminal responding as simply a pause-respond pattern" (p. 497). The following study was designed to assess whether students' computer-interactive academic behavior might approximate any of the above patterns during FI reinforcement and, if so, to determine whether or not such responding may be identified as being under verbal or schedule control.

Experiment 1

Method

Participants, setting, and apparatus. Five fifth- and sixth-grade students (2 males and 3 females), ranging from 10 to 12 years of age, from a self-contained, multiage, regular education classroom participated. All 5 of these students were selected on the basis of having firmly established repertoires in basic multiplication facts as measured by a series of teacher-constructed tests.

Following informed consent, all experimental sessions were conducted on one of two Toshiba notebook computers during the school day in a partitioned classroom adjacent to the students' regular classroom. The computers were positioned so as to preclude distractions from adjacent classrooms. The software was written by Chris Ninness in QBASIC for IBM PC compatible machines.

Experimental design. Experimental conditions were designed to investigate the participants' patterns of responding during FI 30-s schedules of reinforcement. During the experiment, students were able to respond to multiplication problems by typing answers on the keyboard. Correct answers/min were calculated by the computer program and were automatically recorded on disk throughout each experimental session. Following the experiment, participants were questioned regarding what they believed to be the most efficient way to earn money while working problems at the computer.

Reliability checks. Before and after all three experiments, one of the researchers performed math problems at the computer as an independent observer tallied the number of correctly completed problems each minute for 5 min. Calculation of agreements were obtained by dividing the number of min-by-min agreements by the number of agreements plus disagreements and multiplying by 100. Reliability coefficients between the observer and computer calculations were at 100% for observations conducted before and after the experiment.

Procedures. During the experimental session, students were asked to sit in front of a computer. Opening instructions were displayed on the computer screen. Subsequent to having the student/s enter his/her name and date, the computer displayed the following message: "TRY WORKING A FEW PROBLEMS. TYPE 'U' IF YOU UNDERSTAND." Upon typing 'U,' the student/s was/were presented with an opportunity to engage in interactive problem solving as the following light red message appeared against a blue background: "WORK PROBLEM TO CONTINUE. TYPE 'E' TO END THE PROGRAM." Below this message appeared a large font (320 x 200 graphics resolution) single-digit multiplication problem. All answers entailed two-digit responses but did not require hitting the enter key. If the student answered the problem, a new problem immediately appeared with the same message directly above it according to the same format. Correct answers/min were calculated by the computer program and were automatically recorded on disk in terms of accuracy, response-time, interresponse times, and cumulative response time.

During the session, reinforcement appeared on the computer screen according to a FI 30-s schedule. During reinforcement, the computer presented the words "WINNER 5 CENTS" against a green background for a 3-s display. (Ensuing reinforcers were displayed in consecutive increments of 5 cents.) Subsequently, the screen background turned blue and a new problem appeared according to the previous format. If the student typed 'E' the program terminated. After 18 min, one of the researchers interrupted the session by asking the student to type 'E' to end the program. At this time, the researcher exchanged monetary reinforcers for the equivalent amount of money displayed on each student's computer screen. Because students earned 5 cents for the first correct response following each FI 30-s interval, this usually entailed $1.80 per 18-min session. The monetary exchange was made without commentary; however, at the end of the experiment the researcher questioned each student regarding what he/she believed to be the "best way to earn the most money while performing problems at the computer?" Student verbal responses were transcribed as they were given.

Results and discussion. Data in Figure 1 were plotted to the nearest quarter second. All 5 students performed at or above 97% accuracy throughout the experiment. Because inaccurate responses were relatively infrequent and entailed the same response topography as accurate responses, their occurrence was tabulated as part of the cumulative record. Consistent with the categorization procedures recommended by Hyten and Madden (1993), specific response patterns were visually identified on an *interval-by-interval basis.* This procedure was facilitated with the assistance of Cloyd Hyten.

Figure 1 illustrates eight representative 30-s intervals for each subject beginning at the 10th min of each session. (Data from Subject 5 begins on the 8th minute as her session was interrupted 5 min early.) Data from Subject 1 showed a continuous high rate of responses/min throughout the session. The third and eighth intervals showed brief delays following reinforcement; however, these delays were not sufficient to establish pausing as a feature of this subject's general pattern. All eight of the intervals were categorized as showing a *constant high rate.* At the conclusion of the session, she described reinforcement as being *response dependent.* Specifically, she stated that, "The computer gave money every 10 to 15 problems." Generally, her pattern of responding appeared consistent with this verbal interpretation.

More than that of any other subject, data from Subject 2 showed conspicuous pauses following computer-displayed reinforcement. These pauses fluctuated between 7 and 20 s. When her responding eventually commenced, the rate was high and positively accelerating. Her pattern may be described as *scalloped* or showing a *pause-respond* configuration throughout the majority of her intervals; however, given the slow interresponse time and the abrupt transition to constant responding following the initial pause in her performance, *pause-respond* was judged to be a more conservative description. At the conclusion of her session, this subject provided a verbal description suggesting a self-generated *time-dependent* contingency. She noted that the best way to earn money was by "waiting after every nickel and then working some problems."

Subject 3 generated a high and continuous behavior pattern with very short *breaks* occurring on the third, fourth, and fifth intervals of Figure 1. These three intervals were classified as *break-run.* Pauses did not appear in any of the remaining intervals that were categorized as showing a *constant high rate.* After the session, this student indicated that he "was not keeping track of the number of problems it needed to give money each time." Since this student specified number as a variable in accessing reinforcement, his self-generated verbal description of the contingency was classified as *response dependent.*

Subject 4's data represented a high rate of continuous responding with short *breaks* showing at the second, third, and seventh intervals. These pauses consumed approximately 2 sec on each occurrence. Also, this subject showed similar breaks at latter stages of several intervals. Two of this subject's intervals were classified as *break-run* and six were identified as exhibiting a *constant high rate.* Upon completing the session she stated that, "you could earn money by working as many problems as you can." This self-generated description was classified as *response dependent.*

Subject 5's data showed momentary pauses at the beginning of the third, fourth, and fifth intervals. This subject also showed several brief pauses occurring near the end of the second and fifth intervals. Generally, his data were characterized by a relatively high-steady response rate identified as *break-run.* After completing the session, this student told the researcher that the best way to earn the most money was by "always doing as many problems as you can. If you worked fast enough, you get a nickel." This self-generated verbal description of programmed contingencies was classified as *response dependent.*

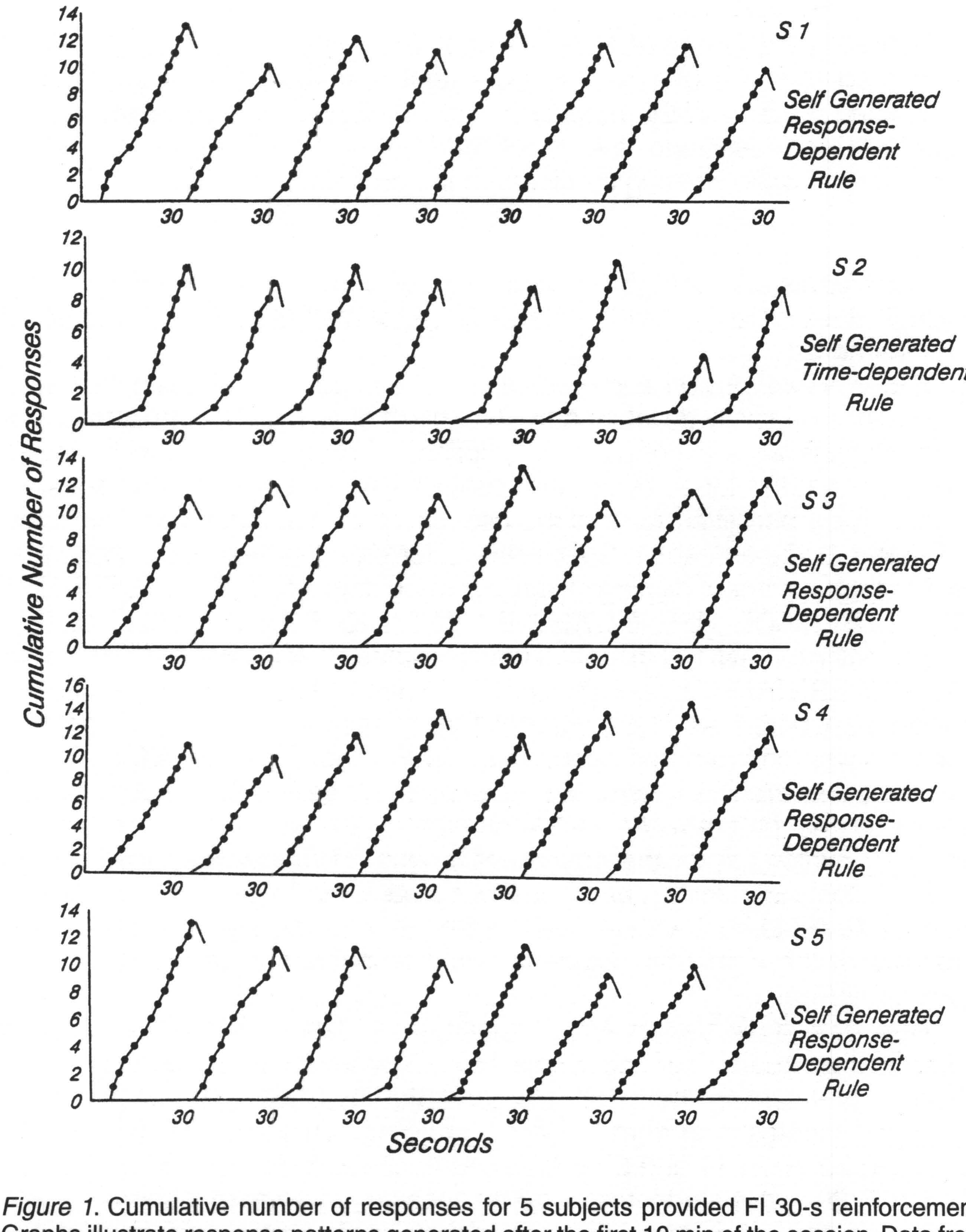

Figure 1. Cumulative number of responses for 5 subjects provided FI 30-s reinforcement. Graphs illustrate response patterns generated after the first 10 min of the session. Data from Subject 5 begins on the 8th min.

Thus, Subject 2 was the only 1 of 5 students who demonstrated a performance approximating a scallop or pause-respond pattern in the majority of her FI 30-s intervals. Moreover, her postsession verbal description of the programmed contingencies was consistent with the manner in which she performed (cf. Lippman & Meyer, 1967).

Experiment 2

Following the format of Experiment 1, Experiment 2 was conducted in order to contrast the effects of FI 30-s reinforcement when subjects were preexposed to a *socially mediated* (Hayes, Zettle, & Rosenfarb, 1989) accurate rule describing the most efficient way to access monetary reinforcement while working problems at the computer.

Method

Participants and setting. Students, 1 male and 1 female, from the same multiage class were exposed to the same experimental context as furnished in Experiment 1.

Experimental design and procedures. The experimental design followed preparations originally developed by Rosenfarb et al. (1992) in the sense that these subjects were exposed to descriptions of programmed contingencies that had been developed by another subject. Prior to beginning the session, subjects were permitted to read the description of contingencies developed by Subject 2, Experiment 1. Specifically, after entering their name and date, the computer screen displayed the following message: "ONE STUDENT SAYS SHE MADE HER MONEY BY WAITING FOR A WHILE AFTER EVERY NICKEL AND THEN WORKING SOME PROBLEMS. TYPE 'U' IF YOU UNDERSTAND." Upon typing 'U,' a series of single-digit multiplication problems appeared. As in Experiment 1, reinforcement for performing these problems was programmed according to a FI 30-s schedule. After 18 min, one of the researchers interrupted the session by asking the student to type 'E' to end the program. As in Experiment 1, the researcher exchanged monetary reinforcers for the equivalent amount of money displayed on the student's computer screen and questioned each student regarding what he or she believed to be the "best way to earn the most money while performing problems at the computer." Student verbal responses were transcribed as they were given.

Results and discussion. As in Experiment 1, data in Figure 2 are plotted to the nearest quarter second. Subjects in Experiment 2 operated under the influence of a socially mediated rule generated by Subject 2, Experiment 1. Figure 2 illustrates data from Subject 6 showing comparatively long pauses averaging between 11 and 25 s following each reinforcement. Near the end of each FI 30-s, this student showed an accelerating level of responding that terminated after acquisition of each monetary reinforcer displayed on the computer screen. All intervals were classified as *pause-respond.* Upon completing the session, the student was questioned regarding what influence the "computer-posted rule had on the way he performed problems?" This student stated, "That computer rule seemed to really work." He further stated that nickels were dispensed after about "fifteen or twenty seconds, and you did a lot of problems." This student's description of programmed contingencies was listed as socially mediated and *time dependent.*

Likewise, Subject 7 exhibited a continuous series of long post-reinforcement pauses followed by accelerated responding; however, this student terminated all responding on the sixth interval of Figure 2. The pause-respond pattern resumed in the remaining records. When questioned regarding the influence of the computer-posted rule, this student noted, "The computer's words seemed right."

Experiment 3

Previous research (e.g., Hayes, Dixon, Caslake, Beckwith, & Shurr, 1997; Lowe et al., 1983) has suggested that many human and infrahuman subjects require an extended number of sessions before scalloping emerges in their response patterns during FI reinforcement. Thus, the 2 subjects in Experiment 3 were exposed to five consecutive 18-min sessions (one session per day). Each of these sessions was a replication of the preparations employed in Experiment 1. Subjects were given *no specific rules* regarding the programmed contingencies prior to initiating any of these consecutive sessions.

Method

Participants and setting. One male and one female student from the same multiage class were exposed to the same experimental conditions as provided in Experiment 1.

Experimental design and procedures. As in Experiment 1, opening instructions were displayed on the computer screen. Subsequent to having the student/s enter his or her name and date, the computer displayed the following message: "TRY WORKING A FEW PROBLEMS. TYPE 'U' IF YOU UNDERSTAND." Upon typing 'U,' the student/s was/were presented with a continuing series of opportunities to engage in interactive problem solving according to the same format as employed in the previous two experiments. Correct answers/min were calculated by the computer program and were automatically recorded on disk in terms of accuracy, response time, interresponse times, and cumulative response time. After each 18 min, one of the researchers interrupted the session by asking the student to type 'E' to end the program. As in the previous experiments, one of the researchers exchanged monetary reinforcers for the equivalent amount of money displayed on each student's computer screen; however, students were not asked to describe any of the experimental contingencies until the completion of the final session.

Results and discussion. As in Experiments 1 and 2, data in Figure 3 are plotted to the nearest quarter second. Both subjects performed at or above 96% accuracy throughout all five sessions in the experiment. Because inaccurate responses were relatively infrequent and entailed the same response topography as accurate responses, their occurrence was tabulated as part of the cumulative record. Using the categorization procedures recommended by Hyten and Madden (1993), response patterns were visually identified on an *interval-by-interval basis*.

Figure 3 illustrates eight representative 30-s intervals for each subject beginning at the 10th min of the fifth and final session. Subject 8's first interval showed a *constant high rate*. Subsequently, this subject exhibited erratic and

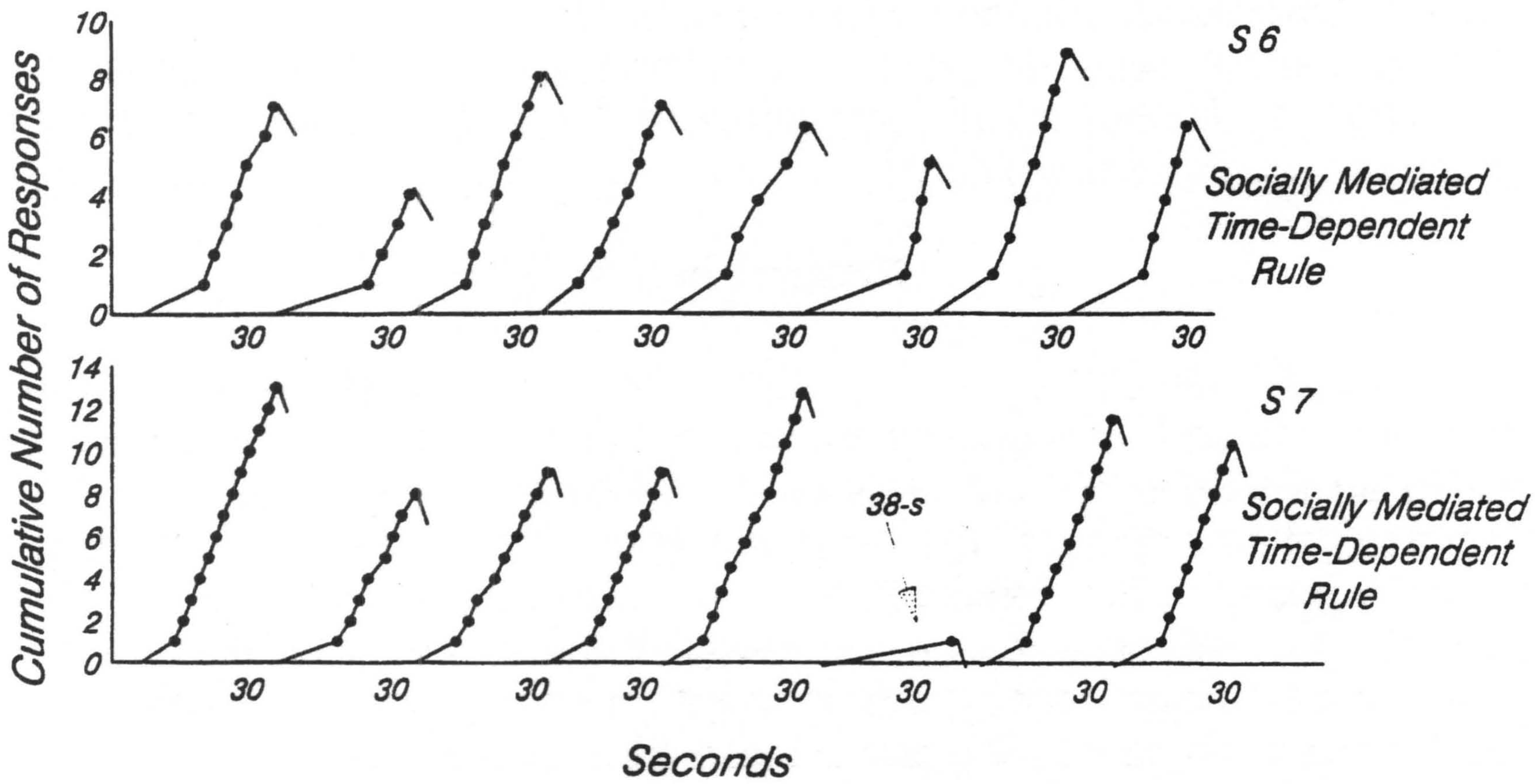

Figure 2. Cumulative number of responses for 2 subjects provided FI 30-s reinforcement following exposure to a computer-posted rule. Graphs illustrate response patterns generated after the first 10 min of the session.

brief pauses in the middle of several intervals; however, these performance delays do not suggest any pattern of regularity across intervals. Most of his data were categorized as *unclassifiable* in that they represent erratic patterns that were not repeated on an interval-by-interval basis.

Only Subject 8's third interval showed a brief pause following reinforcement. This delay was not seen in any of the remaining intervals of this session. In an earlier session (number 2), this subject exhibited two consecutive brief pauses following FI reinforcement. Nevertheless, that pattern did not sustain in subsequent intervals and sessions. After completing his final session, this student told the researcher that the best way to earn the most money was by "Working pretty fast. But sometimes I need to rest." This verbal description of contingencies was classified as *response dependent*.

Subject 9 sustained a high and continuous behavior pattern throughout all five sessions. Figure 3 illustrates one very brief delay occurring near the end of the seventh interval in the final session. Delays did not appear in any other intervals, which are categorized as showing a *constant high rate*. After the session, this student stated that "Working fast gave you the most money." Her self-generated verbal description of the contingency was classified as *response dependent*.

General Discussion

Of the 5 subjects in Experiment 1, 4 showed high rates of continuous responding throughout the majority of the intervals in their respective sessions. Graphs of their response patterns demonstrated relatively few performance pauses following reinforcement delivery. Postsession commentaries by these students suggest that they "believed" reinforcement to be a function of the number (or changing number) of correct answers to computer-posted problems. However, 1 subject in Experiment 1 showed conspicuous and consistent pauses following reinforcement acquisition. Although not shown in the above graphs, this trend became apparent after the first 6 to 7 minutes of her session. Her verbal description of contingencies following the session suggested that she believed that the passage of time was related, at least partially, to the delivery of monetary reinforcement. In Experiment 2, 2 subjects were given an opportunity to preview the accurate rule developed by Subject 2 in the previous experiment. Consistent with the rule provided by this subject, both subjects in the second experiment immediately and continually exhibited long pauses following the posting of each monetary reinforcer on the computer screen. Given the abrupt rather than smooth rate transitions exhibited by Subject 2 (Experiment 1) and Subjects 6 and 7 (Experiment 2), we are inclined to categorize these patterns as *pause-respond* rather than scalloped (as per the recommendation of Hyten & Madden, 1993). However, unlike those in the performance of Subject 2, the *pause-respond* trends of Subjects 6 and 7 (Experiment 2) became apparent at the onsets of their respective sessions. Experiment 3 was conducted to further assess the possibility that scalloping (or some other response pattern) might emerge over an extended series of sessions. Although Experiment 3 did not include exposure to the number of sessions employed in some animal research investigating this phenomena, the number of sessions (and their durations) are consistent with similar investigations of verbal and preverbal humans (e.g., Bentall & Lowe,1987; Bentall et al.,1985; Lowe et al., 1983; Lowe et al., 1978). And, the results correspond with the findings of Bentall et al. (1985) in that subjects' performance patterns did not show any trend toward scalloping (or *pause-respond* patterns) over the extended experimental sessions. Moreover, consistent with the previous two experiments, the subjects' verbal description of programmed contingencies conformed to the way in which they performed over the course of the five 18-min sessions.

Noteworthy is the fact that all 9 students performed at or above 96% accuracy across sessions. However, the units of recorded behavior (2-digit answers) required subjects to respond at comparatively low rates as measured during 30-s intervals. Generally, subjects were unable to produce more than 14 2-digit responses per interval. Similar experimental preparations such as panel pressing (e.g., Cerutti, 1991) or cylinder pushing (e.g., Lowe, 1979) usually entail one-step topographies, and these response rates often exhibit a somewhat smoother moment-to-moment flow across time. Perhaps, the use of a more traditional and ostensibly neutral activity such as lever pressing or longer interreinforcement intervals might have allowed our subjects to execute more salient and easily categorized patterns of responding; however, pilot research (examining intervals between 10 s and 15 min) did not suggest such a trend. Although traditional lever pressing preparations may preclude the possibility of subjects contacting the

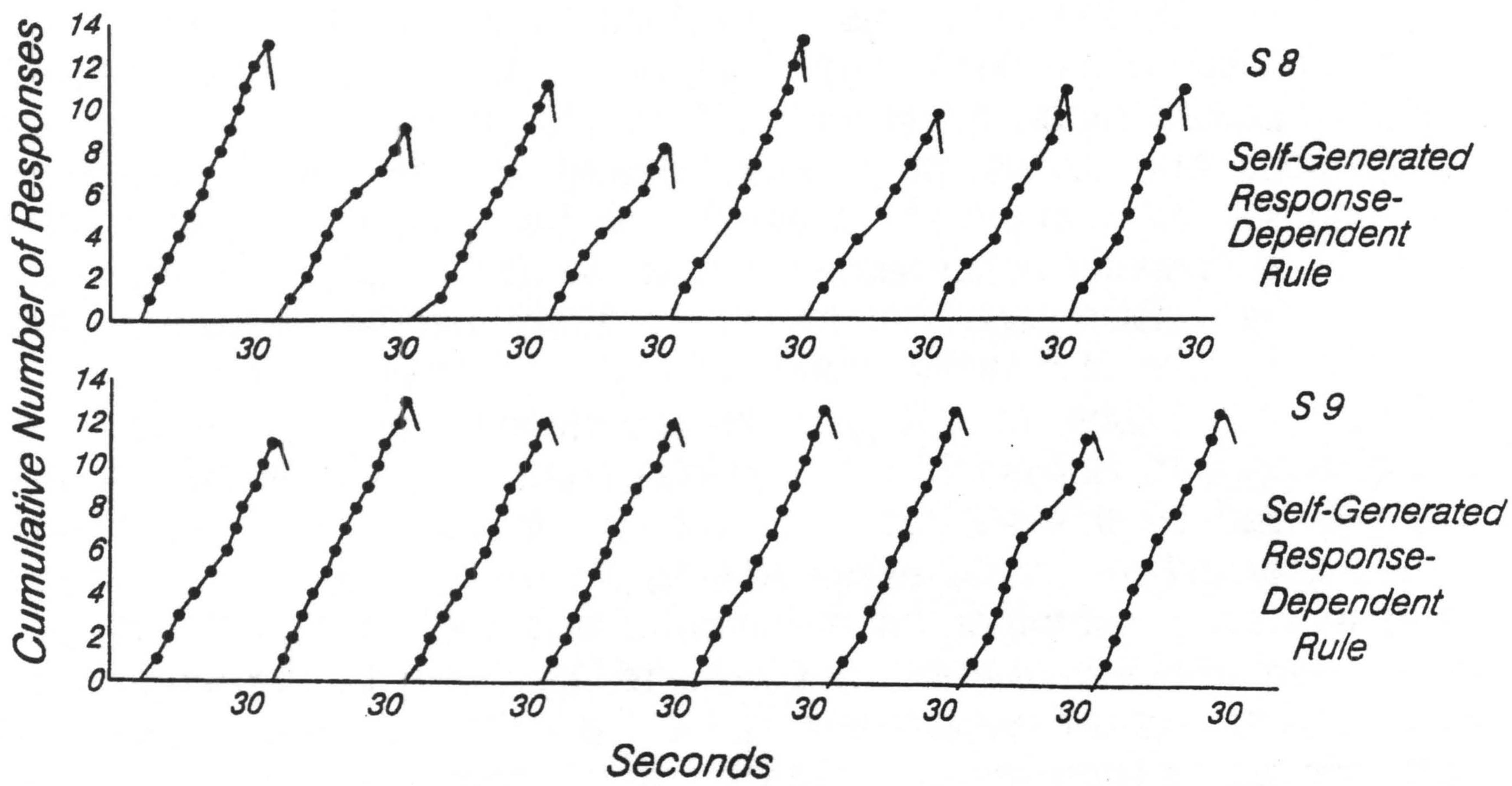

Figure 3. Cumulative number of responses for 2 subjects provided FI 30-s reinforcement. Graphs illustrate response patterns generated in the fifth of five sessions after the first 10 min of that session.

potentially "intrinsically reinforcing" effects of completing academic work, such laboratory measures are less generalizable to performances generated in natural or academic settings.

These results stand in stark contrast to the ubiquitous representations of FI responding in humans portrayed by most introductory psychology and educational psychology texts. For example, Slavin (1997) notes that "Fixed-interval schedules create an interesting pattern of behavior. The individual may do very little until just before reinforcement is available, then put forth a burst of effort as the time for reinforcement approaches. This pattern can be demonstrated with rats and pigeons on fixed-interval schedules, but it is even more apparent in students who cram at the last minute before a test or who write their monthly book reports the night before they are due" (p. 165). Although it is indisputable that humans often procrastinate in the face of deadlines, our outcomes and those of many others (e.g., Bentall et al., 1985) seem to suggest that it is more reasonable to attribute such delayed responding to various features of rule-governed behavior (see Malott, Whaley, & Malott, 1997, for a discussion).

Our interpretation appears consistent with Lowe et al. (1978) who found that human subjects exhibited long FI scallops while exposed to a response-produced digital clock and described their experimental conditions as requiring temporal regularity in order to obtain reinforcement. Other subjects who apparently "believed" that reinforcement was contingent on the number of actual responses performed, rather than on the amount of time elapsing, did not manifest patterns of responding reminiscent of infrahumans in laboratory conditions. Our outcomes also concur with those of Rosenfarb et al. (1992) and Hayes et al. (1997) who demonstrated that college students who were asked to self-generate rules or follow socially mediated rules from yoked subjects were more likely to approximate schedule-like behavior than those who had been asked *not* to formulate or follow socially mediated rules.

Rule generation. With the development of language skills, humans exhibit an increasing sensitivity to social contingencies that support rule-following (Catania, 1993). However, this may not be a function of becoming less sensitive to scheduled reinforcement but becoming more sensitive to socially mediated contingencies (cf. Cerutti, 1991) that are conveyed in the form of rules (Hayes, Brownstein, Zettle, Rosenfarb, & Korn, 1986; Hayes et al., 1989). And, while it is true that verbal behavior may be responsible for the common failure to find FI scalloping (or pausing) in human FI performances (Hayes et al., 1989), it may also be true that verbal events may contribute to a subject's approximating some aspects of *scalloping or pause-respond* performance. Given that a subject accurately anticipates (either by way of a self-generated rule or a socially mediated rule) that reinforcement will be forthcoming only after a certain amount of time has elapsed, it is easy to understand why he or she may postpone performing until the estimated amount of time has elapsed. Nevertheless, our results suggest that unless subjects acquire such a rule it is unlikely that pausing or scalloping will emerge during FI schedules.

The question as to *why* and *how* Subject 2 (Experiment 1) derived a relatively accurate description of the programmed contingencies remains a matter of some speculation. Postsession debriefing of this subject did not prove particularly illuminating; however, it is worth noting that this student has a fairly sophisticated background in computer-interactive technology. Furthermore, members of her immediate family are associated with behavioral research. Previous research (e.g., Catania, Shimoff, & Matthews, 1989) has suggested that prior exposure to the dynamics of a technology prepares a subject to respond more efficiently to programmed contingencies.

Given the growing number of cited discontinuities between the schedule-sensitive performances of lower organisms and the way in which verbal humans respond under the influence of schedules, it may be tempting to ask why behavior analysts persist in studying the effects of schedules of reinforcement. From our perspective, there are at least two excellent reasons: (1) Analyses of the scheduled performances of nonverbal organisms and preverbal humans provide an otherwise unobtainable standard for judging the manner in which humans perform in the absence of verbal interpretations of contingencies. And (2) analyses of these and similar procedures with verbal humans provide a preparation for examining, controlling, and identifying the way in which direct-acting contingencies interact with rule-governed behaviors.

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