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Schedule Sensitivity of Instructed Human Operant Behavior: Effects of a Warning, Length of Training and Variability Pre-training with Elaborate and Minimal Instructions

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Author Note

Experiments 1 and 2 were a collaboration between Christine-Shawn Boisvert, another graduate student, and myself. We were both involved in the designing, planning, and data collection for these two studies. We analyzed our results individually. These studies served as the foundation upon which I subsequently based my Experiments 3 and 4. The results of Experiments 1 and 2 fuelled my reflection and led me to think about a parallel with natural selection and rule-governed behavior. The general theoretical context for Experiments 3 and 4 was the potential usefulness of ideas from the Darwinian survival and evolution of species in understanding the survival and evolution of populations of behaviors. Christine-Shawn Boisvert's reflection led her to conceptualize subsequent experiments that investigated social contingencies.

Abstract

Previously published studies have shown that behavior under the control of instructions is likely to follow the instructions and not change when the schedule of reinforcement changes. A series of four experiments were designed to expand our knowledge of why rules produce this insensitivity. Once responding had been established on a multiple DRL 6 s/FR 18 schedule of reinforcement, an unannounced change in contingencies was introduced. All four experiments contained sufficient numbers of participants to permit the application of statistics in the data analysis. The experiments investigated (a) the effects of instructions on the speed and accuracy with which a new behavior was learned; (b) the "sensitivity" or rapidity of adjustment of the behavior to an unannounced change in contingencies as a function of whether it had been learned with the help of instructions. Experiment 1 attempted to replicate previous "insensitivity of rule-governed behavior" findings and examined schedule sensitivity as the multiple DRL 6s/FR 18 schedule changed to extinction/extinction. Experiment 2 aimed to increase this series of studies' ecological validity, by changing the schedule to something other (FR 18/FR 18) than extinction/extinction. In an attempt to counteract the insensitivity effect, Experiments 1 and 2 also examined the effect of a simple warning that "conditions may change at any time" on the behavior's rapidity of adjustment to changes in contingencies. In light of the results of the first two experiments, a selectionist framework was adopted in Experiments 3 and 4 to provide a procedural explanation for the insensitivity effect. The effects of the length of training, and of a variety of instructions were investigated in relation to the insensitivity of rule-governed behavior effect. Overall, the results have shown that instructions facilitate the acquisition of a new behavior. One of the studies has shown that providing a simple warning that conditions may change increased sensitivity in behavior following a change in contingencies. The results have suggested the elimination of length of training as a potential factor on the insensitivity of rule-governed behavior, in this specific series of studies. Providing a variety of instructions impacted significantly more on the Minimal Instructions groups' than the Elaborate Instructions groups' sensitivity to a change in contingencies. The results are explained in terms of the restriction in the behavioral repertoire during a change in contingencies.

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Introduction

From a very early age, a great portion of a human's behavioral repertoire is founded on following instructions and rules. From "do not play with fire" to "thou shall not kill", humans learn to follow rules and obey instructions. Rules and instructions are a very efficient means of bringing about or altering behaviors in individuals as compared to having them learn slowly with time by direct contact with the environment. For example, giving a new home owner the instruction "if this light on your furnace goes on, leave the house and call the gas company" may prevent a catastrophe; it is not advisable to wait for the new home owner to acquire a first-hand experience of the consequences of a gas leak.

B. F. Skinner's most early comprehensive presentation of his interest in rules and rule-governed behavior can be traced back to his paper "An Operant Analysis of Problem Solving" (1966). He argued that a behavior in verbal humans can result from either shaping through direct contact with contingencies in the environment, or from a verbal description (which he termed "rule"), that describes the contingencies of reinforcement. Skinner (1969, p. 7) defined the contingencies of reinforcement in the following manner:

> "an adequate formulation of the interaction between an organism and its environment must always specify three things: (1) the occasion upon which a reinforcement occurs; (2) the response itself; and (3) the reinforcing consequences. The interrelationships among them are the "contingencies of reinforcement".

To better understand Skinner's (1966) conception of rules and rule-governed behavior it is useful to first examine the distinction he has made between rule-governed behavior and contingency-shaped behavior. Skinner illustrated the differences between rule-governed behavior and contingency-shaped behavior in this frequently-cited example, where he compares a baseball player catching a ball to a naval commander catching a satellite:

> The behavior of a baseball outfielder catching a fly ball bears certain resemblances to the behavior of the commander of a ship taking part in the recovery of a reentering satellite. Both [the outfielder and commander] move about on a surface in a direction and with a speed designed to bring them, if possible, under a falling object at the moment it reaches the surface. Both respond to recent stimulation from the position, direction, and speed of the object, and they both take into account effects of gravity and friction. The behavior of the baseball player, however, has been almost entirely shaped by contingencies of reinforcement, whereas the commander is simply obeying rules derived from the available information and from analogous situations. (Skinner, 1969, p. 146)

Contingency-shaped behavior refers to a behavior that has been developed and maintained by relatively immediate consequences (reinforcement or punishment). Contingency-shaped behavior requires no other person as the behavior is due to direct exposure to the contingencies of reinforcement. Unlike rule-governed behavior, contingency-shaped behavior appears without instruction. Often individuals will have difficulty explaining their "contingency-shaped" behaviors. For example, if we ask someone how he or she succeeds in staying upright on roller blades, he/she may not be able to answer (Baum, 1994).

A behavior is considered to be "rule-governed" when it is under stimulus control by a rule, meaning that it occurs as a result of the statement of that rule. After having distinguished contingency-shaped behavior from rule-governed behavior, Skinner (1966) defined rules. With respect to the form of a rule, he simply described it as a contingency-specifying stimulus. This means that rules are statements that specify at least two terms of a contingency relation. In other words, rules can specify either the behavior and its consequence, the occasion (antecedent) and consequence, or the behavior and the occasion, or it may also describe all elements of the contingency (Andronis, 1991).

Functionally, Skinner (1969) conceptualized rules as verbal discriminative stimuli that describe a contingency "As a discriminative stimulus, a rule is effective as part of a set of contingencies of reinforcement. We tend to follow a rule because previous behavior in response to similar verbal stimuli has been reinforced" (p. 148). In general terms, a stimulus is considered a discriminative stimulus for a behavior because the behavior has been reinforced in its presence and not in its absence (Michael, 1982). For example, a mother telling her child to "take your lunch to school this morning" is verbalising a rule (a discriminative stimulus); in response to this rule, the child will take her lunch to school (the behavior) and will therefore have something to eat during the lunch hour (reinforcing consequence). The rule will usually bring about the appropriate behavior, providing that rule-following behavior has been reinforced in the past (Baum, 1994).

Rules can be presented in a number of ways for example, they can be signed (as used in sign language), written or spoken. In Skinner's framework, rules are instructions in the broadest sense, and include for example, advice, commands, orders, laws, principles. The terms "rules" and "instructions" will hereafter be used interchangeably and will be considered synonyms.

Skinner's (1969) distinction between rule-governed and contingency-governed behaviors has sparked interest within the field of behavior analysis. As a result, a body of research specifically targeting rule-governed behavior has emerged in the past three decades.

The experimental analysis of behavior literature on rule-governed behavior

Hayes, Zettle, and Rosenfarb (1989) have divided the history of behavior analytic work on instructions into three distinct periods, which they have labelled the "early period", the "period of stagnation" and the "modern era of human operant research". In the 1950's, human operant research became a popular sub-field in behavior analysis. Hayes et al. (1989) characterized this early work in human operant research as being based on the "continuity assumption". Following this assumption, researchers tried to determine whether under similar circumstances, human patterns of responding resembled animal responding. Many researchers were interested in replicating, with the human population, principles of behavior discovered in the non human laboratory (Hayes et al., 1989).

Researchers working with human subjects were frequently unable to replicate behavior patterns found in the animal laboratory. However, these results did not challenge the continuity assumption as researchers were quite often able to generalise behavioral responding from non humans to humans, especially when the environment had been stringently controlled. At the time, conclusions generally attributed the inconsistencies in responding between humans and non humans to differences in history or in preparation (Hayes et al., 1989, p.192).

Early Period

During the "early period" of human operant research, instructions emerged as a field of study because it was convenient to use them to establish behavior. Instructions were usually treated descriptively and little attention was given to their nature or role (Hayes et al., 1989). Hayes et al. (1989) reported that behavioral researchers seemed intrigued by the fact that instructions could have a great effect on behavior.

For example, in an applied study, Ayllon and Azrin (1964) studied the effects of instructions on a socially desirable response (picking up cutlery at mealtime) of 18 psychiatric patients. In the first phase, no instructions were given to the subjects. If they picked up their utensils they were given reinforcement in the form of extra milk, candy, cigarettes or coffee. In the second phase, instructions were added to the procedure. The subjects were asked to pick up their utensils after their meal, and if they complied they would then receive the reinforcement. Results showed no change in the targeted behavior in the reinforcement-only condition (i.e., the procedure was ineffective) while most subjects responded adequately in the instructions plus reinforcement condition.

A study conducted by Kaufman, Baron, and Kopp (1966) investigated the effects of instructions on schedule control. Their study took place in a laboratory setting. In the first study, 31 participants were assigned to one of five conditions: (1) Minimal Instructions, (2) Response Instructions, (3) Variable-Interval (VI) instructions, (4) Fixed-Interval (FI) instructions or (5) Variable-Ratio (VR) instructions. Participants were led to believe that they were participating in a "concept formation" experiment, in which success would be commensurate with the number of points appearing on a counter. Participants received 5 cents per point registered. They had to select between one of two choice keys. This selection could only take place when a green choice light was on. The choice light was programmed on a variable-interval (VI) 1 min. schedule. On a variable-interval schedule the first appearance of the specified behavior after a period of time is reinforced. The time interval varies from interval to interval. This schedule is identified by the mean of the various intervals. The Minimal Instructions groups received very general instructions informing them that the registration of points on the counter involved the two choice keys, a button and the green light. In addition to these general instructions, the Response

Instructions group received instructions informing them that the green light was a signal for them to choose between one of the keys and press on it, and that a successful choice (signalled by a white light) would increase the number on the counter by one. They were also told that pressing the button would make the green light go on again. In addition to the Minimal and Response Instructions, the participants in the Variable-Interval group received instructions informing them that their button pressing behavior would bring the green light according to VI 60 s schedule. In addition to the Minimal and Response Instructions, participants in the Fixed-Interval groups were given instructions informing them that the green light was activated according to a FI 60 s schedule. On a fixed-interval schedule, the first appearance of a specific behavior (button pressing) after a fixed period of time has elapsed (60 s) will be reinforced (Domjard & Burkhard, 1986). Finally, participants in the Variable-Ratio group, in addition to the Minimal and Response instructions, received instructions informing them that their button pressing behavior would activate the green light according to variable-ratio (VR) 150 schedule. On a variable-ratio schedule, reinforcement will become available after a number of a specific response have been emitted; the number of responses required for reinforcement will vary unpredictably around a mean value (Domjan & Burkhard, 1986). The reinforcement schedule for all groups was actually a VI 60 s schedule.

Results showed that adding the Response Instructions increased the rate of responding when comparing to the Minimal Instructions groups. Adding further instructions about the three schedules produced distinctly different performances. The FI 60 s instructions led to even lower rates than those of the Minimal Instructions group and produced occasional scalloped patterns of responding, a pattern typical to an FI schedule. The VI 60 s instructions produced intermediate rates and the VR 150 instructions led to high steady rates of responding. Instructions induced behavior that was inappropriate to the VI 1 min. schedule. The authors concluded that instructions had a very important effect on rates of response and could "outweigh" the influence of the actual programmed reinforcement contingencies.

A second study by Kaufman et al. (1966) examined the effects of instructions on behavior during a VI reinforcement schedule and an extinction period. Sixteen different participants were exposed to one level of the three conditions: Instructions (Minimal or VR); Reinforcement (Money or Points); and Schedule (VI 60 s or No-Reinforcement). Half of the participants were assigned to the Minimal Instructions group, where as in Experiment 1, instructions only pointed to the keys, button and lights and mentioned that the goal was to get as many points as possible. The other half of the participants in the VR Instructions group were told, in addition to the Minimal Instructions given above, that button pressing would make the counter advance according to a VR 150 schedule. Half of the participants, assigned to the Money condition, received 2 cents for each point appearing on the counter, while the other half, in the Points condition, were given one dollar per hour they were in the room, plus points on the counter. Finally, half of the participants' button pressing behavior was reinforced (points to the counter) according to a VI 60 s schedule, while for the other half, the counter always remained at zero (extinction).

Results showed that VR instructions led to higher rates of responding than the Minimal instructions. There was little difference between the Money or Points reinforcement conditions. Findings also showed that both the Minimal and VR instructions groups maintained substantial rates of responding even when no reinforcement was available. However, with both groups a weakening of the rates was evident as the session progressed. This weakening was more noticeable in the Minimal instructions groups. The authors concluded that the behavior of participants was controlled by the instructions provided. As in Experiment 1, instructions induced patterns of responding that were inappropriate to the actual programmed contingencies of reinforcement. Participants persisted in their behavior even though the reinforcement was never made available.

In a study by Lippman and Meyer (1967), sixteen subjects earned 50 reinforcements on a button pressing task under a FI 20 s reinforcement schedule. Three groups were formed as subjects were given either instructions that the reinforcement contingency was related to the number of responses (Group R); to an interval of time (Group I); or subjects were given very minimal instructions with no instructions as to the reinforcement schedule (Group N). Results indicated that subjects in the Group I demonstrated the pattern of responding (scalloping) expected when an FI schedule is in effect. Subjects in the Group R had a high steady response rate typical of a ratio schedule. Finally, some subjects in the non-instructed group (Group N) responded as the Group R subjects and some responded as the Group I subjects. All participants were, at the end, asked to describe what they needed to do to add points on the counter. Results showed that the Group I presented, early in training, a pattern of behavior congruent with an FI schedule and verbalized that the interval between reinforcements was fixed. The Group R maintained high rates of responding throughout, and verbalized that the reinforcement was contingent on a varying number of button presses. Of the 10 subjects in the Group N, four verbalised a pattern of responding in correspondence with a response-based schedule, while six described a time-based reinforcement schedule. In sum, the results showed that instructions had the power to override the programmed contingencies.

During this period, Weiner (1970) also studied the effects of instructions on behavior during extinction. He assigned fifteen participants to one of three groups. On a button-pressing task, one group (Group 1) was told that they could earn no more than 700 pennies in the experiment. Group 2 was told that they could earn no more than 999 pennies and Group 3 was told nothing about how many pennies could be earned. All participants were initially subjected to a fixed-ratio (FR) 10. On a fixed-ratio schedule, reinforcement is delivered after a specified number of responses have been emitted since the last reinforcement was delivered. Participants earned points that were later exchangeable for pennies. For all groups, after 700 pennies had been earned by the participant under the FR 10 schedule, a two-hour extinction period was in effect and no reinforcement was given for responding.

The results showed that for all participants, the rates of responding during the extinction period were less than those under the FR schedule. During the extinction period, of the three groups, responding was least frequent for subjects in Group 1. Participants in Group 3, who had received no maximum-reinforcement instructions produced the highest rates of responding during extinction. The authors concluded that instructions can decrease the frequency of unnecessary responding during extinction.

In the same vein, Baron, Kaufman, and Stauber (1969) demonstrated, using a multiple schedule of reinforcement, that instructions can have a great impact on the development and maintenance of human operant behavior. Typically in previous research, only single schedules had been studied. Baron et al. (1969) used a multiple fixed-interval schedule of reinforcement during a button-pressing task. A multiple schedule refers to a schedule composed of different alternating schedule components, each associated with a different discriminative stimulus. All participants were exposed to a multiple schedule with four fixed-interval schedules of different duration (FI 10 s, FI 30 s, FI 90 s, and FI 270 s) and an extinction period, each of these components being associated with a different coloured light. The eighteen participants were assigned to one level of the two conditions: instructions and feedback. Half of the subjects were instructed (instructions groups) as to the duration of the fixed intervals while the other half were not (uninstructed groups). Also, half the participants (feedback groups) received a signal when a reinforcer was earned while the other half (no feedback groups) were given this type of information only at the end of the experiment. Results showed that subjects displayed schedule control (that is, they produced patterns of behavior appropriate to the schedule component in effect) only when they were given both instructions and feedback. There was no schedule control when both instructions and feedback were omitted. There was poor schedule control under the feedback only condition and finally an intermediate schedule control under the instructions only condition. The authors concluded that instructions have major influences on the development and maintenance of operant behavior in humans.

Hayes et al. (1989) reported that some researchers from this early period seemed almost surprised at the importance of the effects that instructions could have on performance. They commented that most studies in this period " however, were not theoretically driven. They were not geared toward an analysis of the nature of instructions. They simply documented instructional effects. In a sense, instructions were treated as an object, not a term that referred to a functional relation between environmental stimulation and the action of the organism" (Hayes et al., 1989, p. 193). Results were interpreted as if instructions about a reinforcement schedule could produce response patterns that were at odds with the actual contingencies.

In summary, the studies from the early period showed that providing instructions about a specific behavior resulted in rapid development of this behavior. Another finding was that omitting instructions about the targeted response sometimes led to a failure of acquisition of that response in a considerable number of participants. In addition, false instructions sometimes interfered with the control by the programmed contingencies. Thus, participants tended to produce behavior in accord with the instructions provided rather than in accord with the schedules of reinforcement. Finally, instructions could diminish unnecessary responding during extinction.

Period of Stagnation

The next period Hayes et al. (1989) identified was a "period of stagnation" which they say took place during the 1970s. During this period, little research was done on instructional control from a behavior analytic perspective. Hayes et al. (1989) commented that the little work that was done during this period showed that humans did in fact respond like non-humans in many situations (p. 194). They mentioned that there seemed to be a feeling of "embarrassment" within the behavior analytic field that instructions could so easily outweigh the direct contingencies. Researchers had worked ardently to demonstrate that the fundamental principles discovered in the animal laboratories could also be applied with various species (Hayes et al., 1989). A theoretical controversy arose during this period. The results of the "early period", reviewed above, showed that instructions could have a great effect on behavior. Focussing on these results, some interpreted the findings as indicating that reinforcement control in humans was limited and therefore this principle's application to humans was in doubt. Others interpreted the findings by treating instructions as discriminative stimuli that are associated with characteristic response patterns (Galizio, 1979). (For an interesting discussion related to this topic, see Hayes et al., 1989, p. 194).

In response to the theoretical controversy, Galizio (1979) undertook a comprehensive study to examine rule-governed behavior. His hypothesis was that instructions function as discriminative stimuli. As described earlier, a discriminative stimulus describes the occasion upon which reinforcement occurs. The rationale was that if instruction-following is an operant behavior, like all operant behaviors, it should be affected by reinforcement and extinction, and should come under discriminative control. Therefore, instruction-following should occur when instructions are accurate. When instructions are inaccurate, instruction-following should lead to a loss of reinforcement and therefore, instruction-following should gradually diminish. To investigate such issues, Galizio (1979) conducted four experiments all using a free-operant avoidance baseline with monetary loss as the aversive event. Participants had to turn a handle to postpone the presentation of a light which signalled monetary loss. The participants could prevent the loss of five cents, signalled by a red light and tone, by turning a handle. Scheduled losses would occur every 10 seconds unless the subject turned the handle. The schedule was composed of three 12.5 min. free-operant avoidance schedules. Depending on the component, the handle-turning response postponed a loss for either 10 s, 30 s or 60 s. There was one fourth 12.5 min. component no-loss period where participants did not need to turn the handle to prevent a loss.

In Experiment 1, Galizio (1979) assessed the role of accurate instructions on the performance of six participants. He compared the performances of participants who had received accurate instructions and who had not received any instructions about the signal lights. All participants were exposed to a preliminary orientation session when they were instructed on the functions of the session light, the loss light and the lever. Finally, they were told that lever turning would postpone the loss for 10 s or longer. Participants were then exposed to the four-ply schedule (described earlier) with no further instructions. A subsequent phase, involved the addition of instructional labels to the components of the schedule. In this phase, different lights signalled different components of the schedule. Participants received written instructions to this effect. Finally, in a last phase, the lights and components were shuffled and the written instructions withdrawn. For each participant, sessions were scheduled at a rate of eight to 12 per week, each 50 min. in duration. Without instructions, only one participant discriminated between all components of the schedule. These results supported findings by previous studies using multiple schedules (e.g. Baron et al., 1969) showing that the absence of instructions led to poor schedule control.

In Experiment 2, Galizio (1979) assessed the effects of inaccurate instructions on behavior. Four of the six subjects studied in Experiment 1 participated in this experiment. The task was identical to that of Experiment 1. In this study, all participants were exposed to the Contact condition, where behavior evoked by inaccurate instructions led to a programmed loss, and to the No Contact condition where behavior evoked no aversive consequence. In a first phase, participants were exposed, once again, to the four-ply reinforcement schedule described earlier. In a second phase, participants were exposed to the No Contact condition once again. The same stimulus lights and their accompanying written instructions were still signalling the four-ply schedule, although no loss was scheduled. After stability was reached, participants were exposed, in a third phase, to the Contact condition. The same lights and written instructions were given to the participant, however, each of the four-ply components of the schedule were activated. In a last phase, all participants were returned to No Contact condition. Results showed that participants stopped following the instructions when they made contact with the contingencies and began losing money (were punished) because of the inaccurate instructions. However, results also showed that when the participants did not make contact with the contingencies and did not lose any money, there was still instructional control by the inaccurate instructions. Instruction-following under this condition led to unnecessary responding.

In Experiment 3, Galizio tried to determine whether instruction-following, like other operant behaviors, can be brought under discriminative control. Two new participants were exposed to three phases, and the same task used in the two previous experiments. The first and third phases represented a No Contact condition where the monetary loss contingency was suspended. The second phase was a Contact phase where participants lost money if they did not turn the handle. In each of these phases, an orange light signalled to the participants that the instructions describing the four-ply (10 s, 30 s, 60 s, no loss) components of the schedule were accurate while a purple light signalled them that the instructions were inaccurate. In reality, the programmed contingency during the Contact phase was a response-loss interval of 10 s. Results showed that the participants' behavior could be brought under stimulus control as they responded only when the orange light was presented and were told that the instructions were accurate. They stopped responding following the instructions when the purple light signalled them that the instructions were inaccurate.

Finally, Experiment 4 examined with two participants from Experiment 1 whether instructions had reinforcing properties. The procedure was identical to the other experiments, except that the participants were required to turn a lever to produce the signal lights (the observing behavior) indicating the response-loss avoidance intervals described in Experiment 1. In the past experiments, these lights had come on automatically. Participants were then exposed to an observing extinction condition where the observing response no longer produced the appearance of the instruction lights. Finally, in a last phase, using the same procedure, the author provided participants with inaccurate instructions. Results showed that participants emitted the observing behavior when this behavior led to accurate instructional stimuli (the lights). There was rapid extinction of the observing response when it no longer produced the instructional stimuli. Finally, when the instructions were no longer accurate, the results indicated that the observing response neared zero and the instruction-following behavior was nearly eliminated. The author concluded that the instructional stimuli were the source of reinforcement for the lever-turning behavior. Galizio concluded that these results were in support of the position that instructions function as discriminative stimuli, "in the sense that both instructions and simple discriminative stimuli can serve as reinforcers in the observing paradigm" (p. 67).

In general, results from this study showed that instruction-following was readily acquired on an avoidance procedure. When the programmed contingencies changed however, participants persisted with their patterns of responding that had been previously effective. The author suggested that, unless a discrepancy between the instructions and the programmed contingencies was very blatant, responding was likely to be maintained by the instructional stimuli. Galizio (1979) also concluded that instruction-following behavior is an operant and can therefore be influenced by its consequences. He concluded that his view of instruction-following is consistent with Skinner's (1974) analysis of the properties of rule-governed behavior. Galizio maintained the position that instructions are a form of complex discriminative stimuli. This study spawned a series of studies on rule-governed behavior.

Modern Era

The late 1970s and the 1980s was a fruitful period in behavioral analytic work on instructional control. Hayes et al. (1989) named this period the "modern era of human operant research". According to these authors, a lesser concern for the continuity assumption characterised this period. Interest in the sources of differences between animal and human responding became greater, which lead some researchers to posit that language in humans could be in part responsible for these differences (for example, Lowe, Beasty, & Bentall, 1983).

During this era, the role of instructions became an important topic of research in the operant literature. Undeniably, instructions greatly facilitate the learning of new behaviors. However, there has emerged, in the "modern era", a body of literature on rule-governed behavior that points to a negative consequence of instructions. In the late 1970's and 1980's, experimental studies on the effects of instructions concluded that behavior under the control of instructions is likely to follow the instructions and not change when the schedule of reinforcement changes. The bulk of the studies during this period have shown that rule-governed behavior, unlike contingency-shaped behavior, may be insensitive to a change in the environment and that instructions may interfere with the learning of a new behavior. This result is often referred to as the "insensitivity of rule-governed behavior" effect.

Matthews, Shimoff, Catania, and Sagvolden (1977) investigated why human responding often appears to be less sensitive to schedule control than is that of other species. They assumed that differences between human and animal operant performances were due to procedural differences in establishing the behavior and giving the reinforcement. First, animal performance is always established through shaping while with humans responding can be established with the use of instructions, modelling or shaping. Second, reinforcement of animal responding usually involves a consummatory response (e.g. eating), which interrupts the operant behavior. The reinforcement of human operant responding usually does not involve consummatory response. In this study, Matthews et al. (1977) established human responding on a telegraph key either by shaping or by using modelling "instructions" (experimenter pressed the telegraph key). For some participants the reinforcement necessitated a consummatory response (of pressing a button to add a point to a counter) while for others, a consummatory response was not required. They assessed sensitivity to contingencies by using 18 pairs of subjects. One subject of each pair was exposed to a variable-ratio (VR) schedule and the second to a yoked variable-interval (VI) schedule. In this yoking procedure, when the person on the VR schedule received a reinforcement, the experimenters arranged for the other member of the pair, under a VI schedule, to also receive a reinforcement for the next key press. The interreinforcement intervals for the yoked member of the pair (VI schedule member) were determined by the responding of the VR member of the pair and equalled his/her interreinforcement intervals. By using the yoking procedure, differences in response rates would be attributed to differences between the ratio and interval contingencies, since the distribution of reinforcers was equivalent temporally and the number of distributed reinforcement was equated. Responding was considered sensitive if the VR schedule maintained higher response rates than the VI schedule.

The results indicated schedule sensitivity when key pressing was established by shaping. As expected, the VR schedules maintained higher response rates than did the VI schedules. The authors reported that instructed responding (through modelling) was insensitive to the difference between the ratio and interval contingencies as compared to shaped responding. When there was no consummatory response, schedule sensitivity was present in only two of the five pairs. They concluded that schedule sensitivity therefore depended on both shaped responding and the consummatory response.

In previous experiments (Kaufman et al., 1966; Baron et al., 1969; Matthews et al., 1977) where the sensitivity of rule-governed behavior had been assessed, response rates were higher than what the programmed contingencies called for. Shimoff, Catania, and Matthews (1981) questioned whether instructed lower rates of responding could also be insensitive to contingencies. Twenty-one students participated in this study. Key pressing was shaped for 11 of the participants, while for the other 10, key pressing was established with the help of instructions. The schedules were introduced only once responding was established either by instructions or by shaping through reinforcement of successive approximations. Sessions lasted 50 minutes each and participants usually received three sessions. Low rates of responding were maintained by using a random-interval (RI 15 s) (Experiment 1) or a random-ratio (RR) schedule (Experiment 2) with superimposed differential-reinforcement-of-low-rate (DRL) contingencies. A RI schedule is very similar to a VI schedule, and an RR schedule is very similar to a VR schedule. Instead of varying towards a mean value however, the RI and RR schedules present variability randomly. Often, probability generators are used to program the schedule. During a DRL schedule, participants need to wait a certain period of time between responses in order to receive reinforcement; a response made before this set period of time is elapsed, resets the clock to zero. A superimposed schedule means that following (in this case) 15 seconds after the last collection of a point, only the first response terminating an interresponse time (IRT) greater than 3 seconds (Experiment 1) and 4 seconds (Experiment 2) was reinforced. The authors then tested for sensitivity by making a change in the reinforcement schedule. During this test phase, they discontinued the DRL component (Experiment 1) or reduced the DRL to 1 second (Experiment 2).

Subjects sensitive to the change should have demonstrated an increase in responding following this change. The results demonstrated that during the sensitivity test phase (no DRL or DRL 1 s), shaped responding usually increased and was sensitive to the change, while instructed responding usually continued at a low-rate, despite the loss of reinforcement. Although instructions delayed sensitivity to a change in contingencies, they did not permanently prevent its development in that responding eventually increased in rate. The authors concluded that low-rate responding which is established by shaping is generally sensitive to changes in contingencies.

However, low-rate responding which is established with the use of instructions may be insensitive to changes in contingencies.

Catania, Matthews, and Shimoff (1982) examined whether the distinction between rule-governed and contingency-governed behavior is applicable to verbal as well as non verbal behavior. The targeted nonverbal behavior was button-pressing while the verbal behavior was written sentence completion. A multiple reinforcement random-ratio and random-interval (RR 20/RI 10-s) schedule was in effect with 50 participants during a button pressing task. There were two red buttons, each beneath a lamp. In most conditions, the RR schedule was associated with the left-button presses while the RI schedule was associated with the right-button presses. However, during some conditions without any warning, the assignment of the schedules to the red buttons was reversed. The lamps over the two red buttons would light alternately. During interruptions in the task, participants were asked to complete guess sheets (describing how to best earn points). Some of the participants were instructed what to guess and received points for guesses consistent with instructions; others were shaped across guesses and received points for responses that approximated more and more the desired response; finally others did not receive differential consequences for their guesses (they received points for every guess sheet they handed in). During reversal of the assignment schedule/red buttons, the participants continued to be reinforced for guesses that were in accordance with the conditions prior to reversal of schedules. The results showed that, when guesses were shaped, there was a correspondence between the verbal (guesses) and non verbal (button-pressing) behaviors, even when the rate of responding was opposite to the scheduled contingencies of reinforcement. However, when guesses were instructed, a correspondence between the verbal and non verbal behaviors was not necessarily found. Guessing without differential consequences did not lead to differential rates on the two red buttons. The authors concluded that there is more likely to exist a correspondence between nonverbal and verbal behaviors when verbal behaviors are shaped rather than instructed. They also concluded that the distinction between rule-governed and contingency-shaped behavior is relevant to verbal behaviors as well as non verbal behaviors. The authors suggested that an effective way of changing non verbal behavior in humans may be to change their verbal behavior and private talk.

As a follow-up to their 1982 study, Matthews, Catania, and Shimoff (1985) studied more specifically the nature of instructions with seven new participants. The procedure for this experiment was identical to that of Catania, et al. (1982). Matthews, et al. (1985) distinguished between two forms of instructions: "performance" descriptions and "contingency" descriptions. The former refers to a description such as "push rapidly on the right hand button", while a contingency description could be for example "push eight times for the green light to go on".

Matthews, et al. (1985) were considering whether one form of instructions or another led to greater sensitivity to the programmed contingencies following a change. In their earlier study, Catania et al. (1982) had used performance descriptions, only, in their procedure. In the 1985 study, participants' guesses were shaped to produce either performance or contingency descriptions. The procedures in this experiment were very similar to those described in Catania et al. (1982). The button-pressing behavior was occasionally reinforced by points exchangeable for money. A multiple random-ratio (RR) random-interval (RI) schedule was in effect throughout the session. Each component of the schedule was associated with a different light. The seven participants received instructions informing them that there were two ways to acquire points: 1) by pressing the buttons, and 2) by guessing. After 3 min. (1.5 min. of each component of the schedule), participants were asked to fill out their guess sheets. This schedule cycle was repeated

8 to 12 times within a session. The experimenter shaped responding through the reinforcement of successive approximations of the targeted behavior. All participants were at some point (different for each participant) shaped for contingency descriptions while at another point they were shaped for performance descriptions. Also during various periods of the session, a reversal of the RR and RI schedules was introduced. Results showed that when participants were shaped to produce performance descriptions, the button-pressing behavior was consistent with the verbal behavior, even when the actual schedule would have commanded an opposite rate of responding. These results were congruent with the Catania et al. (1982) results. However, when contingency descriptions were shaped, the button-pressing rates were not consistently related to the verbal descriptions. Therefore, participants producing contingency descriptions, did not necessarily show a correspondence between what they said and what they did. In sum, the authors concluded that performance descriptions led to consistent effects on behavior while the contingency descriptions produced more variable effects.

Hayes, Brownstein, Zettle, Rosenfarb and Korn (1986) used multiple schedules of reinforcement to directly compare contingency sensitivity produced by high-rate and low-rate instructions. In Experiment 1, 17 subjects were randomly assigned to one of four groups: (1) Minimal instructions, (2) "Go Fast" instructions, (3) "Go Slow" instructions, and an (4) Accurate Rate instructions group. Movement of a light through a 5 X 5 matrix was possible through button pressing according to a multiple differential-reinforcement-of-low-rate 6 seconds (DRL 6 s)/fixed-ratio 18 (FR 18) schedule; the components of the schedule alternated every 2 minutes. A square red light on top of the buttons was associated with the DRL component while a square orange light was associated with the FR component. The participants responded during three consecutive sessions of 32 minutes each. When the white light in the matrix reached the bottom right hand corner, a round red light would lit and the subject would press a button to collect a point (exchangeable for money prizes or a chance for prizes).

The Minimal instructions group was informed that the round red light would occasionally go on, and during this time a push on a middle button would advance the counter by one point. They were simply told that getting the round red light to go on involved two buttons and the lights on top of the buttons. The "Go Slow" group was given these minimal instructions plus they were also told to push slowly on the buttons. The "Go Fast" group were also given the minimal instructions plus they were told to push rapidly on the buttons. The Accurate Rate group, in addition to the minimal instructions, were informed that when one of the square lights on top of the buttons was lit, rapid pushes on the buttons would work best, while when another square light was lit, waiting several seconds between pushes would work best.

Schedule sensitivity was apparent if participants displayed low rates of responding on the DRL component and high rate responding on the FR component. By the third session, all subjects in the Minimal instructions group were responding at different rates on the two components of the schedule. However, none of them obtained more than two points on both schedules. Most of the points were obtained in the FR component. The authors reported great variability in behavior across schedule components and participants. Participants in the Go Fast group, by the end of the third session, were exhibiting higher response rates in the FR component of the schedule. Half of the subjects (2) earned points in the FR component only, while the other two earned points in both components. In the Go Slow group, three of the five participants responded with different rates to the two components of the multiple schedule. However, four of the five subjects primarily earned points in the DRL component. Finally, in the Accurate Rate instructions group, almost immediately, all four subjects showed differential responding on the two components of the schedule. By the third session, all subjects in this group were earning at least 15 points in both components of the schedule. The authors concluded that instructions had an impact on the participants' responding patterns. Participants' responding was influenced by the current consequences of the responding and also by the instructions provided. They noted that instructions seemed to affect the range of behavior displayed by the participants, and therefore to directly influence whether they made contact with the programmed contingencies.

In Experiment 2, the authors attempted to separate two sources of control that may have contributed to the effects of instructions: 1) the range of behavior available to make contact with the contingencies; and 2) social contingencies added by instructions that may compete with the programmed contingencies. The first source of control refers to the authors' contention that instructions affect the range of behaviors displayed by a participant. For example as seen in Experiment 1, "Go Slow" instructions will bring mostly low-rate responding. When the behavioral repertoire has been decreased this way, participants may therefore not emit other behaviors that would permit contact with the new programmed contingencies. The second source of control refers to humans' long history of compliance to instructions and "doing what they're told". The authors studied these sources of control by introducing instructions and then withdrawing them. Twenty-five new participants, were exposed to the same multiple DRL 6 s/FR 18 schedule as in Experiment 1, where components of the schedule alternated every two minutes. In addition to the apparatus described in Experiment 1, there were two new lights on the control panel. These lights were situated near the 5X5 matrix and each had a different label beside it. One saying "Go Slow" and the other "Go Fast". Participants were randomly assigned to one of six groups. Two groups were given only the Go Slow light, two others only the Go Fast light, and the final two, the Go Fast and Go Slow lights, alternating every minute. In each of these three conditions, half the subjects had all instruction light(s) turned off (and therefore received no instructions) after the first session; while for the other half, the light(s) were lit for all three sessions. A critical comparison in this study, to separate the two sources of control mentioned above, was between subjects with the instruction lights on for the first session only, as compared to those with the instruction lights on for all three sessions. If the source of control was attributable to the range of behavior available to make contact with contingencies, participants (with one session of instruction lights) would have continued to respond according to instructions even after these had been withdrawn. The participant's repertoire would have been restricted by the instructions given initially. However, if the source of control was attributable to the social contingencies for rule-following, the instruction effects would have dissipated once the instructions had been removed after the first session. Participants would no longer need to behave "as told". Evidence was found for both sources of control.

Result showed that in the Go Slow and in the Go Fast conditions, removing the instruction lights after one session did not increase responding according to the programmed contingencies. Participants kept responding according to the instructions even after their removal. Participants in the Go Fast-Go Slow group receiving alternating signals every minute for only one session differed from those with alternating signals for all three sessions. Almost all subjects in this condition for three sessions showed control by the instructions regardless of which schedule component of the multiple schedule was in action. Most of the points earned by the subjects were obtained when the lights matched the schedule in operation. Subjects in this condition for one session demonstrated control by the instructions lights for the initial session in which the lights were operative. However, when the lights were removed, subjects quickly responded according to the programmed contingencies.

Hayes, Brownstein, Zettle et al. (1986) concluded that instructions tended to interfere with responding when contingencies of reinforcement changed. They stated that the insensitivity of rule-governed behavior was due to competing contingencies (two sources of control). First, instructional prompts (lights) can override the control by the programmed contingencies. In other words, subjects will respond according to the instructions (lights) and do as they're told rather than according to the programmed contingencies. Second, their results also suggested that instructing participants on more than one way to respond may have taught them to vary their behavior. Instructing participants on "Go Fast-Go Slow", led them to adapt more quickly to the change in contingencies, than if they had been given only "Go Slow" or only "Go Fast" instructions. Participants instructed on a broader range of behaviors ("Go Fast-Go Slow") presented a greater array of behaviors, some of which were eventually reinforced when the programmed contingencies changed. The authors concluded that the range of behavior instructed to make contact with contingencies may be another factor responsible for the effects instructions have on behavior.

Hayes, Brownstein, Haas, and Greenway (1986) examined the degree of agreement between two types of assessment of schedule sensitivity. They wanted to see whether the two methods of assessment found in the literature were comparable. One method used to measure sensitivity had been to develop steady-state responding on a given schedule, and then to make an unannounced change to the schedule. The main objective in the Shimoff et al. (1981) study for example, was to investigate whether participants would adjust their responding following a change from a random-interval schedule to extinction. A second approach had involved using multiple schedules of reinforcement (e.g. DRL 6 s/fixed-ratio 18), and frequently alternating the components of the schedule (e.g., see Hayes, Brownstein, Zettle et al., 1986). Using this second approach, the goal was to see whether subjects would respond in accordance with each component of the schedule when it was in effect. Hayes, Brownstein, Haas, and Greenway (1986) combined the two approaches. After establishing steady-state responding on a multiple schedule, they introduced an unannounced change to the schedule, so that both components were extinction. The 55 participants were assigned to one of four groups: (1) Minimal instructions, (2) "Go Fast" instructions, (3) "Go Slow" instructions, and (4) Accurate Rule instructions. These were the same as those described by Hayes, Brownstein, Zettle et al. (1986). Sessions 1 and 2 consisted of a training phase. During these sessions, in a task very similar to that used by Hayes, Brownstein, Zettle et al. (1986), subjects were able to move a plus sign in a 5X5 matrix on a computer screen, according to a multiple DRL 6 s/FR 18 schedule. Schedules alternated every two minutes. During session 3, there was a change to extinction, with no reinforcement available, regardless of the button-pressing patterns.

Results showed a relation between schedule sensitivity in the multiple schedule and sensitivity during the extinction session. The authors found that when there was little schedule control in the multiple schedule (session 2), there was also little sensitivity during the extinction session. However, for subjects who showed schedule sensitivity in the multiple schedule session (session 2), schedule sensitivity during extinction varied depending on the instructions received. Sensitivity during extinction, which took the form of a decrease in responding, occurred only with subjects whose differential responding in the multiple schedule of session 2 was not due to the instructions supplied. In other words, subjects who had received more elaborate instructions in session 2, and developed differential responding, were more insensitive to a change in contingencies in that they were more likely to take longer to decrease their rate of responding during the extinction session.

Rosenfarb, Newland, Brannon, and Howey (1992) designed a study to compare the effects of self-developed instructions and externally given instructions on the performance of participants during a button-pressing task. The authors hypothesised that self-instructions (like external instructions) may facilitate learning by bringing behavior under the control of the contingencies sooner. But as with external instructions, self-instructions may render the behavior more insensitive to a change in contingencies. In a task similar to Hayes, Brownstein, Zettle et al. (1986) and Hayes, Brownstein, Haas et al. (1986), twenty-nine participants responded under a multiple DRL 5 s/FR 8 schedule alternating every two minutes, during a period of acquisition and maintenance, followed by a period of extinction. Behavior was sensitive to the contingencies if it decreased in rate during the extinction period. During acquisition, some of the participants were asked to formulate rules (self-generated rules condition) that best described the contingencies of reinforcement. Another group of participants were yoked (yoked condition) to the first group and given as instructions the rules that participants in the self-generated rules condition had presented. A third group received only minimal instructions and were not asked to formulate any rules.

Results revealed that, during acquisition, participants who were asked to develop rules developed schedule appropriate behavior quicker than those participants not asked to formulate rules. The responding of participants in the yoked condition, given the instructions formulated by the self-rules group, closely resembled that of the self-rules group. During the extinction session, results showed that only three of the nine participants in the self-generated rules condition were sensitive to the change in contingencies and significantly lowered their responding and only two of the five yoked instructions participants similarly lowered their responding. However, all ten participants given minimal instructions lowered their responding during the extinction session to a rate of less than 30 presses per minute. The authors concluded that self-generated instructions seemed to function very similarly to externally given instructions, in that they seemed to facilitate learning but they also rendered behavior less sensitive to change.

LeFrancois, Chase, and Joyce (1988) studied the effects of exposing participants to a variety of instructions about multiple schedules in an attempt to counteract the insensitivity of rule-governed behavior. They hypothesised that exposure to instructions on a variety of schedules might produce responding that would change when contingencies changed. Ninety subjects participated in this study. The participants were randomly assigned to one of six conditions: (1) Specific instructions variable interval, (2) Specific instructions variable ratio, (3) Minimal instructions variable interval, (4) Minimal instructions variable ratio, (5) Variety 1, a series of fixed-time, variable-interval, fixed-ratio, and DRL schedules, and (6) Variety 2, a similar series but in a different order. Subjects were presented with a computer task where they had to press a button for points. For all subjects, the experiment consisted of three phases: a training phase (32 min.), a testing phase (at least 25 min.) and an extinction phase (10 min.). All participants' sensitivity to contingency changes was assessed during the testing phase (FI 30 s) and during the unannounced extinction phase. Responding was insensitive to a change in contingencies if, during the FI 30 s testing phase, the rates were high. Participants' responding was also insensitive if they responded during the extinction phase as they had during the previous FI 30 s testing phase.

In the training phase for each specific instruction condition, subjects were exposed to one schedule of reinforcement (VI 30 s or VR 80) and were specifically instructed on the number of button-presses to receive reinforcement. The Minimal instructions groups received vague instructions informing them it was up to them to figure out how to respond. Like the Specific instructions groups, the two Variety instructions groups received, before each schedule was in effect, specific instructions on the schedule (e.g., the number of presses required). These subjects were exposed to a different reinforcement schedule every four minutes. The eight schedules for Variety 1 were FR 60, FR 100, DRL 15 s, DRL 45 s, FT 15 s, FT 45 s, VI 20 s, and VI 40 s. The eight schedules for Variety 2 were FT 45 s, FR 40, FR 100, VI 40 s, VI 60 s, FT 15 s, VI 20 s, FR 60.

During the testing phase, an FI 30 s schedule was in effect for all subjects. In this session, participants were told "It is now up to you to figure out how to best earn points". Twenty-five minutes into the schedule, a stability criterion was calculated. If stability had been achieved, the participant moved on to the extinction phase. If behavior was not stable, the FI 30 s session continued until behavior had attained the stability criterion. The extinction phase started once the subjects met a stability criterion and lasted 10 minutes.

Results showed that 25 of the 30 subjects in the Variety instructions groups changed their responding from the training phase to the testing phase. Across the four other groups, only 14 of the 60 subjects changed their response rates from training to testing. Statistical analyses revealed that response rates under the FI schedule of the testing phase were significantly lower in the two Variety instructions groups than in the other groups. During the testing phase, the Minimal and Specific instruction groups emitted rates of responding that were similar to the rates exhibited during the training phase.

In the final phase (extinction), results showed that 40 of the 60 subjects in the single reinforcement schedule kept responding as they had in the FI schedule. In contrast, only 6 of the 30 subjects in the variety of schedules condition continued to respond in the extinction phase as they had during FI phase (testing phase).

The results showed that giving participants a variety of instructions about the programmed contingencies led to greater sensitivity to a change in contingencies than giving them an instruction about a single schedule of reinforcement. LeFrancois et al. (1988) concluded that exposing participants to a variety of different schedules and having them produce schedule appropriate behavior under these schedules may be enough to assure sensitivity to changing contingencies. According to the authors, a possible explanation of these results might be that the variety conditions involved changing response patterns in the participants. The variety conditions may have cultivated specific response patterns that were tried out in the change session when the FI schedule was in effect. The authors concluded with this statement "Instructed behavior may be sensitive to changing conditions if the instructions prompt a range of behavior that overlaps with efficient behavior under the changing conditions" (LeFrancois et al., 1988, p.391). In conclusion, the results indicated that under certain conditions, human responding under the control of instructions can be sensitive to changes in contingencies.

Joyce and Chase (1990) also examined the relationship between response variability and sensitivity to changes in reinforcement contingencies in a button pressing task. They hypothesised that the insensitivity to changing contingencies is due to the lack of variability in behavior produced by the instructions; therefore, instructions that allowed for variability, might be more likely to produce responding that is sensitive to changes in contingencies. The apparatus consisted of a computer, with two buttons exposed on the keyboard. One was for earning points (marked "Earn") and one was for registering points (marked "Register"). When a point was earned, a beep was heard and a press on the register button increased the number displayed on the screen, which represented the number of reinforcers earned. Points earned were exchangeable for money.

In Experiment 1, 19 subjects were randomly assigned to one of four groups: (1) Complete instructions with stability criterion (CI-stable), (2) Complete Instructions without a stability criterion (CI-short exposure), (3) Incomplete Instructions with a stability criterion (II-stable), and (4) Incomplete Instructions without a stability criterion (II-short exposure). Each group contained four or five participants. The complete instructions described the stimuli and the contingencies, plus the specific form of the response (e.g., press 40 times). The incomplete instructions did not describe the pattern of responding necessary to obtain a reinforcer.

Sessions lasted approximately 20 minutes with no more than three sessions conducted during one day. Only the two stable condition groups participated in a pre-training condition where responding was established under a FR 40 schedule, until they met a stability criterion. All four groups then participated in four sensitivity testing sessions where subjects were exposed to a FR 40 schedule until they had earned six reinforcers, followed by 15 minutes of exposure to an unannounced sensitivity testing session (FI 10 s schedule). The two short exposure groups received this as their initial session. The two Incomplete Instructions groups were told that it was up to them to figure out how best to earn points. The Complete Instructions groups were told to press on the button 40 times to earn points.

The authors measured sensitivity to contingencies by calculating the efficiency of responding under the FI 10 s schedule. This was calculated by dividing the number of responses in the last 5 minutes of the FI 10 schedule by the total number of reinforcers available during that period. During the sensitivity testing sessions, variability in responding was also measured. The authors measured variability during the FR 40 reinforcement schedule by calculating the distribution of interresponse times (IRTs). Greater IRTs would show greater variability during the FR 40 schedule.

During the sensitivity testing sessions, during the FR 40 schedule and prior to the contingency change (FI 10 s), subjects in the II-short exposure group displayed the greatest variability in behavior. The results also showed that the greatest efficiency and therefore sensitivity was exhibited by the II-short exposure and the CI-short exposure groups. Joyce and Chase (1990) concluded that once responding to a schedule had reached stability either by exposure to the contingencies or by instructions, behavior became insensitive to a change in contingencies.

In Experiment 2, Joyce and Chase (1990) investigated whether responding that had become stable would become more variable following the introduction of an instruction to respond variably. They then assessed whether this responding would be sensitive to a change in contingencies. Only six subjects participated in this experiment. They were randomly assigned to an incomplete instructions group (IC) or a complete instructions group (CI) for responding on the FR 40 schedule. There were three experimental conditions to which all subjects were exposed: 1) a training condition (FR 40 to stability); 2) a baseline sensitivity condition (FR 40, FI 10 s schedule); 3) a strategic instructions condition (where participants were instructed to respond variably (a FR 40, FI 10 s schedule was in effect).

During the training condition, responding was established under an FR 40 schedule. Subjects of both groups responded until a stability criterion was attained. Once the responding was stable, subjects were exposed to the baseline sensitivity session where they responded to a FR 40 schedule until six reinforcers had been earned. The schedule then changed to an unannounced FI 10 s schedule for a period of 15 minutes. A strategic instruction session followed the FI 10 s schedule. First, all subjects were given instructions (the authors referred to this as a strategic instruction) to vary their speed of responding. Then responding was reinforced under the FR 40 schedule until six reinforcers had been accumulated. The unannounced FI 10 s schedule was again in effect for 15 minutes. Each experimental condition (training, baseline sensitivity and strategic instruction) was then repeated.

The authors found that introducing a strategic instruction increased response variability in both groups. Efficiency ratios showed that no subject in either group responded efficiently in the FI component of the initial baseline sensitivity session. However, following the first strategic instruction session, all subjects showed sensitivity to the contingency change and increased their efficiency ratios on the FI 10 s schedule. Following a return to a baseline sensitivity session, the efficiency of responding decreased for all subjects. Responding rates were very high during the FI 10 s schedule. During the second strategic instruction session, efficient responding under the FI 10 s schedule returned. The authors concluded that, as in Experiment 1, stable instructed responding was insensitive to a change in contingencies, whether or not the behavior had been completely instructed. The results of this experiment showed that variability could be increased by using a strategic instruction. Subsequently, subjects showed greater sensitivity to a change in contingencies. The authors concluded that behavior variability is important to contingency sensitivity, and may account for the "insensitivity of rule-governed behavior" effect. An important limit of these two studies is the very small number of participants used.

Overview of the cognitive approach to rule-governed behavior

Overskeid (1995) reported that through the centuries, philosophers have distinguished between two forms of knowledge. One form related to knowledge acquired through the use of rules, maxims or hypotheses. The other form of knowledge is more difficult to describe verbally; it is usually acquired through practice. Different schools of thought have, at different times, addressed these issues (Overskeid, 1995). However, a lack of integration seems to have plagued the writings on this topic. In the field of psychology, behaviorists and cognitivists have not been the exception and have had poor communication on these two forms of knowledge.

Behavior analysts have investigated the two above-mentioned forms of knowledge and identified them as "rule-governed" and "contingency-shaped" behaviors, both of which have been described in detail earlier in the introduction. In the cognitive literature, Overskeid (1995) points out that reference to these concepts also exists and have been identified using various terminology: "controlled" versus "automatic" processing (e.g., Schneider & Shiffrin, 1977), "explicit" versus "implicit" knowledge (e.g., Berry & Broadbent, 1988), or "declarative" versus "procedural" knowledge (e.g., Lewicki, Hill, & Bizot, 1988). Hunt (1984, p. 597), a researcher from the cognitive tradition wrote:

> Skinners' distinction between rule-governed and contingency-shaped behavior bears more than a superficial resemblance to the 1980's distinction between controlled and automatic processing... Presumably a good deal of effort could have been saved if Skinner's paper [An operant analysis of problem solving, 1966] had been read more carefully by the information-processing psychologists.

Controlled processes refer to mental processes that require focussed attention and effort. For example, a person trying to do a mathematical calculation will need to focus on the task. Usually, the individual will not be able to attend to another task. Automatic processes refer to mental processes that necessitate very little attention, for example, driving a car. Many activities can take place (listening to the radio, talking to someone) while a person is driving (Stillings & al., 1987).

Learning is considered "explicit", when the person is given "deliberate instructions to search for the rules that underlie some set of materials" (Berry & Broadbent, 1988). Learning may however be implicit when the person is only asked to memorize the specific material given, but manages to learn the underlying rules (Berry & Broadbent, 1988). These authors conclude that "the explicit mode of learning is characteristic of that generally adopted by subjects in standard problem-solving experiments". The explicit mode involves evaluating hypotheses, applying rules and other similar conscious processes. Berry and Broadbent (1988) also conclude however that very little is known about implicit processes. The more complex the task, the more the implicit mode seems to have an impact on learning (Berry & Broadbent, 1988).

Declarative knowledge refers to the "knowing that". According to Stillings et al. (1987), "declarative is simply a way of referring to the static, fact-like nature of representations: they are inert structures that are operated on by processes". For example, knowing your friend's telephone number would represent declarative knowledge. Procedural knowledge has been described as knowledge where the person is unable to articulate the rules involved. It refers to the "knowing how" to do something. Lewicki et al. (1988) gave the example where people are unable to clearly articulate the most basic proportions of a human's face. However, when faced with pictures of human faces that are not proportioned, they will be able to recognize that "something is not right". Procedural knowledge usually refer to tasks that are done automatically.

A major issue in the studies concerned with implicit/procedural versus explicit/declarative knowledge has been the degree to which learning without awareness is possible in humans (Overskeid, 1995). There has been resistance in the cognitive literature to accept that unconscious learning or the learning of rules which are not verbalized is possible (e.g., Brewer, 1974).

In his review of Pavlovian and operant conditioning of human behavior, Brewer (1974, p. 1) presented arguments to show that "conditioning in human subjects is produced through the operation of higher mental processes, rather than vice versa" or in other words, that unconscious learning is not possible. According to Brewer (1974), the naive subject comes to an experiment curious about what will happen. In operant conditioning situations, he/she develops hypotheses about the reinforcement contingency. He adds that "in operant autonomic conditioning, subjects should condition only to the extent that he can develop a conscious cognitive strategy which allows him to bring his autonomic responses under voluntary control" (1974, p. 3).

Brewer (1974) took any demonstration of instructional control as evidence that conditioning had not taken place. He reviewed some of the articles mentioned earlier in the introduction (Baron et al., 1969; Weiner, 1970; Lippman & Meyer, 1967). Behaviorists have criticized Brewer's review as having ignored the behavior-analytic account of verbal behavior. Contemporary cognitivist work on this topic seems to have seriously undermined some of Brewer's arguments however (e.g., Reese, 1989). There now seems to be a greater acceptance of unconscious processes within the cognitivist tradition. Reese (1989) criticized Brewer's (1974) criterion for awareness of rule use. According to Reese (1989, p. 51), "one problem is that "awareness" cannot be assessed directly". He points to a distinction between "awareness" and "reported awareness". He denounces that "awareness of using a particular rule is therefore sometimes taken as evidence that the rule was actually used" (1989, p. 51).

In conclusion, early on, a source of disagreement between the behaviorist and cognitivist approaches to rule use and rule-governed behavior has been the notion of awareness or consciousness of rule use during conditioning experiments. However, more recent cognitivist studies have accepted that humans may not be able to describe the rules (e.g., Kilhlstrom, 1984). An evolution in the behaviorist perspective is also becoming increasingly evident. The behavior analytic literature on rule-governed behavior has shown that behavior analysts are attributing greater importance to the interrelationship between verbal and non verbal behaviors.

Conclusion and Rationale for Experiments 1 and 2

In sum, research during the modern era of human operant has shown that instructions interfere with the sensitivity of behavior to changing contingencies (Matthews et al., 1977; Hayes, Brownstein, Zettle et al., 1986; LeFrancois et al., 1988). This research has also shown that non verbal behavior is more likely to be influenced by shaped verbalizations than by instructed verbalizations (Catania et al., 1982). This finding was refined in a subsequent research (Matthews et al., 1985) where the correspondence between verbal and non verbal behavior depended on the type of verbalizations that were shaped (performance or contingency). Also, self-instructions, like external instructions facilitate the acquisition of behavior, but as with external instructions, they render behavior more insensitive to a change in contingencies (Rosenfarb et al., 1992). Various factors have been identified as moderators of the insensitivity of rule-governed behavior. Punishment for following inaccurate instructions brought greater sensitivity in behavior following a change in schedules of reinforcement (Galizio, 1979). Giving participants a history of responding to a variety of instructions was more likely to induce an adjustment in responding following a contingency change, than giving them a single instruction about one reinforcement schedule (LeFrancois et al., 1988). Finally, variability in behavior prior to the contingency change is more likely to bring sensitivity in responding, than behavior that is stable prior to the change (Joyce & Chase, 1990).

Expanding the collection of means of counteracting the insensitivity of rule-governed behavior might prove worthwhile, as research has demonstrated the utility of rules and instructions. We may for example speculate that a simple warning that "conditions may change" might render behavior that is under the control of instructions, more likely to be sensitive to a change in reinforcement schedule.

A series of four experiments reported below were designed to attempt to replicate previous "insensitivity of rule-governed behavior" findings and expand our knowledge of why rules produce this insensitivity. Experiment 1 investigated (a) the effects of instructions on the speed and accuracy with which a new behavior was learned; b) the "sensitivity" or rapidity of adjustment of the behavior to an unannounced change in contingencies as a function of whether it had been learned with the help of instructions; and c) the effect of a simple warning that "conditions may change at any time" on the behavior's rapidity of adjustment to changes in contingencies.

Experiment 1

Introduction

Previous experiments that have investigated the insensitivity of rule-governed behavior had relatively small samples and most have not used statistics to evaluate the results. This Experiment contained sufficient numbers of participants to permit the application of statistics to analyze the data. The method and procedure used for this study were very similar to those of Hayes, Brownstein, Haas et al. (1986). The sensitivity of a rule-governed behavior was assessed by using a multiple differential-reinforcement-of-low-rate 6 seconds (DRL 6 s)/fixed-ratio 18 (FR 18) schedule, and making an unannounced change in both components of the schedule to extinction. Behavior is said to be insensitive to a change in the environment when it still follows a set of contingencies even though they are no longer in effect and does not change when the schedule of reinforcement changes. Insensitivity would be shown if responding during the Change Phase (extinction session) persisted in the low/high behavioral pattern established during the first two Training Sessions. In Hayes, Brownstein, Haas et al. (1986), the schedule components alternated every two minutes. Preliminary work in our laboratory had shown that alternating the DRL/FR schedules every 2 minutes allowed participants from all groups to learn the task very rapidly. As a result, it was very difficult to assess differences in speed and accuracy of acquisition between the Minimal and Elaborate Instructions groups. In order to differentiate between groups in this study, the task was made more difficult by having the DRL/FR components of the schedule alternate every minute. In addition, for some groups, the effect of a warning that "conditions may change at any time" was also assessed.

Based on the literature, it was hypothesized that participants in the Elaborate Instructions groups would come under the control of both components of the multiple schedule more rapidly than would participants in the Minimal Instructions groups. In addition, participants in the Minimal Instructions groups would change their behavior more quickly than the Elaborate Instructions groups following the unannounced change to extinction. Finally, participants in the Warning groups would be more sensitive to the changing contingencies than the No Warning groups. The Warning groups would decrease their responding more quickly following the change to extinction.

Method

Participants

Seventy-one undergraduate students (48 females and 23 males) from the University of Ottawa volunteered to participate in this study. Participants were recruited from various undergraduate classes. The average age was 23 years with a range of 19 to 43 years. Fifty-nine participants met the Training Criterion and were included in this experiment. Participants were randomly assigned to one of four groups: Minimal Instructions - No Warning (MNW), Minimal Instructions - Warning (MW), Elaborate Instructions - No Warning (ENW), Elaborate Instructions - Warning (EW). To be included in the experiment, participants had to meet a Training Criterion (described below) in the Training Phase.

Setting and Apparatus

All participants were tested individually. They were seated in a small room at a table before a Commodore 64 computer. The keyboard was covered by a template that exposed only two keys (D and L). The symbols on these keys were covered with masking tape. The computer screen presented a 5X5 matrix of 4 cm wide by 3.5 cm high rectangles. At onset, a circle (about 10 mm in diameter) was found in the upper left rectangle of the matrix. The subject could move the circle by using the two exposed keys. The pattern of responding on the keys required to move the circle was governed by the schedule described below. As schedule components alternated every minute, a border surrounding the matrix alternated from black to white. The computer was connected to a printer, situated in an adjoining room. The printout indicated the number of movements right, the number of movements down, and the number of times the participant moved the circle down to the bottom right hand corner of the matrix.

Procedure

Three sessions were conducted with a short break (about 2-3 minutes) between each. The first two sessions were considered Training Sessions and lasted 24 minutes, and 20 minutes respectively. The last session or Change Phase lasted 24 minutes. In this last session, no movement of the circle was possible. At the beginning of each session, all participants were asked to read the following general printed instructions:

> This is a straightforward study concerning learning processes. It is a not a psychological test and it does not involve any deception. During this study, you will be alone in this room except for two brief breaks when I will be with you while the computer is printing. Your task is to move the circle from the upper left corner to the bottom right corner as many times as you can. Moving the circle involves these two buttons and the color of the border around the screen.

The MNW group was given only these instructions to read. The participants assigned to the MW group were given these instructions with an added warning printed at the end that "Conditions may change at any time". This warning was provided at the beginning of Sessions 2 and 3, but not at the beginning of Session 1. The participants in the Elaborate Instructions groups (both with and without Warning) were given these additional instructions following the original set of instructions:

> When the screen border is dark, the best way to push the buttons is slowly with several seconds between each push, and when the screen border is light, the best way to push the buttons is rapidly.

Before Sessions 2 and 3 but not Session 1, the EW group received in addition to these instructions, the printed warning that "Conditions may change at any time". Participants' questions were answered by re-reading the appropriate section of the written instructions. Before the experiment began, participants were verbally instructed to use only the two keys exposed, using only one finger. The Experimenter reviewed the instructions with the participant by pointing to the two exposed keys on the keyboard, to the circle on the top left hand corner of the screen, and to the border around the matrix on the screen. Participants were then given a consent form to read and sign and were left alone to begin the experiment.

Training Phase: Sessions 1 and 2. The experimenter activated the program before leaving the room. The goal of the participant was to bring the circle from the upper left hand corner to the bottom right hand corner, using the two exposed keys. The left key (D) moved the circle down one row while the right key (L) moved the circle one column to the right. When the circle was in the bottom row, pressing the left key reset the circle to its starting position in the upper left corner of the matrix. Similarly, when the circle was in the right hand column, pressing the right key reset the circle to its starting position. During the Training Phase, a multiple DRL 6 s/FR 18 schedule was in effect. During the DRL component, participants had to wait 6 seconds between key presses to successfully move the circle by one rectangle. Responses made before the 6 seconds had elapsed since the last key press would reset the clock counter to 0, meaning the participants had to wait another full 6 seconds to push a key and move the circle. The direction of movement was determined by which key was pressed. The FR component required that participants press the key(s) 18 times to move the circle once. The 18th response in the FR component of the schedule determined the direction to which the circle moved. When the 18th response used the left button, the circle moved down one row. When the 18th response used the right button, the circle moved one column to the right. The two components of the schedule alternated every 60 seconds. During the DRL component, the border around the screen was black, while during the FR component, it was white. When the participants succeeded in bringing the circle down to the bottom right corner, a tone was heard that signalled a "win" to the participant. Automatically, the circle would reset to the starting position and the participants could immediately restart key pressing.

Change Phase (Session 3): Extinction. Following Sessions 1 and 2, the components of the reinforcement schedule were changed from DRL 6 s/FR 18 to extinction/extinction without a signal or warning to the participant. No matter what the pattern of responding, the participant could not move the circle and obtain any "wins". However, as in the first two sessions, the border continued to alternate between black and white every 60 seconds.

Experimental Design and Variables

A repeated measures design was adopted for this experiment in which the responses of the participants were collected across three sessions. The experimental design was a two between-participants and one within-participants independent variables design. The two between-participants variables were the type of instructions received (Minimal or Elaborate), and the presence or absence of a warning (Warning or No Warning). The within-participants variable was the DRL/FR two-minute blocks across the three sessions. For the first two sessions, a block consisted of the one-minute presentation of the DRL component with the screen border dark followed by a one-minute presentation of the FR component of the reinforcement schedule with the screen border light. For the Change Phase, the two-minute block consisted of the comparable one-minute periods with the screen border dark, followed by the screen border light, but the schedule was extinction/extinction. The three sessions contained the following number of blocks: Session 1 (12 blocks), Session 2 (10 blocks) and Change Phase (12 blocks).

The dependent variables were the Number of Responses during the FR and DRL components of the schedule, the Index of Response, the Relative Change in Extinction Index and the Training Criterion. The Index of Response (Rosenfarb et al., 1992) was calculated by the computer for each block to determine whether participants were responding according to both components of the reinforcement schedule. For each participant, the Number of Responses on the one-minute FR component was divided by the total number of responses in the DRL and FR components of that two-minute block. The Index of Response could vary between 0 and 1.00. The closer an index was to 1.00, the more likely the participant had shown high-rate responding on the FR component of the schedule and low-rate responding on the DRL component. Participants who had attained an Index of Response of 0.85 or higher during each of the last three blocks of Session 2 and had demonstrated movement of the circle in the matrix on both components of the schedule were considered to have attained the Training Criterion.

The Relative Change in Extinction Index (Hayes, Brownstein, Haas et al., 1986), used in some of the insensitivity of rule-governed behavior literature, was calculated for the Change Phase. This index was calculated by dividing the sum of responses across the first cluster of three blocks (23-25) of the Change Phase for the component of the schedule with the highest rate (FR) by the sum of responses across the last cluster of three blocks of the Training Phase (Session 2, blocks 20-22) for the component with the highest rate (FR). To examine the results of the remainder of the Change Phase, the sum of responses across the next cluster of blocks (26-28) was also divided by the sum of responses on the FR component across the last cluster of three blocks of the Training Phase. This procedure was repeated with the following clusters of blocks (29-31) and (32-34) of the Change Phase. In each case, the sum of responses was compared to the cluster of blocks 20-22. Hayes, Brownstein, Haas et al. (1986) have suggested the use of the dominant schedule when changing to extinction because it is the component in which participants in all groups earned points. This Index can vary between values of 0 and 1.00. If no change or relatively little change was shown during the Change Phase (i.e., little extinction effect), the index would be of a higher value (e.g., 0.5 and above). However, if the index was of a value lower than 0.5, then there was evidence for extinction effects. For parsimony, in certain statistical analyses, where a session was examined in its entirety, clusters of blocks were created. The analyses were performed, where specified, on "clusters" of blocks consisting each of the average of three (or four) consecutive blocks (i.e., blocks 1-3, 4-6, 7-9, 10-12).

Results

In total, 71 students volunteered to participate in this study. The data for three participants were discarded due to technical difficulties and they were subsequently replaced. Nine participants failed to meet the Training Criterion by the end of the Training Phase. Five of these excluded participants were in the MNW group, two were in the MW group, and two were in the ENW group. Additional participants were recruited to replace them. In total, 59 participants met criterion and were included in the analyses. This resulted in a total of 14, 16, 14, and 15 participants in the MNW, MW, ENW, and EW groups respectively.

The statistical analyses were conducted using the Statistica software package (Statsoft, 1995). Descriptive statistics are reported for each variable. Kruskall-Wallis ANOVA by ranks were performed to examine overall differences between groups in their speed of acquisition of behavior in accordance with the programmed contingencies, and in their responses to a change in contingencies during the Change Phase. Testing of assumptions underlying the use of the parametric ANOVA revealed the presence of heterogeneity of variances and also that the means and standard deviations in each group seemed to be substantially correlated. The limits of the Kruskall-Wallis ANOVA by ranks are recognized, in that they do not provide an analysis of the results of potential interactions. In this and subsequent experiments, the alpha level was set at .05.

Training Phase: Session 1

Graphical Representation. Only the results of the participants who had met the Training Criterion are presented. Figure 1 displays the results for each group during the first session (first 12 blocks) of the Training Phase. In comparison to the Minimal Instructions groups, the Elaborate Instructions groups produced high mean Indexes of Response more quickly. The Elaborate Instructions groups responded at different rates to the two components of the schedule very early on in the session. The Minimal Instructions groups took longer to respond appropriately to both components of the schedule. However, as the first session advanced, the Minimal Instructions groups progressively increased their mean Indexes of Response. Figure 1 also shows that the two Elaborate Instructions groups (Warning and No Warning) were responding very comparably. Similarly, the two Minimal Instructions (Warning and No Warning) groups had very comparable mean Indexes of Response throughout the first session.

Statistical Analyses. To determine whether there were differences between groups in their speed of acquisition of responding in accordance with the multiple DRL/FR schedule, a Kruskall-Wallis ANOVA by ranks was performed, on the Index of Response during the first session in the Training Phase. For this analysis, the Indexes of Response of the first session were grouped in four clusters consisting each of the average of three consecutive blocks (i.e., 1-3, 4-6, 7-9, 10-12). Descriptive statistics including means and standard deviations for each block of Session 1 are presented in Table 1. First, a Kruskall-Wallis ANOVA by ranks was performed on the Instruction variable using the Index of Response across four clusters of three consecutive blocks. This analysis is presented in Table 2 and confirmed results from the graphical representation of the data. The results showed significant differences between the Minimal and Elaborate Instructions groups at Cluster 1-3, Cluster 4-6, and Cluster 7-9, but this difference disappeared by Cluster 10-12. The Minimal Instructions groups took longer to start responding in accordance with the programmed contingencies. A second Kruskall-Wallis analysis on the Warning condition (see Table 3) revealed that the Warning and No Warning groups did not significantly differ from each other during any of the clusters of blocks of the first session. This confirmed the results from the graphical representation, that the Warning condition therefore did not seem to have an impact on the speed of acquisition of the schedule appropriate responding.

Training Phase: Session 2

Graphical Representation. Figure 2 presents the mean Index of Response for each group during the entire second session of the Training Phase. This figure shows that all groups started responding in this session with high mean Indexes (0.90 and above). The mean Indexes of Response increased as the session progressed to attain levels higher than the Training Criterion. In sum, all four groups were clearly responding according to the programmed contingencies during this session.

Statistical Analyses. Descriptive statistics of the Index of Response of each block of Session 2 appear in Table 4. To determine whether the groups had comparable Indexes of Response during Session 2 of the Training Phase, Kruskall-Wallis ANOVA by ranks analyses were performed using the Index of Response on three clusters consisting each of three (or four) consecutive blocks. A first analysis, presented in Table 5, was performed on the Instruction condition and showed that the Minimal and Elaborate Instructions groups responded differently during the beginning of the session only (Clusters 13-15). Another analysis, performed on the Warning condition, revealed that the Warning and No Warning groups did not respond differently from each other during any of the clusters of blocks of Session 2 (see Table 6). These analyses show that by the end of the Training Phase, all groups were responding similarly and in accordance with the programmed contingencies.

Change Phase

Graphical Representations. Figure 3 displays the mean Index of Response for all groups during the Change Phase. During the early part of the Change Phase and until Block 26, the two Elaborate Instructions groups had higher mean Indexes of Response than the two Minimal Instructions groups. The Elaborate Instructions groups therefore still maintained a pattern of low and high responding that had been appropriate during the Training Sessions. As of the first block in the Change Phase, the Minimal Instructions groups had decreased their mean Indexes of Response to 0.65 and 0.67, while the Elaborate Instructions groups still maintained mean Indexes of Responses of 0.91 and 0.83. By the end of the Change Phase, the MNW and ENW groups had decreased their mean Indexes of Response very considerably to levels of 0.44 and 0.52, while the MW group maintained a mean Index of 0.58. The EW group still showed a very high mean Index of Response of 0.91.

Figures 4 and 5 illustrate the mean Number of Responses per minute for each of the four groups during the Change Phase. The graphs show that, in comparison to the Minimal Instructions groups, the Elaborate Instructions groups maintained a pattern of lower responding on the exDRL component and higher responding on the exFR component for a longer period.

From early on in the session, the Minimal Instructions groups displayed more variable responding than the Elaborate Instructions groups.

Figure 6 displays the mean Relative Change in Extinction Index for each group across the four clusters of blocks during the Change Phase. Initially, during the first cluster of blocks the Minimal Instructions groups responded with lower mean Relative Change in Extinction Indexes than the Elaborate Instructions groups. All groups decreased their mean Relative Change in Extinction Index as the Change Phase progressed. The Minimal Instructions groups therefore showed greater evidence of extinction effects. The Warning/No Warning condition did not seem to have an effect on responding.

Statistical Analyses. The results were examined to determine whether the groups differed with regard to their responses to an unannounced change in contingencies. First, the effects of extinction were measured using the Index of Response. Only the first three blocks were used in this analysis because all groups each still contained, all their participants. After the third block, some groups contained data for less participants, given that some participants had zero responses on the FR and DRL components during some of the blocks. In these cases, the Index of Response could not be calculated. Descriptive statistics for each block of the Change Phase using the Index of Response appear in Table 7. The effects of extinction were examined using Kruskall-Wallis ANOVA by ranks. Results of a first ANOVA (presented in Table 8) on the Instruction condition revealed a significant difference between the Minimal and Elaborate Instructions groups at each Block (23, 24 and 25). The same analysis performed on the Warning condition revealed no differences between groups at any of the first three Blocks (see Table 9).

Second, the effects of extinction were examined using the Kruskall-Wallis ANOVA by ranks on the Relative Change in Extinction Index. Descriptive statistics are presented in Table

10. Results from a Kruskall-Wallis ANOVA by ranks (presented in Table 11) on the Instruction condition revealed a significant difference between the Minimal and Elaborate Instructions groups during the first cluster of blocks (23-25), during the third cluster of blocks (29-31) and during the last cluster of blocks (32-34) of the Change Phase. A second Kruskall-Wallis ANOVA by ranks, presented in Table 12, showed no significant differences between the Warning and No Warning groups at any of the four clusters of blocks of the Change Phase.

Discussion

The findings of Experiment 1 support the hypothesis that instructions facilitate the learning of a new behavior. At the beginning of the Training Phase, the Elaborate Instructions groups responded according to the programmed contingencies sooner than the Minimal Instructions groups. However, by the end of the first session of the Training Phase, both the Elaborate and Minimal Instructions groups were responding according to the programmed contingencies. The warning condition did not have any significant impact on the rapidity with which participants started responding in accordance with the programmed contingencies. These results suggest that behavior established by elaborate instructions was not as sensitive to changing conditions as was behavior that was more dependent on shaping by the natural contingencies of the situation (the Minimal Instructions groups). This replicated the "insensitivity of the rule-governed behavior" effect reported in the literature (e.g. Galizio, 1979; Hayes, Brownstein, Haas et al., 1986; Hayes, Brownstein, Zettle et al., 1986; Kaufman et al., 1966; Matthews et al., 1977). The results suggested differences in responding until the last cluster of blocks of the Change Phase.

The results of this study failed to support the hypothesis that a simple warning might counteract the insensitivity effect. The Warning and No Warning groups responded with very similar patterns to the change in contingencies during the Change Phase.

In conclusion, with numbers of subjects sufficiently large to allow for statistical analyses, the results of this experiment confirmed that instructions facilitate the acquisition of a new behavior. The results have also shown that all groups decreased their responding during the extinction session. Elaborate instructions affected the responding patterns of participants until the end of the Change Phase. The results suggest that the warning did not have an impact on responding of the participants during the Change Phase. Further investigation of this issue is needed to increase our confidence in this finding.

Experiment 2

Introduction

Previous research, including Experiment 1 reported above, has investigated the "insensitivity of rule-governed behavior" effect by changing the DRL/FR schedule to extinction/extinction. In an attempt to increase this series of studies' ecological validity, this experiment investigated the sensitivity of rule-governed behavior to a change in contingencies by changing the schedule to something other than to extinction/extinction. The participants were trained under a DRL 6 s/FR 18 schedule and then the unannounced change was to a FR 18/FR 18 schedule. Behavior was considered to be insensitive to a change in contingencies when participants persisted in a pattern of low/high responding following the introduction of the change to a FR 18/FR 18 schedule.

Considering the absence of significant results from the Warning condition in Experiment 1, the simple warning that "Conditions may change" was kept in this experiment. Further investigation is needed before any conclusions about the warning effect on the sensitivity of a rule-governed behavior can be ascertained with confidence.

Method

Participants

Eighty-three students (63 females, 20 males) from the University of Ottawa volunteered to participate in this study. Sixty-one participants were included in this experiment. Their ages ranged between 18 and 45 with a mean of 23. Participants were randomly assigned to one of four groups: Minimal Instructions - No Warning (MNW), Minimal Instructions - Warning (MW), Elaborate Instructions - No Warning (ENW), and Elaborate Instructions - Warning (EW).

Setting and Apparatus

The setting and apparatus used in this Experiment were identical to that of Experiment 1.

Procedure

Other than the following exception, the procedure for this experiment was identical to that of Experiment 1. Instead of changing to extinction/extinction during the Change Phase, participants were exposed to a FR 18/FR 18 schedule.

Experimental Variables and Design

The variables and design were identical to Experiment 1, with the following exception. The Relative Change in Extinction Index was replaced by a Relative Change Index and was calculated on the DRL component rather than on the FR component. The index was calculated on the exDRL component since the schedule changed from DRL 6 s/FR 18 to FR 18/FR 18 during the Change Phase. The effects of the change in contingencies would therefore be expected to be most noticeable on the DRL component. This index was calculated by dividing the sum of responses across the first cluster of three blocks of the Change Phase (Blocks 23-25) for the DRL component by the sum of responses across the last cluster of three blocks of the Training Phase (Session 2- Blocks 20-22) for the DRL component. This calculation was repeated with the other three clusters of blocks of the Change Phase (26-28, 29-31 and 32-34), each cluster also being compared to Blocks 20-22. This Index can vary between 0 and no set maximum value. The greater the Relative Change Index, the greater were the effects of the Change Phase.

Results

The statistical analyses were conducted using the Statistica software package (Statsoft, 1995). The data for two participants were discarded and replaced due to technical difficulties. One participant's data (EW) was thrown out since he was found reading a book while the experiment was in progress. In total, 19 participants failed to meet the Training Criterion by the end of the Training Phase and were subsequently replaced. Two of these excluded participants were in the MNW group, twelve in the MW group, two in the ENW group and three in the EW. Additional participants were then randomly added in each of the four groups until each group had the planned 15 participants. All groups contained 15 participants, with exception of the ENW group which contained 16 participants. Only the results of the 61 participants having met the Training Criterion are presented below.

The results were analysed using the Kruskall-Wallis ANOVA by ranks. Testing of assumptions underlying the use of the parametric ANOVA revealed the presence of heterogeneity of variances and also that the means and standard deviations in each group seemed to be substantially correlated. The limits of the Kruskall-Wallis ANOVA by ranks are recognized, in that they do not provide an analysis of the results of potential interactions.

Training Phase: Session 1

Graphical Representation. Figure 7 displays the mean Index of Response for each group for the first session of the Training Phase. The two Elaborate Instructions groups rapidly started responding according to the programmed contingencies. The Minimal Instructions groups took longer to respond to both components of the schedule. As the session progressed however, the Minimal Instructions groups slowly increased their mean Indexes of Response; the rate of responding on the FR component increased and the rate of responding on the DRL component decreased. By the end of the first session of the Training Phase, the Elaborate and Minimal Instructions groups had attained very comparable responding with mean Indexes of Response ranging between 0.86 and 0.91. The MNW and MW groups showed comparable patterns of acquisition and responded very similarly to one another. The ENW and EW groups also responded with very similar patterns of responding.

Statistical Analyses. Only the results of the participants who had met the Training Criterion were retained for analyses. Descriptive statistics including means and standard deviations of the Index of Response for each block of Session 1 are presented in Table 13. To determine whether the Minimal and Elaborate groups differed in terms of their speed with which they responded in a manner appropriate to the schedules in effect, Kruskall-Wallis ANOVA by ranks analyses were performed using the Index of Response. For these analyses, the Indexes of Response of the first session were grouped in four clusters each consisting of the average of three blocks (i.e., 1-3, 4-6, 7-9, 10-12). The results revealed that the Minimal Instructions groups had significantly lower Indexes than the Elaborate Instructions groups at Clusters 1-3, 4-6 and 7-9 (see Table 14). The same analysis performed on the Warning variable revealed no significant differences between the Warning and No Warning groups at any of the clusters of blocks (see Table 15). These results confirmed the findings from the graphical representations of the data.

Training Phase: Session 2

Graphical Representation. Figures 8 illustrates the mean Indexes of Response for each group during Session 2 of the Training Phase. The four groups started responding with slightly different mean Indexes of Response during the first block of this session. However, very rapidly, beginning with the second block all groups demonstrated very comparable mean

Indexes of Response. All groups were clearly responding according to the programmed contingencies.

Statistical Analyses. Descriptive statistics, including means and standards deviations for the Indexes of Response during each block of Session 2 of the Training Phase are presented in Table 16. To determine whether all groups had comparable Indexes of Response during Session 2 of the Training Phase, Kruskall-Wallis ANOVA by ranks analyses were performed on the Indexes of Response of four clusters of three (or four) consecutive blocks in the second session (i.e., 13-15, 16-18, 19-22). Results of the first Kruskall-Wallis ANOVA performed on the Instruction condition (Table 17) showed that the Elaborate Instructions groups had higher Indexes of Response than the Minimal Instructions groups during Cluster 13-15 only. A second analysis, performed on the Warning condition, revealed that the Warning and No Warning groups did not respond differently from each other during any of the clusters of blocks of Session 2 (see Table 18). All groups were responding similarly and in accordance with the programmed contingencies by the end of the Training Phase. These findings are confirmed by the graphical representation of the data.

Change Phase

Graphical Representations. Figure 9 portrays the mean Indexes of Response during each block of the unannounced Change Phase (change to FR 18/FR 18). Initially, during the first block, the MNW group exhibited the lowest Index of Response, followed by the MW and EW groups with slightly higher mean indexes. These lower indexes and visual inspection of the data revealed that participants had increased their responding on the exDRL component of the schedule and kept responding with high rates on the FR component. The ENW group clearly responded very differently from the other groups with an Index of Response of 0.90 during

Block 23. This high index revealed that the ENW group was responding as they had prior to the change in contingencies. For most of the session, the ENW group had a much higher mean Index of Response than the other three groups. The Warning condition therefore seemed to have an impact on the speed with which the EW group adjusted their behavior during this session. However, by the end of the Change Phase, all groups were exhibiting comparable mean Indexes of Response.

Figure 10 presents the mean Number of Responses per minute for each of the four groups. In comparison to the other three groups, the ENW clearly maintained a pattern of lower responding on the exDRL component of the schedule and higher responding on the FR component during most of the Change Phase. As mentioned earlier, by the end of the Change Phase, all groups presented very similar rates of responding on both the exDRL and FR components of the schedule.

Figure 11 displays the mean Relative Change Index for each group during the Change Phase. As a reminder, in this study, the greater the mean Relative Change Index, the greater were the effects of the Change Phase. Visual inspection of this figure reveals that the MNW, MW and EW groups had similar mean Relative Change Indexes during the first cluster of Blocks. Their mean Indexes did not increase dramatically as the session progressed. The ENW had a much lower mean Index during the first cluster of blocks but increased its mean Index as the session progressed.

Statistical Analyses. The results were examined to determine whether there was a difference between groups in response to a change in contingencies. First, the effects of the Change Phase (change to FR 18/FR 18) were measured with the Index of Response across the four clusters of blocks of the Change Phase. Descriptive Statistics are presented in Table 19. A

Kruskall-Wallis ANOVA by ranks, presented in Table 20, was performed on the Instruction condition for the four clusters of three consecutive blocks of the Change Phase. Results showed that the Elaborate Instructions groups presented higher Indexes of Response than the Minimal Instructions groups at Clusters 23-25 and 26-28. Another analysis, performed on the Warning condition (see Table 21), revealed that the Warning and No Warning groups did not respond differently from each other during any of the clusters of blocks of Session 3.

A second group of analyses were performed on the Relative Change Index, using the exDRL component. This index was calculated across four clusters of three consecutive blocks of the Change Phase. Descriptive statistics including means and standard deviations appear in Table 22. Results from a Kruskall-Wallis ANOVA by ranks performed on the Instruction condition did not reveal any significant differences between the Minimal and Elaborate Instructions groups at any of the four clusters of three consecutive blocks (see Table 23). Another Kruskall-Wallis analysis, presented in Table 24, was performed with the Warning condition and showed a significant difference between the Warning and No Warning groups during the Cluster 23-25. At Cluster 23-25, the Warning groups had significantly increased their responding compared to the No Warning groups on the exDRL component, following the change in contingencies.

Discussion

The results of Experiment 2, with numbers sufficiently large to allow the use of statistical analyses, have again confirmed the hypothesis that instructions facilitate the acquisition of a new behavior. Groups that received more elaborate instructions started responding in accordance with the programmed contingencies significantly sooner than those that received minimal instructions. However, by the end of the Training Phase, all groups had learned the targeted behavior and were responding in accordance with the programmed contingencies.

The graphical representation of the data for the Change Phase showed that, as all groups progressed through the session, their Relative Change Index increased and their mean Index of Response decreased. The analysis on the Instruction condition using the Index of Response showed that the Elaborate instructions groups persisted longer than the Minimal groups in their previously acquired behavioral patterns during the first six minutes of the Change Phase. These results therefore replicated the insensitivity of rule-governed behavior effect using a change in contingencies to something other than extinction/extinction. However, the analysis performed using the Relative Change Index did not support this finding. These results might be explained by the effect of the warning. The EW group, as evidenced by the graphical representation of the data, was behaving very similarly to the two Minimal Instructions groups.

The simple warning that "conditions may change" had an effect on the participants' responding. When compared to the No Warning groups, the Warning groups significantly increased their Relative Change Index during the first three blocks of the Change Phase. AS mentioned, visual inspection of the data however suggests an interaction between Instructions and Warning, with the Warning having a greater impact on the EW groups sensitivity to a change contingencies.

The findings of Experiments 1 and 2 can be summarized as follows. These studies have clearly confirmed the hypothesis that more elaborate instructions facilitated the learning of a new behavior. Both studies have shown that participants who had received elaborate instructions concerning the computer task responded in accordance with the programmed contingencies more quickly than those who had received minimal instructions.

Experiments 1 and 2 replicated the "insensitivity of rule-governed behavior" effect. The findings for the Change Phase in both Experiments supported the hypothesis that participants given more elaborate instructions take longer, at least in the first six minutes of this session, to adjust their responding after a change in contingencies, as opposed to those given minimal instructions.

The results for the Warning condition were not congruent between Experiments 1 and 2. The hypothesis that a simple warning might counteract the "insensitivity of rule-governed behavior" has been confirmed in Experiment 2, but not in Experiment 1. In Experiment 2, the participants in the Elaborate Instructions - Warning group adjusted their responding to the change in schedule more rapidly than the Elaborate Instructions - No Warning group. In Experiment 1, however, the warning had no effect during the Change Phase. Further research is therefore needed to clarify the effects of a simple warning on rule-governed behavior.

Rule-governed behavior and selectionism

In an attempt to better understand the insensitivity of rule-governed behavior, the following section will draw a parallel between Darwinian natural selection and operant conditioning, and then more specifically apply this parallel to rule-governed behavior. First, a very brief description of natural selection will be given, as extensive coverage of this topic goes beyond the scope of this work. Second, the important selectionist principles will be described and then applied to behavior analysis and more specifically to rule-governed behavior. Third, the selectionist perspective will be applied to this series of studies in an attempt to provide a framework within which to understand the insensitivity of rule-governed behavior effect.

Donahoe (1991, p. 119) describes *selectionism* as "a general class of approaches to understanding complexity in which higher-level organization is the by-product of the action of lower-level processes". At the core of selectionism (a paradigm within which natural selection and radical behaviorism fall), we find the idea that a complex phenomenon is the result of "unintended" effects of the cumulative product of repeated, relatively simple processes (Donahoe, Burgos, & Palmer, 1993). Darwin was the first to propose that no external intervention or "being" was responsible for the complexity of species. He claimed that there existed no principle that dictated an order or a vision of the evolution of species (Donahoe et al., 1993).

In his book, *On the Origin of Species*, Charles Darwin (1859) described the principle of natural selection. Natural selection refers to a process by which the environment selects certain individuals. The theory of evolution based on natural selection is still very prevalent in evolutionary biology. However, some debate over details of the evolutionary process persist. Some researchers claim that the gene, rather than the individual, as stated by Darwin, is the unit of selection (Pierce & Epling, 1999). For example, Richard Dawkins (1989) in his book *The Selfish Gene* argues that we, as animals, "exist as survival machines" for genes. This and other different points of view on the process of evolution do not, however challenge the theory itself. As Dawkins (1989, p. 1) says, "Today the theory of evolution is about as much open to doubt as the theory that the earth goes round the sun".

Some authors argue that behavior analysis is an example of selectionism (Skinner, 1981; Donahoe et al., 1993; Pennypacker, 1992; Baum, 1994; Ringen, 1993) and others have also drawn a parallel between Darwin's theory of natural selection and operant conditioning (Campbell, 1956; Catania, 1992; Staddon & Simmelhag, 1971). Some behavior analysts assert that radical behaviorism and evolutionary biology should be building more bridges (Baum, 1994, 1995; Palmer & Donahoe, 1992; Donahoe et al., 1993; Ringen, 1993; Smith, 1983). Smith (1983) has eloquently described this analogy:

> Natural selection is to the origin of species as operant conditioning is to the origin of behavior. Just as the members of a population of organisms exhibit variation, and the environmental consequences of each variation play a role in determining the probability that given individuals will reproduce, and thus influence the probability that a given organic variety will reoccur, so likewise do the actions composing a population of operants of an individual organism exhibit variation, and the environmental consequences of each variation play a role in determining the probability that given operants will be reinforced, and thus influence the probability that a given behavioral variety will reoccur. (p. 136)

B. F. Skinner (1981) established his work squarely within the selectionist paradigm with his paper *Selection by Consequences*. He identified three levels of selection by consequences: (1) evolution, (2) operant conditioning, and (3) culture. At the level of evolution, natural selection is the form of selection by consequences identified and studied by Darwin. It occurs at the biological level. Operant conditioning is a second kind of selection and occurs at the behavioral level. The third kind of selection by consequences occurs at the level of social environments or cultures.

The survival of behavior patterns would be analogous to the survival of characteristics of a species. In the Skinnerian framework, the initiating causes of behavior were found in the environment and there was no intentionality, or "intervention of a principle of mind" (Skinner, 1981, p. 503). Skinner rejected mentalistic "explanations" of behavior. Similarly, Darwin rejected the notion of an intervention from a superior being, as a scientific explanation of evolution. In 1953, Skinner made this statement describing the relationship between the two types of selection:

> In both operant conditioning and the evolutionary selection of behavioral characteristics, consequences alter future probability. Reflexes and other innate patterns of behavior evolve because they increase the chances of survival of the *species*. Operants grow strong because they are followed by important consequences in the life of the *individual* (1953, p. 90).

Staddon and Simmelhag (1971) also proposed a common link between biology and psychology, by suggesting the application of evolutionary principles to the psychology of learning in animals. In their 1971 article, they replicated Skinner's (1948) classic "superstition" experiment. Skinner (1948) had investigated whether it was possible to establish instrumental conditioning even when the animal is not required to perform a response in order to get reinforcement. Skinner gave pigeons a 5-second access to food every 15 seconds, irrespective of the pigeons' behavior. Some of his observations were as follows:

> In six out of eight cases the resulting responses were so clearly defined that two observers could agree perfectly in counting instances. One bird was conditioned to turn counterclockwise about the cage, making two or three turns between reinforcements. Another repeatedly thrust its head into one of the upper corners of the cage. A third developed a "tossing" response, as if placing its head beneath an invisible bar and lifting it repeatedly. (Skinner, 1948, p. 168)

Skinner called this phenomenon "superstitious" behavior which he explained in the following manner. Animals are always engaged in some type of behavior. The accidental following of a response by a reinforcer increased the probability that the same response re-occurred. This in turn increased the probability that the response would be occurring just before the next delivery of a reinforcer. The response made just before the delivery of the reinforcer became strengthened and its probability of re-occurrence increased even more. Skinner had adopted at that time a "stamping in" view of reinforcement, as each subsequent accidental pairing of a particular behavior and reinforcement further strengthened the probability of the response (Staddon & Simmelhag, 1971).

More recent research has cast some doubt on Skinner's conclusions (Domjan & Burkhard, 1986). Skinner (1948) delivered food to his pigeons irrespective of their behavior. However, the reinforcement delivery was predictable since it occurred every 15 seconds. Staddon and Simmelhag (1971) concluded that the "superstitious" behavior observed by Skinner was created by the predictability with which food was delivered, and not by accidental reinforcement.

In their replication study, Staddon and Simmelhag (1971) placed pigeons on three schedules of food reinforcement. The three schedules were: a) a response-independent fixed-interval 12 s schedule; b) a response-independent variable-intervals 8 s schedule; and c) a response-dependent fixed-interval 12 s schedule. In the two response independent schedules, pigeons received reinforcement irrespective of their behavior. The third schedule was response dependent; a standard fixed-interval schedule was used in which pigeons had to peck at least once to receive the food. They defined and measured the occurrence of various behaviors including orienting responses, pecking the response key, wing flapping, turning in quarter circles.

Staddon and Simmelhag (1971) observed that some of the responses occurred mainly toward the end of the interval between reinforcers. They called these *terminal responses*. They included activities that are part of a pigeon's eating behaviors such as pecking and putting the head in the magazine. Another group of behaviors occurred predominantly after the delivery of reinforcement. These activities decreased in frequency as inter reinforcement time progressed, and reward time approached. They called these activities *interim responses*. In contrast, these activities (interim responses), such as preening and turning, were activities which were not related to eating behaviors. The results of the response-dependent and response-independent conditions were very similar. Interim responses occurred in all pigeons and at times when reinforcement was not available. Terminal responses were also very similar in the response-dependent and response-independent conditions. The results between the two conditions differed in that pecking as a terminal response was aimed at the key for the response-dependent condition while it varied in location for the response-independent conditions.

Staddon and Simmelhag (1971) suggested that it was not always clear whether Skinner (1948) had observed interim and/or terminal responses. They rejected the "stamping in" view of reinforcement because of changes they observed in the terminal behavior as the experiment progressed. For example, they observed that early on, three of the four birds made the "head in magazine" at a very high rate and for a larger fraction of the total time. It was therefore this behavior which was most often contiguous with reinforcement, and been most "stamped in". During later sessions however, "head in magazine" diminished radically in frequency and was replaced by "pecking", a finding not expected from the "stamping in" viewpoint.

Staddon and Simmelhag (1971) proposed an alternative to Skinner's "stamping in" view of reinforcement. They adopted an "evolutionary response-selection model of reinforcement" (Domjan & Burkhard, 1986). Within this framework, reinforcement is viewed as a process by which particular responses are selected out of the animal's behavioral repertoire. The model that Staddon and Simmelhag (1971) put forth is built on Darwin's theory of evolution, described earlier. They proposed that the processes of variation, selection and adaptation found at the core of Darwin's theory would also be at work with behavior. According to their view, reinforcement would not "stamp in" behavior but would limit behavioral variation at particular times.

Of particular interest in Staddon and Simmelhag's (1971) account is their proposal of the impact of length of training on variation in behavior during the procedure of extinction. They commented that extinction is often used to test what has been learned during a particular training episode. During such a procedure, an effort is made to keep conditions very similar to those found during training. It is assumed that a "transfer of behavior from baseline" will be found, provided conditions in extinction are very similar to training and the length of training received prior to extinction has been long enough (Staddon & Simmelhag, 1971). However, when conditions during extinction are too different from training or when the training length has been very short, they noted that the transfer in behavior from training to extinction is not usually found. They found evidence of this pattern in the research of Antonitis (1951) and Millenson & Hurwitz (1961). Interestingly, under these conditions, the procedure of extinction is usually associated with an increase in variation in behavior. Staddon and Simmelhag (1971) suggested that this increase in behavior variation would be expected if reinforcement had a purely selective effect on behavior. In their terms, "training involves a progressive reduction in variability under the selective action of reinforcement...." (p. 24). In the absence of reinforcement (extinction), and therefore in the absence of selection, the variation in behavior should reappear.

However, as Staddon & Simmelhag (1971) noted, the onset of behavior variation during the procedure of extinction can often be delayed if the training preceding extinction has been prolonged. They extended their analogy between natural selection and learning to propose that variation can be delayed in both evolution and behavior. Staddon & Simmelhag (1971) reported that similar delays in variation have been reported in experiments on artificial selection. These delays have been termed "genetic inertia" or "genetic homeostasis".

Staddon and Simmelhag (1971) proposed that "a similar mechanism might account for the dependence of variability in extinction on the duration of the preceding training period, ..." (p. 24). They suggested a mechanism in the study of behavior to explain the delayed arrival of behavior variation during the procedure of extinction. They believed that the delay in onset of behavior variation might be correlated with the duration of the preceding behavioral training. Following a shorter training period, they expected that the onset of variation in behavior would be sooner. Conversely, a longer training period would produce a greater delay in the appearance of extinction effects. The mechanism proposed here by Staddon and Simmelhag will be revisited in Experiment 3 and will provide an interesting framework from which to understand the insensitivity of rule-governed behavior effect.

Baum (1995, p.2) asserted that "logically, there is every reason for behavior analysis to align with evolutionary biology". In his paper, Baum (1995) used rules and rule-governed behavior as an example of a topic that should be understood within an evolutionary framework. Baum (1995) claimed that since Skinner's (1969, 1974) discussion of rule-governed behavior, a great amount of literature on rules has emerged in the field of behavior analysis. However, Baum (1995, p. 3) also stated, that none of this literature "has placed rules in the larger context that Skinner's ideas logically implied: the context of culture and evolution". An exception was found with the paper by Joyce and Chase (1990) who have adopted a selectionist perspective on rules to understand the insensitivity of rule-governed behavior.

An evolution-based definition of rules was elaborated by Baum (1995). He described a rule as a "verbal discriminative stimulus (a) that sets the occasion for a listener's behavior to be reinforced by short-term consequences arranged by the speaker and (b) that is given by a speaker's behavior under the stimulus control of a long-term contingency connecting that same listener's behavior ultimately to the fitness of the listener's genes" (p. 9). In his definition, Baum (1995) identifies that a rule relates to two contingencies: the proximate and ultimate. The proximate contingency refers to the behavior of a rule-follower that is reinforced by a rule-giver. Usually, this contingency is social in nature (e.g., approval). The ultimate contingency is more long-term and relates to fitness of an individual by promoting health, resources, relationships or reproduction. Baum (1995) specifies that relations to fitness apply to the average population rather than to specific individuals and on a long-term basis rather than in the short-term.

Baum (1995, p.4) represented each of the proximate and ultimate contingencies in the form of S^D:B $\rightarrow$ S^R, where the S^D represents the discriminative stimulus; B stands for operant behavior and S^R for consequence. The colon represents the "occasion-setting function of S^D and its effect of increasing the likelihood of B". The arrow suggests that the presence of the behavior will increase the probability of receiving the consequence. This conceptualisation of contingencies is congruent with Skinner's view which has been presented in the introduction.

Baum (1995) gave the example of eating vegetables to illustrate the differences between the proximate and ultimate contingency. A parent saying to a child "Eat your vegetables" serves according to Baum (1995), as a rule and a discriminative stimulus. If the child complies, the parent will provide a proximate reinforcer, approval (or absence of disapproval). The impact of this social contingency is to maintain the behavior of eating vegetables. This example can also represent an ultimate contingency. The S^D in this case could be, according to Baum (1995) any "sights and signs of vegetables" in a grocery store, or on a table. The ultimate reinforcer of eating vegetables in this case would be increased fitness in the long run and greater chances of reproduction. The proximate and ultimate contingencies each have their own discriminative stimuli and either a short-term or a long-term consequence. Baum (1995) suggested that short-term reinforcement of a rule-governed behavior usually strengthens a behavior that will increase fitness on average in the long run.

Viewed from a selectionist perspective, the series of studies reviewed earlier and the studies performed in our laboratory on the insensitivity of rule-governed behavior to a subsequent change in contingencies can be understood in terms of variation and selection of behaviors. A selectionist framework does not attribute special "imbued" properties to verbal stimuli in order to explain the insensitivity of rule-governed behavior (Andronis, 1991). Andronis (1991) suggested that a selectionist framework, would permit the formulation of questions on rule-governed behavior in more procedural terms.

Andronis (1991) presented the following line of argument to support the view that the insensitivity of rule-governed behavior effect can be explained from a selectionist perspective:

i) *a contingency can select a particular form of behavior only after that species of behavior has been emitted in the first place, and any procedure which a priori restricts* *responding to a narrow range of variants (i.e., one which excludes any particular form) ensures that an excluded form cannot be selected by subsequently changed contingency requirements;*

ii) *verbal instructions can affect the variability of responses emitted by our subjects, sometimes specifically restricting the range of behavioral variants available for selection; therefore*

iii) *restriction of response variability may be the basis for the observed resistence or insensitivity of rule-governed behavior to changes in prevailing contingencies.* (p. 232)

Experiment 4 in this series of studies will examine Andronis' argument and study the restricted variation in behavior as a potential variable contributing to the insensitivity of rule-governed behavior.

In summary, the preceding section outlines a parallel between the theory of natural selection and the shaping of operant behavior. Natural selection provides an interesting model that could be applied to operant behavior. It is possible to draw an analogy between the effects of a history of reinforcement and punishment on a behavior, and a history of selection on a species. Natural selection operates over the generations of a species, while the history of reinforcement and punishment operates on one individual's population of actions. Staddon & Simmelhag (1971) argued that variation can often be delayed in both evolution and behavior. Pertinent to Experiment 3 is Staddon & Simmelhag's contention that the duration of prior training might have an impact on the onset of behavior variation following the procedure of extinction.

Experiment 3

Introduction

Staddon & Simmelhag's (1971) account provides a framework from which to investigate aspects of the insensitivity of rule-governed behavior effect. They proposed that variation in behavior can be delayed depending on the duration of prior training. The longer the prior training, the longer will be the delay in producing a behavior pattern that will come under the control of the new contingencies. In this experiment, it was proposed that the delay in onset of behavior variation, following a change in the programmed contingencies, could be related to the differences in duration of prior training between the Elaborate and Minimal Instructions groups. In the initial phase of the "insensitivity of rule-governed behavior" literature, researchers have given the same length of sessions to subjects in all experimental groups (Minimal and Elaborate Instructions), no matter how long it took participants to start responding according to the programmed contingencies. The actual number of blocks during which participants responded in accordance with the programmed contingencies therefore varied between groups. This was confirmed by the results from Experiments 1 and 2 which showed that the Elaborate Instructions groups started responding sooner in accordance with the programmed contingencies than did the Minimal Instructions groups. Experiment 3 aimed at eliminating this confound variable present in the previous experiments.

Experiment 3 investigated whether the "insensitivity of rule-governed behavior" effect is related to the longer contact with the contingencies by the Elaborate Instructions groups during the Training Phase. To test this hypothesis, the study manipulated the duration of training once the subjects were responding according to the programmed contingencies. Depending on which group participants were assigned to, they received either a long or a short training period prior to the Change Phase. Participants were assigned to one of four groups: Minimal Instructions - Long Training, Minimal Instructions - Short Training, Elaborate Instructions - Long Training and Elaborate Instructions - Short Training.

The rule-governed behavior literature suggests that instructions per se have the effect of rendering behavior less "sensitive" following a change in contingencies. Based on this perspective, it was expected that the Minimal Instructions groups would change their behavior more quickly following a change in contingencies than would the Elaborate Instructions groups. There was no reason to expect a difference between the Long and Short Training groups.

However, from the perspective based on a selectionist framework, it was hypothesized that the insensitivity of rule-governed behavior effect was due to the difference in length of contact with the contingencies between the Minimal and Elaborate Instructions groups. Based on this perspective, it was expected that the Minimal and Elaborate Instructions - Short Training groups would adjust their behavior more quickly following a change in contingencies, when compared to the Minimal and Elaborate Instructions - Long Training groups. A difference between the Minimal Instructions - Short Training and Elaborate Instructions - Short Training was not expected. Similarly, no difference was expected between the Minimal Instructions - Long Training and Elaborate Instructions - Long Training.

Method

Participants

One hundred and twenty one students from the University of Ottawa volunteered to participate in this study. Their ages ranged between 18 and 45 with a mean of 23.4 years. Participants were randomly assigned to one of four groups: Minimal Instructions - Short Training

(MS), Minimal Instructions - Long Training (ML), Elaborate Instructions - Short Training (ES) and Elaborate Instructions - Long Training (EL). Each group contained 20 participants. The sample on which analyses were performed was composed of 30 males and 50 females.

Setting and Apparatus

The setting and apparatus were identical to the ones used in Experiments 1 and 2.

Procedure

The procedure for this experiment was very similar to that of Experiments 1 and 2. All four groups received three sessions (two sessions in the Training Phase followed by an unannounced Change Phase) with a short break in between. In Experiments 1 and 2, the Minimal Instructions groups responded according to the programmed contingencies on average for a period of 13 blocks before the Change Phase began. The Elaborate Instructions groups responded according to the programmed contingencies on average for a period of 20 blocks before the Change Phase. In an attempt to make the length of the training period with responding according to the programmed contingencies comparable to that of Experiments 1 and 2, the Training Phase in this experiment had a fixed number of blocks starting once the subjects met their respective Training Criterion as described below. For all four groups and as in previous experiments, the circle moved through the matrix according to a multiple DRL 6 s/ FR 18 schedule of reinforcement during the Training Phase.

For the ML and EL Training groups, the Training Phase varied in duration depending on how soon the participants attained the Training Criterion. The Index of Response (Rosenfarb et al., 1992) was calculated by the computer for each block to determine whether participants were responding according to both components of the reinforcement schedule. For each participant, the Number of Responses on the FR component were divided by the total number of responses in the DRL and FR components of that two-minute block. The Index of Response can vary between 0 and 1.00. The closer an index is to 1.00, the more likely it is that the participant has shown high-rate of responding on the FR component of the schedule and low-rate responding on the DRL component. The participants in the Long Training groups met the Training Criterion when they obtained an Index of Response of 0.85 or higher (and moved the circle) for a duration of ten consecutive blocks before they were allowed to move on to the next session. During Sessions 1 and 2, the computer program calculated the Index of Response after each block and shut off and printed, once the participant had reached the Training Criterion for the ten consecutive blocks. Sessions 1 and 2 therefore lasted at least 20 minutes each (with 10 consecutive blocks in each session at Criterion). The Change Phase (extinction session) was unannounced and lasted 24 minutes (12 blocks) as in the previous experiments. The border alternated between black and white every 60 seconds.

For the MS and ES Training groups, the Training Phase also varied in duration depending on how soon the participants attained their Training Criterion. The subjects in these groups had met their Training Criterion when they obtained an Index of Response of 0.85 or higher (and moved the circle) for a duration of six consecutive blocks in Session 1 and seven consecutive blocks in Session 2, before they were allowed to move on to the next session. The computer program calculated the Index of Response after each block in Sessions 1 and 2 and then shut off and printed, once the participant had reached the Training Criterion for six and seven consecutive blocks respectively. The unannounced Change Phase started after Session 2 and lasted for 24 minutes (12 blocks) as in previous experiments. The border alternated between black and white every 60 seconds.

The instructions given to the participants were the same as those used in Experiments 1 and 2, with the exception that the warning message was deleted. Participants' questions were answered by re-reading the appropriate section of the written instructions. Before the experiment began, participants were verbally instructed to use only the two keys exposed, using only one finger. They were then given a consent form to read and sign and were left alone to begin the experiment.

Experimental design and variables

A repeated measures design was adopted for this experiment in which the responses of the participants were collected across three sessions. The experimental design was a two between-subjects and one within-subjects independent variables design. The two between-subjects variables were the type of instructions received (Minimal or Elaborate), and the length of training (Long or Short). The within-subjects variable was the DRL/FR two-minute blocks across the three sessions (two sessions in the Training Phase and one session in the Change Phase). As in previous experiments, a Block was considered to be the presentation of one DRL and one FR component of the schedule and therefore had a duration of two minutes. The dependent variables were identical to those described in Experiment 1. For parsimony, in certain statistical analyses, where a session was examined in its entirety, clusters of blocks were created. The analyses were performed, where specified, on "clusters" of blocks consisting each of the average (typically) of three consecutive blocks (i.e., blocks 1-3, 4-6, 7-9, 10-12).

Results

The statistical analyses were conducted using the Statistica software package (Statsoft, 1995). In total, 121 students participated in this experiment. The data from 41 of the 121 subjects was not included in the analyses. Additional participants were then randomly assigned to each of the four groups until each group contained 20 participants. The data for one of these 41 participants was discarded and replaced due to technical difficulties. In total, 33 of the 41 discarded participants failed to meet the Training Criterion within the first 54 minutes and were subsequently replaced. Seven of the 41 participants decided to stop the experiment part way through. Only the results of the 80 participants having met the Training Criterion are presented below. Throughout this study, testing of assumptions underlying the use of parametric ANOVA revealed that the means and standard deviations seemed to be substantially correlated across cells of the design and that there was the presence of heterogeneity of variances. The main effects were therefore analysed using a non parametric procedure, the Kruskall-Wallis ANOVA by ranks. These analyses do not provide information on potential interactions.

Training Phase: Session 1

Graphical Representation. Figure 12 displays the mean Index of Response for each group for the first six Blocks of the first Session of the Training Phase. Only the first six blocks of this session are presented since by block 7, some participants had met their Training Criterion for this session and had therefore moved on to Session 2. The Elaborate Instructions (ES and EL) groups rapidly started responding according to the programmed contingencies with mean Indexes of Response of 0.78 and above. The Minimal Instructions (MS and ML) groups took longer to respond to both components of the schedule. As the first session progressed however, the two

Minimal Instructions groups progressively increased their mean Indexes of Response, therefore showing that they were responding with high rates on the FR component and lower rates on the DRL component.

Statistical Analyses. To determine whether there were differences between groups in their speed of acquisition of responding in accordance with the multiple DRL/FR schedule. Kruskall-Wallis ANOVA by ranks analyses were performed on the Instruction and Training conditions for the first six blocks of the first session using the Index of Response. Again, only the first six blocks of this session were included in these analyses since all 80 participants were still responding by this point, and none had yet reached their Training Criterion. Descriptive statistics including the means and number of participants at each block of Session 1 are presented in Table 25. The results of the Kruskall-Wallis ANOVA by ranks performed on the Instruction condition are presented in Table 26 and confirmed results from the graphical representation of the data. The results showed significant differences between the Minimal and Elaborate Instructions groups at each of the first six blocks of Session 1. The Minimal Instructions groups presented significantly lower Indexes of Response and therefore took longer to start responding according to the programmed contingencies. A second Kruskall-Wallis ANOVA by ranks performed on the Training condition also confirmed results from the graphical representation of the data. The results of this Kruskall-Wallis analysis are presented in Table 27 and revealed no significant differences between the Short and Long Training groups at each of the first six blocks of the first session.

Training Phase: Session 2

Graphical Representation. Figure 13 presents the mean Index of Response for each group during the first seven blocks of the second session of the Training Phase. Only the first seven blocks of Session 2 were examined since the mean of each group was based on 20 participants. After Block 7, some participants had attained their Training Criterion and therefore moved on to the Change Phase. Results show that all four groups had very comparable responding at each of the first seven blocks of Session 2. During this period, the groups had mean Indexes of Response ranging from 0.88 and 0.96. An Index of Response of this magnitude indicated that all groups were clearly responding according to the programmed contingencies.

Statistical Analysis. Descriptive statistics are presented in Table 28. Results of a Kruskall-Wallis ANOVA by ranks performed on the Index of Response of the first seven blocks of Session. The results, presented in Table 29, confirm results from the graphical representation of the data. The results indicated a significant difference between the Minimal and Elaborate Instructions groups at Block 1 of Session 2 only. Another Kruskall-Wallis analysis, presented in Table 30, was performed on the Training condition. The results revealed a significant difference between the Short and Long Training groups at Block 6 only. No significant difference between these groups was found however during any of the other blocks. The Short and Long Training groups were therefore responding very comparably during most of Session 2.

Change Phase

Graphical Representations. Figure 14 presents the mean Index of Response for each group during the Change Phase. Throughout the entire Change Phase, the Elaborate Instructions groups maintained clearly higher mean levels of Indexes of Response than the Minimal

Instructions groups. The Elaborate Instructions groups presented mean Indexes of Response ranging between 0.66 and 0.93, while the Minimal Instructions groups' mean Indexes of Response ranged between 0.37 and 0.69.

Figure 15 presents the mean Number of Responses per minute for each group. The mean Number of Responses per minute of the two Elaborate groups on the exFR component seemed to stay at a rate comparable to the one found in Session 2. Their mean Number of Responses on the exDRL component was low and also comparable to their responding in the previous session. The two Elaborate Instructions groups maintained throughout the Change Phase a pattern of low and high responding. The Minimal Instructions groups, however, decreased considerably their mean Number of Responses on the exFR component, as compared to their FR responding during Session 2. The mean Number of Responses per minute of the Minimal groups on the exDRL component increased quite rapidly following the change in contingencies. The pattern of low and high responding on the exDRL and exFR components very quickly disappeared. Participants in the two Minimal groups adopted very similar patterns of responding on both components of the schedule.

Finally, Figure 16 presents the mean Relative Change in Extinction Index for each group during four clusters of three consecutive blocks of the Change Phase. Results show that the Minimal Instructions groups showed lower mean Relative Change in Extinction Indexes than the Elaborate Instructions group throughout the entire Change Phase. The Minimal Instructions groups therefore adjusted their responding more than the Elaborate Instructions groups following the change in contingencies.

Figures 14 to 16 show that the length of Training did not have an effect on the rapidity of adjustment in behavior during the Change Phase. Long and short Training groups responded very similarly to one another in each of the instruction conditions.

Statistical Analyses. Table 31 presents descriptive statistics including means, standard deviations and number of participants for each block of the Change Phase using the Index of Response. The Index of Response was not used in the statistical analyses to examine data from the Change Phase since it dit not adequately reflect the raw data. The Index of Response could not be calculated when the participant did not respond on the exDRL and exFR components of the schedule. Therefore, a missing Index of Response was recorded in these cases and an analysis performed with the Index of Response would not have included data from all 80 participants.

The effects of extinction were measured using the Relative Change in Extinction Index. This index was calculated across four Clusters of the Change Phase. Descriptive statistics are included in Table 32. Results of a Kruskall-Wallis ANOVA by ranks performed on the Instruction condition are presented in Table 33. As suspected, the Elaborate Instructions groups adjusted their behavior significantly more during the Change Phase, when compared to the Minimal Instructions groups. The Elaborate Instructions groups differed significantly from the Minimal groups at each of the four Clusters. A Kruskall-Wallis analysis was also performed on the Training condition and revealed no significant difference between the Long and Short Training groups (see Table 34). These results confirmed those from the graphical representation of the data.

Discussion

The results of Experiment 3 have confirmed once again the finding that instructions facilitate the acquisition of a new behavior. The more Elaborate Instructions groups started responding in accordance with the programmed contingencies significantly sooner than those who had received Minimal Instructions. However, by the end of the Training period, all groups had learned the targeted behavior and were responding in accordance with the programmed contingencies.

The results from the Change Phase showed that persistence in the behavioral pattern acquired during the Training Phase was more noticeable in the Elaborate Instructions groups than in the Minimal Instructions groups. Visual analysis of the results confirmed that the Elaborate Instructions groups maintained, throughout the Change Phase, a pattern of low and high responding on the exDRL and exFR components of the schedule, respectively. For the two Minimal Instructions groups, this pattern ceased early on in the session. Furthermore, the statistical analyses performed on the Relative Change in Extinction Index indicated that the Elaborate Instructions groups demonstrated significantly less extinction effects than did the Minimal Instructions groups throughout the Change Phase.

The graphical and statistical results of this experiment did not lend support to the hypothesis that the longer training groups would take longer in adjusting their behavior following a change in programmed contingencies. It is felt that the procedures, apparatus, values of parameters and the number of blocks of difference between the Minimal and Elaborate instructions groups were a fair representation of what had been used in the literature, and more particularly in Experiments 1 and 2. From these results, we may conclude that length of training is probably not a factor contributing to the insensitivity of rule-governed behavior effect. Replication of this study, or a form of it that would control for length of training, would increase our confidence in this finding.

Experiment 4

Introduction

The general theoretical context for Experiment 4 is as for Experiment 3 and that is the potential usefulness of ideas from the Darwinian survival and evolution of species in understanding the survival and evolution of populations of behaviors. As described earlier, Andronis (1991) argued that instructions, by selecting certain specific behaviors, may restrict the range of behaviors available once contingencies change. This author suggested that this restriction in the behavioral repertoire may be an important factor in the insensitivity of rule-governed behavior effect. Hayes, Brownstein, Zettle et al. (1986) also claimed that sensitivity to changing conditions can be partially attributed to the range of behavior available to make contact with the programmed contingencies. They suggested that instructions limit the range of behaviors available to make such contact.

In most experiments, one critical difference (and confound) between the instructed conditions and the contingency shaped conditions is that, the instructed condition led to less variability in the patterns of behavior during training (Chase & Danforth, 1991). Participants having received elaborate instructions, did not emit variable responding in the beginning of the experiment, but rather quickly followed the instructions, came in contact with the contingencies and were reinforced. Participants given minimal instructions took longer than the others to acquire behavior in accordance with the programmed contingencies. The Minimal Instructions groups tended to emit variable patterns of responding until their behavior was reinforced by the contingencies.

To date, only two studies have looked at the relation between variability in behavior and sensitivity to a change in programmed contingencies (LeFrancois et al., 1988; Joyce & Chase, 1990). These studies have been described in detail in the Introduction section. LeFrancois et al. (1988) studied the effects of a variety of instructions on human performance. They hypothesised that instructions on a variety of schedules might produce responding that would change when contingencies changed. The authors concluded that giving participants variety training may be sufficient to assure sensitivity to changing contingencies.

Joyce and Chase (1990) examined the relation between response variability and sensitivity to changes in reinforcement contingencies. They hypothesised that the insensitivity to changing contingencies is due to the lack of variability produced by the instructions; therefore, rules that allowed for variability, might be more likely to produce responding that is sensitive to a change in contingencies. The authors concluded that behavior variability is important to contingency sensitivity, and may account for the "insensitivity of rule-governed behavior" effect.

Chase and Danforth (1991) concluded, in their review of the rule-governed behavior literature, that further analyses of the effects of a history of response variability are needed before the importance of this factor can be ascertained. They suggested that "it is important to demonstrate that response variability is a critical feature of the sensitivity to changing conditions that characterizes contingency shaping" (p. 213). They also suggested that further study is needed to define the limiting features of variability.

The issue of behavioral variability and its impact on the insensitivity of rule-governed behavior was assessed in Experiment 4, by adopting a different methodology than had been used in the studies by LeFrancois et al. (1988) and Joyce and Chase (1990). Experiment 4 investigated the insensitivity of rule-governed behavior by training participants on a multiple schedule and then making an unannounced change in contingencies, keeping the methodology closely related to the one adopted in Experiments 1, 2 and 3. This experiment manipulated the variety of instructions given to the participants during a Variability Pre-Training Session. The hypothesis that the insensitivity of rule-governed behavior may be due, not to the use of rules per se to establish the behavior, but rather to the restricted variability in behavior early on in the experiment was tested. Instead of exposing participants to a great variety of schedules, as in the study by LeFrancois et al. (1988), this study aimed at exposing participants to three multiple schedules of low/low rates, high/high rates and low/high rates before the initiation of the standard Training Sessions (DRL 6 s/FR 18). The hypothesis to be tested was that instructing participants on three multiple schedules would result in a greater array of patterns of behaviors (low/low, high/high, low/high rates), and therefore expand the range of behaviors still available in the repertoire during the change in contingencies.

Participants were assigned to one of six groups: Minimal Instructions - Short Training (MS); Minimal Instructions - Long Training (ML); Minimal Instructions - Variability Pre-training (MVAR); Elaborate Instructions - Short Training (ES); Elaborate Instructions - Long Training (EL); Elaborate Instructions - Variability Pre-training (EVAR).

The training received by the MS and ES groups was identical to the standard training all groups received in Experiments 1 and 2. They received three sessions (two Training Sessions and one Change Phase) of a fixed number of blocks. The two Variability Pre-training groups received in addition to the three standard sessions, a Variability Pre-training Session where participants were trained under a variety (three) of schedules. The two Long Training (ML and EL) groups were added to this design to equate for the longer length of training received by the Variability Pre-training groups. Like the two Variability Pre-training groups, the Long Training groups also received four sessions. By having two Long Training groups and two Short Training, this study could check again to see if the length of training may be a factor in the insensitivity of rule-governed behavior.

It was expected that the rapidity of adjustment in behavior during the Change Phase would depend on the type of instruction (Minimal or Elaborate) received and the amount of variability in behavior during the Pre-training and Training Sessions. The participants in the Variability Pre-training groups were exposed to a variety of schedules. In turn, this variety of schedules should have resulted in a less restricted range of behaviors being available in the individual's repertoire once the unannounced change in contingencies was introduced. The greater the range of behaviors available in the Pre-Training and Training Sessions, the more rapidly the behavior should have adjusted during the Change Phase. Of all groups, it was predicted that the MVAR group would show the greatest sensitivity in behavior following the onset of the change of contingencies. It was also predicted that the MS and ML groups would be next in rapidity of adjustment and sensitivity to a change. It was hypothesized that the EVAR group would be significantly more sensitive than the ES and EL groups to the unannounced change in contingencies. Finally, it was expected that the ES and EL groups would take the longest to adjust.

Method

Participants

One hundred and eight undergraduate volunteers from the University of Ottawa participated and were included in this study. The sample was composed of 70 females and 38 males. The ages ranged between 18 and 56 years of age with a mean of 23.3 years. The participants were randomly assigned to one of six groups: Minimal Instructions - Short Training (MS); Minimal Instructions - Long Training (ML); Minimal Instructions - Variability Pre-training (MVAR); Elaborate Instructions - Short Training (ES); Elaborate Instructions - Long Training (EL); Elaborate Instructions -Variability Pre-training (EVAR). There were 18 participants per group.

Setting and Apparatus

The setting and apparatus used in this Experiment were identical to that of Experiments 1, 2 and 3.

Procedure

The procedure for this experiment was very similar to that of Experiments 1, 2 and 3. The two Short Training groups (MS and ES) received three sessions; two 20 minute Training Sessions (hereafter called the Training Sessions) followed by 20 minutes of extinction (the Change Phase) with a short break in between, as in previous experiments. The two Long Training groups (ML and EL) received four sessions; one 36 minute Training Session (hereafter called the Prolonged Training Session) which was divided into three 12 minute portions; two 20 minute Training Sessions; and finally followed by 20 minutes of extinction (Change Phase). The printer would automatically start after each of these sessions, including after each of the three 12 minute portions of the Prolonged Training Session.

During the Prolonged Training Session and the 20 minute Training Sessions, the circle moved according to a multiple differential-reinforcement-low-rate (DRL) 6 seconds and fixed-ratio (FR) 18 schedule of reinforcement, with the components alternating every minute. All sessions took place in one seating. Participants received instructions before each 12 minute portion of the Prolonged Training Session, before each 20 minute Training Session, and before the Change Phase. For all groups, during the Change Phase, both components of the multiple schedule changed to extinction/extinction, without participants being informed or warned of this change. During the unannounced Change Phase, there is no longer a DRL/FR schedule in effect but only the alternating screen border, which had been associated with the exDRL and exFR components of the multiple schedule, during the Training Phase.

The two Variability Pre-training groups (MVAR and EVAR) also received four sessions. In addition to the three standard sessions (two 20 minute Training Sessions under DRL 6 s/FR 18 schedules and 20 minutes of extinction during the Change Phase), the MVAR and EVAR groups initially received a 36 minute Variability Pre-training Session that was divided into three 12 minute portions. After each of these sessions, the printer would also automatically start printing.

During one 12 minute portion, the circle on the grid moved according to a DRL 6 s/DRL 6 s schedule with the components and screen border alternating every minute. During another 12 minute portion of the Variability Pre-training Session, the circle moved according to a FR 18/FR 18 schedule with components and screen border alternating every minute. During a third portion of the Variability Pre-training Session, the circle moved according to a DRL 6 s/FR 18 schedule with components and screen border alternating every minute. The printer printed after each of these sessions. There are six different orders for presenting these three schedules. Each schedule order was assigned at random to six participants in each of the two Variability Pre-training groups.

The printed instructions given to the participants in the MS and ES groups were the same as those used in Experiment 3 and were given at the beginning of each session. The general instructions were as follows:

> This is a straightforward study concerning learning processes. It is a not a psychological test and it does not involve any deception. During this study, you will be alone in this room except for two brief breaks when I will be with you while the computer is printing. Your task is to move the circle from the upper left corner to the bottom right corner as many times as you can. Moving the circle involves these two buttons and the colour of the border around the screen.

No further instructions were given to the MS group. The printed instructions given to the participants in the ML and EL groups before each session were identical to the MS and ES groups with exception that they were told they would have five brief breaks instead of two. As in previous experiments, the participants in the ES and EL groups were given these additional printed instructions following the original set of instructions:

> When the screen border is dark, the best way to push the buttons is slowly with several seconds between each push, and when the screen border is light, the best way to push the buttons is rapidly.

All participants in the two groups with Variability Pre-training were given instructions before each of the four sessions (Pre-training, Training - Session 1, Training - Session 2, Change Phase) that were identical to those given to the ML and EL groups. In addition to these general instructions, participants in the two Variability Pre-training condition were given additional instructions at the beginning of each 12 minute portion of the Pre-training. For the DRL 6 s/DRL 6 s portion of the Pre-training Session they were given these printed instructions:

> When the screen border is dark, the best way to push the buttons is slowly with several seconds between each push, and when the screen border is light, the best way to push the buttons is slowly.

For the FR 18/FR 18 portion of the Pre-training Session, they were given these printed instructions:

> When the screen border is dark, the best way to push the buttons is rapidly, and when the screen border is light, the best way to push the buttons is rapidly.

For the DRL 6 s/FR 18 portion of the Pre-training Session, the participants were given these printed instructions:

> When the screen border is dark, the best way to push the buttons is slowly with several seconds between each push, and when the screen border is light, the best way to push the buttons is rapidly.

The participants in the MVAR group then received no further instructions. However, the participants in the EVAR group were given these additional printed instructions following the original set of instructions before each session (Training - Session 1, Training - Session, Change Phase):

> When the screen border is dark, the best way to push the buttons is slowly with several seconds between each push, and when the screen border is light, the best way to push the buttons is rapidly.

Experimental Design and Variables

The variables and design were identical to Experiments 1 and 3. As in previous experiments, a repeated measures design was adopted for this experiment. The experimental design was a two between-subjects independent variables and a one-within subjects independent variable design. The two between-subjects variables were the type of Instructions (Minimal or Elaborate), and the Training (Short, Long and Variability Pre-training) received. The within-subjects variable were the two-minute blocks across sessions. The dependent variables were the number of responses under the FR and DRL components of the schedule, the Index of Response (described in Experiment 1), and the Relative Change in Extinction Index (described in Experiment 1).

Participants who had attained an Index of Response of 0.85 or higher during each of the last three blocks of Session 2, and had demonstrated movement on both components of the schedule were considered to have attained the Training Criterion. For the Prolonged Training Session and the Training Session, a block consisted of the one-minute presentation of the DRL component with the screen border dark followed by the FR component of the reinforcement schedule with the screen border light. For the Variability Pre-Training Session for the DRL/DRL 12 minute portion, a block consisted of the one-minute presentation of the DRL component with the screen border dark followed by another DRL component of the reinforcement schedule with the screen border light. For the FR/FR 12 minute portion, a block consisted of the one-minute presentation of the FR component with the screen border dark followed by another FR component of the reinforcement schedule with the screen border light. During the DRL/FR 12 minute portion of the session, a block consisted of a one-minute presentation of the DRL component with the screen border dark followed by one minute of the FR component of the reinforcement schedule with the screen border light. For the Change Phase, the two-minute block consisted of the comparable one-minute periods with the screen border dark, followed by the screen border light, but the schedule was extinction/extinction. For parsimony, in certain statistical analyses, where a Session was examined in its entirety, clusters of blocks were created. The analyses were performed, where specified, on "clusters" of blocks consisting each of the average of three (or four) consecutive blocks (i.e., blocks 1-3, 4-6, 7-9, 10-12).

Results

In total, 137 students participated in this experiment. The results of 108 of these participants were retained for analyses. Of these 29 excluded participants, two participants' data were discarded due to technical difficulties. Seven of these 29 participants decided to stop the experiment part way through. These seven participants were found in each of the six groups. Finally, 20 participants failed to meet the Training Criterion. The breakdown per group of these 20 participants was as follows: MS (10), ML (5), MVAR (0), ES (1), EL (2), EVAR (2). Throughout this study, testing of assumptions underlying the use of parametric ANOVA revealed that the means and standard deviations seemed to be substantially correlated across cells of the design and that there was the presence of heterogeneity of variances. The main effects were therefore analysed using a non parametric procedure, the Kruskall-Wallis ANOVA by ranks.

Prolonged Training and Variability Pre-training Sessions

Graphical Representations. Figure 17 displays the mean Number of Responses per minute during the ML and EL groups' initial Training Session (the Prolonged Training Session). This figure shows that, as expected, the EL group starting responding in accordance with the DRL/FR schedule of reinforcement more rapidly than the ML group. Throughout the session, in comparison to the ML group, the EL group maintained lower levels of responding on the DRL component and higher levels on the FR component of the schedule. By the end of the Prolonged

Training Session however, both groups were responding with a similar pattern of low responding during the DRL component and high responding during the FR component of the schedule.

Figures 18 to 23 display the mean Number of Responses per minute for the Variability Pre-Training groups during the Variability Pre-training Session. Six graphs are presented, showing the mean Number of Responses of subjects exposed to each schedule order in the Variability groups. During this Variability Pre-training Session, the MVAR and EVAR groups had received identical written instructions, and their data is therefore collapsed in these figures. In summary, visual inspection of these graphs reveals that the Variability Pre-training Session seemed to have fulfilled its purpose in that the participants in the Variability Pre-Training groups responded in accordance with a variety of schedules of reinforcement and therefore presented varying patterns of responding.

Training Phase: First 20 minute Training Session

Graphical Representation. Figure 24 displays, for all six groups, the mean Index of Response of the first 20 minute Training Session. This was a first session for the MS and ES groups and the second session for the other four groups (ML, EL, MVAR and EVAR) which had received prior Prolonged Training or Variability Pre-training. Figure 24 shows that the EL, EVAR, ML and MVAR groups started responding according to the programmed contingencies very quickly. The mean Indexes of Response were in the 0.84 and 0.97 range throughout the entire session. High mean indexes such as these signify that participants were responding as expected at a high rate on the FR component of the schedule and at low rates on the DRL component of the schedule. The mean Indexes of Response for the ES group were initially at lower levels but fairly quickly reached the 0.85 and higher mark. Finally, as expected, the MS group took the longest to start responding appropriately to both components of the schedule. As the session progressed however, the MS group increased their mean Indexes of Response to also attain by the last block, an Index of 0.87.

Statistical Analyses. Only the results of the participants who later met the Training Criterion were retained for analyses. Descriptive statistics including means and standard deviations of the Index of Response are presented in Table 35. A Kruskall-Wallis ANOVA by ranks was performed to determine whether there were significant differences between the groups in the speed of acquisition of responding, in accordance with the multiple DRL/FR schedule. It was expected that the Elaborate Instructions groups would learn more quickly than the Minimal Instructions groups. It was also expected that the groups having had prior training (the Long Training groups) would acquire the appropriate responding more rapidly than the two Short Training groups which were exposed to the task and the contingencies for the first time. The analysis was performed on the Index of Response for three clusters of three (or four) consecutive blocks of the first 20 minute Training Session (which represented a second session for the ML, EL, MVAR, EVAR groups). Results from a Kruskall-Wallis ANOVA by ranks performed on the Instruction variable, presented in Table 36, confirmed results from the visual inspection of the data. Results showed significant differences between the Minimal and Elaborate Instructions groups at Cluster 1-3 and Cluster 4-6. The Minimal Instructions groups took longer to start responding to the programmed contingencies. By the Cluster 7-10 however, there were no significant differences between the Minimal and Elaborate Instructions groups. A second Kruskall-Wallis ANOVA by ranks performed on the Training condition (see Table 37) revealed, as expected, that the Short Training groups responded with significantly lower Indexes than the Long and Variability Training groups at each cluster of Blocks during this session.

Training Phase: Second 20 Minute Training Session

Graphical Representation. Figure 25 presents the mean Index of Response for all groups during the second 20 minute Training Session. From the very beginning of this session, the ES, EL, EVAR and ML groups were responding with very high mean Indexes of Response in the 0.95 and 0.97 range. The MVAR group initially responded with a slightly lower mean Index of Response (0.88) to then quickly attain levels similar to those of the ML, ES, EL, and EVAR. The MS group again differed from the others. It started with a lower mean Index of Response of 0.82 which progressively increased to a final Index of 0.93.

Statistical Analyses. To determine whether participants in all groups were responding at comparable levels on both components of the reinforcement schedule by the second 20 minute Training Session, Kruskall-Wallis ANOVA by ranks were performed using the Index of Response. Descriptive statistics are presented in Table 38. The data for the Instruction condition were examined first and the results are presented in Table 39. This analysis confirmed results from the visual inspection of the data. The Minimal and Elaborate groups only differed in their responding to the programmed contingencies during the first cluster of blocks of the second 20 minute Training Session. The Minimal Instructions groups had a lower Index of Response during Cluster 1-3. Kruskall-Wallis analyses were performed on the Training variable (see Table 40) revealed significant differences between the Short and Long Training groups at each of the three clusters of blocks, with the Short Training groups having a lower Index of Response. The Short Training groups responded with a significantly lower Index of Response than the Variability

Training groups during Cluster 4-6 and 7-10. This analysis showed that the Long and Variability Training groups responded significantly differently from each other during the Cluster 1-3 only; the Long Training groups had a higher Index of Response. It should be noted, however, that all groups were responding at or above the Training Criterion by the end of Session 2.

Change Phase

Graphical Representations. Figure 26 displays for all six groups, the mean Index of Response during the Change Phase. The results showed minimal overlap between the Minimal groups and the Elaborate groups for the entire Change Phase. All three Elaborate Instructions groups presented higher mean Indexes of Response than the three Minimal Instructions groups. The three Elaborate Instructions groups displayed greater persistence, behaving in a manner appropriate to the second Training Session and were therefore more insensitive than the Minimal Instructions groups to the change in contingencies. Of the three Elaborate Instructions groups, during the first block, the EVAR group had the lowest mean Index of Response; similarly, of the three Minimal Instructions groups, the MVAR group initially had the lowest mean Index of Response.

Figures 27 and 28 present the mean Number of Responses per minute for the Minimal and Elaborate Instructions groups, respectively. The graphs show that, in comparison to the Minimal Instructions groups, the Elaborate Instructions groups maintained a pattern of lower mean Number of Responses per minute on the exDRL component and higher responding on the exFR component for a longer period. From early on in the session, the Minimal Instructions groups displayed more variable responding than the Elaborate Instructions groups. The Minimal Instructions groups were displaying various patterns of responding.

Figure 29 shows for all six groups, the mean Relative Change in Extinction Index across three clusters of blocks during the Change Phase. During the first cluster of blocks, the three Elaborate Instructions groups all responded with higher mean Relative Change in Extinction Indexes when compared to the three Minimal Instructions groups. Overlap between the Minimal and Elaborate Instructions groups appears however beginning with Cluster 4-6. Of all groups, the MVAR had the lowest mean Relative Change in Extinction Index, indicating the best adjustment to the change to extinction/extinction. Of the three Minimal Instructions groups, the MS group decreased the mean Index the least. All groups decreased their mean Relative Change in Extinction Indexes as the Change Phase progressed.

Statistical Analyses. The results of the Change Phase were examined to determine whether the groups differed with regard to their responses to a change in contingencies. Table 41 presents descriptive statistics for the Index of Response including the means, standard deviations and number of participants for each block of the Change Phase. A Kruskall-Wallis ANOVA by ranks, presented in Table 42, was performed using the Index of Response of the first three blocks of the Change Phase. Only the first three blocks were used in this analysis because all groups still contained, 18 participants each. After the third block, some groups contained data for less than 18 participants, given that some participants had given zero responses on the FR and DRL components during some of the blocks. In these cases, the Index of Response could therefore not be calculated. The results showed a significant difference between the Minimal and Elaborate Instructions groups at each of the first three blocks of the Change Phase. The Minimal Instructions groups had a lower Index of Response during each of the three blocks, indicating greater sensitivity to the change in contingencies. Table 43 presents the results of the Kruskall-

Wallis ANOVA by ranks performed on the Training condition. The results showed that the Variability Pre-training groups had significantly lower Indexes of Response than the Short and Long Training groups at Block 1.

Kruskall-Wallis ANOVA by ranks were performed using the Relative Change in Extinction Index during the first nine blocks of the Change phase. The tenth block was not included since the Relative Change in Extinction Index is calculated using clusters of three consecutive blocks. Descriptive statistics for this Index are presented in Table 44. Results from a Kruskall-Wallis ANOVA found a significant difference between the Minimal and Elaborate Instructions groups at Cluster 1-3 and at Cluster 4-6 (see Table 45). The Minimal Instructions groups therefore changed their behavior significantly more than the Elaborate Instructions groups during the first six blocks of the Change Phase. Another Kruskall-Wallis ANOVA by ranks was performed on the Training condition using the Relative Change in Extinction Index. These results are presented in Table 46. There were significant differences between the Training conditions at Cluster 1-3 only. The Variability Pre-training groups differed from the Short and Long training groups at Cluster 1-3. The Variability Pre-training groups had a significantly lower Relative Change in Extinction Index during Cluster 1-3 and therefore showed evidence of greater extinction effect.

Discussion

The results of Experiment 4 have confirmed once again the hypothesis that elaborate instructions facilitated the acquisition of a new behavior. In comparison to the Minimal Instructions groups. the groups having received Elaborate Instructions started responding sooner in accordance with the programmed contingencies during the Pre-training Session (when applicable) and the first 20 minute Training Session. Although all groups were clearly responding in accordance with the programmed contingencies by the end of the second 20 minute Training Session, the Short Training groups, in comparison to the Long and Variability Training groups, were still exhibiting slightly lower Indexes of Response. These results were not surprising. By the end of the second 20 minute Training Session, the Short Training (MS, ES) groups had received one less Training Session than the ML, EL, MVAR and EVAR groups and therefore less exposure to the programmed contingencies. The MS group's somewhat greater delay in acquiring the appropriate responding during the first two Training Sessions was predictable in that this group was given Minimal Instructions and unlike the other two Minimal Instructions groups, they had received no prior Variability Pre-training or Prolonged Training. It is to be noted that for all groups, the mean Index of Response had attained the 0.90 level by the third Block into the second Training Session. Indexes of all groups were therefore clearly above the Training Criterion. This high value of the mean Index of Response indicated that all six groups were responding according to the programmed contingencies and were demonstrating high rates during the FR component of the schedule and low rates during the DRL component.

Using the mean Relative Change in Extinction Index during the entire Change Phase, the results revealed, as expected, a greater persistence in behavior from the Elaborate Instructions groups than the Minimal Instructions groups during the first two clusters of blocks of the Change Phase. The Minimal Instructions groups changed their behavior more quickly following the start of the extinction session. Following the first six minutes however, there were no significant differences between the Minimal and Elaborate Instructions groups.

The results from the Change Phase supported those of Experiment 3, and did not show a significant effect for length of Training. The Short Training groups did not significantly differ from the Long Training groups. Importantly, during the first six minutes of the Change Phase, this study supported the findings by LeFrancois et al. (1988) and the hypothesis that providing a variety of instructions and then exposing participants to such schedules, will more likely bring sensitivity in responding following a change in contingencies.

Visual inspection of the data suggests however that the Variability Pre-training effect might be explained more by the MVAR group's responses rather than the EVAR group. Although the Variability Pre-training led the MVAR group to adjust their behavior following the change in contingencies, it did not seem to have any important effect on the EVAR group's responding. In fact, unlike our expectations, the EVAR was responding very similarly to the ES and EL groups during the entire Change Phase. When looking at the results of the Change Phase in its entirety, the Variability Pre-training Session therefore seems to have had a more specific impact on the Minimal Instructions groups than on the Elaborate Instructions groups.

The potential differences in mean Relative Change in Extinction Index between the MVAR and EVAR groups may be explained also in terms of restriction in behavioral variability. Both groups were exposed to the variety of schedules (with specific, elaborate instructions) during the Variability Pre-Training in an attempt to promote behavioral variability. Following this Variability Pre-Training participants were exposed to two 20 minute Training Sessions and a Change Phase. During the Training Sessions however, the MVAR group received only vague, minimal instructions while the EVAR group received detailed, specific instructions about the reinforcement contingencies. It is possible that during the Training Sessions, the EVAR group experienced a selection in their behavioral repertoire as the range of behaviors available was further restricted by the elaborate instructions. The MVAR group, on the other hand, did not experience such a selection and restriction in range of behaviors during the Training Sessions. In other words, the selection in range of behaviors that took place following the Variability Pre-training might explain the observed differences in responding between the MVAR and EVAR groups during the Change Phase.

An interesting finding suggested by the visual representation of the data, was that the MVAR group, of all groups, displayed the greatest change in behavior during the extinction session, despite the fact that they had been given detailed, elaborate instructions during the Variability Pre-training Session. If elaborate instructions had special "imbued" attributes that explained the insensitivity of the rule-governed behavior effect, the MVAR should not have adjusted their behavior more than the MS group during the Change Phase, considering that the MVAR group had received elaborate instructions while the MS group had not. This finding supports the hypothesis that the insensitivity of rule-governed behavior may be due not to the effect of rules per se, but rather to restricted behavioral variability.

General Discussion

Findings and Theoretical Implications

Behavior Acquisition: Training Sessions. From a selectionist perspective, verbal instructions affect the variability of responses emitted by participants. Within this framework, elaborate, detailed instructions restrict the variability in responding more than do minimal, vague instructions. Minimal Instructions groups should therefore exhibit greater variability in behavior than the Elaborate Instructions groups initially during the training period. From the range of behaviors displayed by the Minimal Instructions groups, one pattern of behavior should eventually come in contact with the reinforcement schedule in effect and be selected. Comparatively, the Elaborate Instructions groups should behave "as told", exhibit less behavioral variants, and very quickly be reinforced for the pattern of behavior which is in accordance with the schedule of reinforcement.

As predicted within this framework, the findings have shown that the Minimal Instructions groups (contingency-shaped behavior) featured, initially in the Training Sessions, high levels of variability before a pattern of behavior was selected by the contingencies of reinforcement. Comparatively, the Elaborate Instructions groups (rule-governed behavior) exhibited little variability during the Training Sessions, as the groups of participants promptly responded in accordance with the instructions and were reinforced for their responding.

The findings have also shown very clearly that instructions facilitate the acquisition of a new behavior. Responding developed through minimal, very general instructions and simple exposure to the contingencies (contingency-shaped behavior) was less rapidly acquired than responding established with the use of elaborate, detailed instructions (rule-governed behavior).

This confirms results from previous studies (e.g., Ayllon & Azrin, 1964; Baron et al., 1969; Galizio, 1979).

Change Phase. Baum's (1994, 1995) evolution-based definition of rules might help the understanding of the insensitivity of the rule-governed behavior effect. He proposed that a rule relates to proximate and ultimate contingencies. The proximate contingency is usually social in nature (e.g., approval) while the ultimate contingency is more long-term and relates to fitness of an individual by promoting health, resources, relationships or reproduction (Baum, 1995). The proximate contingency provides a relatively immediate reinforcement, which in this series of studies was the movement of the circle and the auditory "boing" when the circle reached the lower right-hand corner of the matrix. The movement of the circle in the matrix and the "boing" may not, at first glance, seem like social consequences. However, we may argue that they are social. The movement of the circle and the "boing" are not inherently reinforcing, but are rather arbitrary stimuli. The movement and the boing have become effective reinforcing stimuli because they (or similar stimuli) have been, in the past, followed by social stimuli such as a pat on the back, congratulations, smiles, etc. The ultimate contingency in this series of studies is more difficult to define. Baum (1994) suggested that "delayed consequences and ill-defined contingencies tend to be ineffective: rarely does a smoker quit the habit after hearing that it may lead to lung cancer in 30 years" (p. 136).

According to Baum (1994), the control by the proximate contingency may be temporary, but with enough training, behavior will come in contact with and be maintained by the ultimate contingency. However, he says that "if occasions for the rule-governed behavior are too infrequent, then transition to the ultimate contingency may never occur" (p. 139). Baum (1994) suggested that this may have explained Galizio's (1979) results. When the programmed contingencies changed, participants in Galizio's study persisted with their patterns of responding that had been previously reinforced. Galizio concluded that, unless a discrepancy between the instructions and the programmed contingencies was very noticeable, responding was likely to be maintained by the instructional stimuli. Baum (1994) suggested that the students in Galizio's (1979) study may eventually have become sensitive to the new contingencies with further training.

The results of these four studies have supported the literature in demonstrating that rule-governed behavior is less likely to change when the contingencies of reinforcement change than is behavior that has been shaped by the natural contingencies (Galizio, 1979; Hayes, Brownstein, Zettle, et al., 1986; Hayes, Brownstein, Haas, et al., 1986; Joyce & Chase, 1990; Kaufman et al., 1966; LeFrancois et al., 1988; Matthews et al., 1977; Shimoff et al., 1986). Importantly, unlike most of the previous studies, this series of four experiments had sufficient numbers of participants to permit the use of statistical analyses in the verification of these findings.

Following Baum's (1994) argument, it could be hypothesized that a procedure that would bring participants to contact the ultimate contingencies more quickly might attenuate the insensitivity effect. Experiments 1 and 2 have explored the use of a simple warning as a way to counteract the insensitivity of rule-governed behavior. The warning was shown, in Experiment 2, to have an effect on responding and increase sensitivity to a change in contingencies. The effect of the warning might be understood in terms of a selectionist framework. The warning may have modulated the social, proximate contingency by giving participants the "permission" to not follow the rules. This may possibly have permitted a contact with an ill-defined ultimate contingency. More research is needed to isolate the possible relation between a warning and the proximate and ultimate contingencies, and their impact on the insensitivity of rule-governed behavior.

Conceptually, Staddon and Simmelhag (1971) proposed a mechanism which provided an interesting framework from which to understand the insensitivity of rule-governed behavior effect. They had noted that the onset of behavior variation during the procedure of extinction can often be delayed depending on whether the training preceding extinction has been prolonged. They suggested a correlation between the onset of behavior variation during extinction and the duration of the preceding behavioral training. Following a shorter training period, they expected that the onset of variation in behavior would be sooner. Conversely, a longer training period would produce a greater delay in the appearance of extinction effects.

Experiment 3 investigated the role of length of training (with contact with the reinforcement contingencies). Based on the mechanism suggested by Staddon and Simmelhag (1971), it was proposed that variation in behavior could be delayed depending on the duration of prior training. The longer the prior training, the longer would be the delay in producing a behavior pattern that would come under the control of the new contingencies. It was hypothesized that the delay in onset of behavior variation, following a change in the programmed contingencies, would be related to the differences in duration of prior training between the Elaborate and Minimal Instructions groups. Length of training had been a confound variable present in previous studies. Researchers had given the same length of sessions to subjects in all experimental groups (Minimal and Elaborate Instructions), no matter how long it took participants to start responding according to the programmed contingencies. The actual number of minutes (blocks) during which participants responded in accordance with the programmed contingencies varied between groups. Experiment 3 therefore equated for the number of blocks during which participants were actually responding in accordance with the programmed contingencies. No evidence was found in Experiment 3 to support the hypothesis that length of training was having an effect, in this series of studies, on the insensitivity of rule-governed behavior.

Since no effect had been found in Experiment 3, length of training was once again investigated in Experiment 4. Two Long Training groups and two Short Training groups were compared to further assess the length of training as a potential factor in the insensitivity of rule-governed behavior. Experiment 4 investigated the length of training using a slightly different method than had been used in Experiment 3. The number of blocks during which the participants were actually responding according to the programmed contingencies were not equated. The Short Training groups received, as in previous studies, two 20 minute Training Sessions. The Long Training groups received much longer training, with an initial 36 minute Prolonged Training Session plus the two standard 20 minute Training Sessions. The results of Experiment 4 also did not support the hypothesis that length of training had an impact on the insensitivity of rule-governed behavior. In sum, the results of Experiments 3 and 4 have permitted the elimination of length of training as a potential important factor on the insensitivity of rule-governed behavior, in this specific series of studies.

Another implication of the selectionist perspective is that behavioral variability may play a very important role in the insensitivity of rule-governed behavior effect. Andronis (1991) argued that, in parallel with natural selection, a contingency can only select a specific behavior once the behavior has been emitted. A procedure (e.g., detailed instructions) which *a priori* restricts the behavioral repertoire assures that a particular abandoned behavioral variant will not be available once contingencies change. Based on Andronis' (1991) argument, it was hypothesized that the detailed instructions given to the Elaborate Instructions groups restrict the range of behavioral variants available for selection. Consequently, the restriction in the behavioral repertoire might explain the insensitivity of rule-governed behavior to a change in programmed contingencies.

To examine Andronis' (1991) argument, Experiment 4 assessed, within a selectionist framework, the impact of a variety of instructions on the insensitivity of rule-governed behavior. In most previous experiments, one critical confound between the Elaborate and the Minimal Instructions conditions was that the Elaborate Instructions condition led to less variability in the patterns of behavior during training. It was hypothesized that the insensitivity of rule-governed behavior may have been due to the restricted variability in behavior (ensured by detailed instructions) early on in the experiment rather than by the instructions per se. This study was based on the postulate that the greater sensitivity of contingency-shaped behavior to changing contingencies may be attributable to the response variability demonstrated during the initial Training Session. To test this hypothesis, participants in both the Minimal and Elaborate Instructions groups were exposed to a variety of instructions and schedules to produce variability in behavior very early in the training. This variability training was followed by two sessions of exposure to one schedule (DRL 6 s/FR 18), which was then followed by the Change Phase.

The results showed a significant impact of variability pre-training during the first three blocks of the Change Phase. The groups of participants having received variability pre-training had decreased their Relative Change in Extinction Index significantly more than the Short or Long Training groups.

However, when examining visually the results of the Change Phase in its entirety using the mean Relative Change in Extinction Index, a different picture seems to be drawn. The results suggested that the Variability Pre-training Session had a more significant impact on the Minimal Instructions group (MVAR). The Elaborate Instructions group with Variability Pre-training (EVAR) did not seem particularly affected by the variety of instructions and schedules. In fact, the EVAR group responded very similarly to the other two Elaborate Instructions groups (ES, EL) during the entire Change Phase. These results do not correspond to those of Joyce and Chase (1990). With the use of an instruction to "vary the speed of responding", these authors had found sensitivity to a change in contingencies, whether the behavior had been completely instructed or not.

A critical difference between the previous literature and Experiment 4 is the time at which the Variability Pre-training was implemented. Previous studies had introduced variability in responding just prior to the change in contingencies, either by exposing participants to a variety of instructions and schedules (LeFrancois et al., 1988) or by introducing instructions that allowed for variability ("strategic instruction") immediately before the change in schedule (Joyce & Chase, 1990). Experiment 4 exposed participants to the Variability Pre-Training initially before the two standard Training Sessions and the Change Phase. The difference in the time at which variability training was introduced may explain the finding in Experiment 4, that the EVAR group had not been particularly affected by the Variability Pre-training.

Unlike the previous variability studies (LeFrancois et al., 1988: Joyce & Chase, 1990), the timing of the Variability Pre-training in Experiment 4 emulated more closely the variability that naturally occurs with contingency-shaped behavior. Results of Experiments 1, 2 and 3 have shown that contingency-shaped behavior (minimal instructions) is variable early in the first Training Session. However, typically by the end of the training period and before the Change Phase, the Minimal Instructions groups' responding was not variable and resembled very closely that of the Elaborate Instructions groups'. In trying to understand the insensitivity effect in this series of studies and the role that variability had played in Minimal Instructions groups, presenting the Variability Pre-training at the beginning of training seemed more appropriate. In response to Chase and Danforth's (1991) comment that further research was needed to define the limiting features of variability, the findings of Experiment 4 suggest that the moment where variability training is introduced may be an important factor. Further research is needed to isolate the impact of timing of the variability training.

Further research is also needed to separate the impact of instructions per se versus the impact of variability training. Considering the findings of Experiment 4, another study designed to expose participants in a Variability Pre-training Session, to a variety of schedules of reinforcement similar to those in Experiment 4, would further increase our knowledge of the impact of variability. However, participants would be given only Minimal Instructions about these schedules. With time, simple exposure to the contingencies of reinforcement would shape the behavior for all participants in accordance with the said contingencies. Following this Pre-training, the usual standard Training Sessions and Extinction Session with Minimal and Elaborate Instructions could be given.

Practical Implications

The practical implications of the results are somewhat limited considering the experimental task and restricted population sample adopted for these studies. However, it is possible to draw certain tentative educational and clinical implications from the findings. First, rule-governed behavior is acquired more quickly than behavior that is contingency-shaped. Much of the education system is based on this premise. Giving instructions will expedite learning more than waiting for the learner to naturally come in contact with the environmental requirements (reinforcement contingencies).

Of greater interest however, is the finding that behavior established by instructions may prove to be somewhat insensitive to a change in environmental requirements. A concrete example of this would be an instance where a student continues to follow an instruction ("lift your hand to speak") even though this instruction is no longer applicable in the new situation (lifting his hand to speak during a soccer game). A clinically relevant example of the insensitivity of rule-governed behavior would be that of a person continuing into adulthood, to follow a parent's maladaptive rule or advice. An adult having grown up with the "rule" that he and his family are not "destined to achieve much" may have difficulty applying for a new work position. Such a rule might have restricted the individual's behavioral repertoire and prevented contact with reinforcing contingencies, such as getting a promotion when opportunity arose or even having a successful job interview.

Poppen (1989) argues that many verbal behaviors that we find in therapy (for example, pep talks, encouragement, "positive-thinking", reassurance) are models of rules provided by the therapist to be adopted by the client. When instructions are used in a therapeutic relationship, we can presume that in certain circumstances, the client's behavior would be under the control of the therapist's instructions, rather than the natural contingencies (Hayes et al., 1989). For example, a client having received in therapy instructions to promote social skills might behave inappropriately in certain situations. Excessive instruction following (practising social skills) might, for example, endanger the client's personal security in a circumstance where aloofness would have been more appropriate.

When Minimal Instructions are sufficient to bring about a desired behavior, giving a variety of elaborate instructions about a variety of schedules can actually improve sensitivity to a change in contingencies. However, when the use of instructions is needed to permit the acquisition of specific skills, certain precautions could be taken. The findings suggest the importance of introducing a variety of instructions to the student or client in order to prevent a great restriction in the range of behaviors available in the repertoire, which could prove problematic once the environment requirements change. The findings have also suggested that even a simple warning may be enough to prevent excessive rule-following.

Limitations

In this series of studies, the measurement of variety in behavior was rather coarse and indirect as the behavior patterns in response to a multiple schedule were examined. For future experiments, a methodological refinement, in this particular series of studies, would be to introduce a more precise measure of behavioral variability. The use of a measure of interresponse times during the standard DRL 6 s/FR 18 multiple schedule might prove useful. Evidently, as the effect of behavioral variability on the insensitivity of rule-governed behavior becomes increasingly evident, more research should address the issue of measurement of behavioral variability.

A strength of laboratory experiments is that they allow for the control of key variables. On this topic, Kazdin (1998) said:

> As a general rule, *design features that make an experiment more sensitive as a test of the independent and dependent variables tend to limit the generality of the findings. Conversely, features of an experiment that enhance generality of the results tend to increase variability and to decrease the sensitivity of the experimental test.* (p. 59)

As is usually the case with fundamental research, the greater control allowed by laboratory experiments compromises our capacity to generalize the findings. Often, a direct application of the results to a broader segment of the population, and to clinical and educational settings is difficult. Applied research is necessary to draw any conclusions from these studies to more natural settings.

A potential selection bias always exists when utilizing a volunteer sample of individuals, and this may affect the generalizability of the results (Bordens & Abbott, 1996). It is possible that the students who decided to volunteer in our experiments had particular characteristics when compared to the larger population of adults. For instance, we may speculate that if the sample of students who volunteered in our experiments was more "compliant" than the average student, our results could potentially be biased by this, as there could have been an inflation of the insensitivity effect in the Elaborate Instructions groups. Anecdotally, we all know that some people are more apt to follow rules and instructions than others are. There is a great proportion of individual differences in any population. However, we are confident that the random assignment of participants to each group would have roughly equated these individual differences across groups.

With group studies, another limitation is that the reported results do not necessarily reflect the responding of individuals, but rather are a reflection of a group average. The data therefore gives us little information as to how an individual responds to instructions and a change in contingencies, but rather information on the average responding of groups. Previous studies however, performed in a behavior analytic framework, with small samples and no reliance on group means or inferential statistics, have succeeded in demonstrating the insensitivity effect. Replication of those findings in these studies with larger number increases external validity.

As we find out more about the insensitivity of rule-governed behavior effect, the portrait being drawn is increasingly complex with each new study. Other studies in our laboratory have delimited a social component to the insensitivity of rule-governed behavior effect. The reasons for the insensitivity effect seem to be multi-faceted and may involve individual differences, proximate and ultimate contingencies, social contingencies, and variability in behavior.

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Table 1

Means and Standard Deviations of the Index of Response for Each of the Twelve Blocks of the First Session of the Training Phase in Experiment 1

Groups	Blocks					
	1	2	3	4	5	6
MNW	0.56	0.56	0.58	0.64	0.68	0.73
	(0.12)	(0.09)	(0.11)	(0.16)	(0.18)	(0.19)
MW	0.59	0.58	0.65	0.69	0.73	0.79
	(0.08)	(0.10)	(0.16)	(0.14)	(0.15)	(0.15)
ENW	0.79	0.82	0.87	0.87	0.85	0.89
	(0.24)	(0.20)	(0.22)	(0.20)	(0.23)	(0.22)
EW	0.80	0.80	0.77	0.79	0.83	0.87
	(0.17)	(0.21)	(0.22)	(0.29)	(0.29)	(0.23)

(table continued)

Groups	Blocks					
	7	8	9	10	11	12
MNW	0.78	0.75	0.82	0.83	0.83	0.86
	(0.18)	(0.21)	(0.21)	(0.20)	(0.22)	(0.22)
MW	0.88	0.84	0.89	0.95	0.94	0.95
	(0.09)	(0.15)	(0.12)	(0.03)	(0.04)	(0.03)
ENW	0.86	0.90	0.92	0.94	0.91	0.94
	(0.21)	(0.13)	(0.07)	(0.06)	(0.09)	(0.06)
EW	0.85	0.88	0.84	0.84	0.84	0.87
	(0.27)	(0.22)	(0.32)	(0.32)	(0.32)	(0.24)

Note: Values presented in parentheses are the standard deviations; Minimal Instructions - No warning (MNW), Minimal Instructions - Warning (MW), Elaborate Instructions - No warning (ENW), Elaborate Instructions - Warning (EW). To be included in the sample, participants had to meet the Training Criterion.

Table 2

Kruskall-Wallis ANOVA by Ranks (Minimal vs Elaborate Instructions) Using the Index of Response During the First Session of the Training Phase in Experiment 1

Kruskall-Wallis ANOVA by ranks: Cluster 1-3

Kruskall-Wallis test: $H(1, N = 58) = 25.73$, $p < 0.0001$

	Valid n	Sum of ranks
Minimal	30	559.00
Elaborate	28	1152.00

Kruskall-Wallis ANOVA by ranks: Cluster 4-6

Kruskall-Wallis test: $H(1, N = 59) = 19.60$, $p < 0.0001$

	Valid n	Sum of ranks
Minimal	30	608.00
Elaborate	29	1162.00

(table continued)

Kruskall-Wallis ANOVA by ranks: Cluster 7-9

Kruskall-Wallis test: $H(1, N = 59) = 7.28$, $p = 0.01$

	Valid n	Sum of ranks
Minimal	30	722.00
Elaborate	29	1048.00

Kruskall-Wallis ANOVA by ranks: Cluster 10-12

Kruskall-Wallis test: $H(1, N = 59) = 1.78$, $p = 0.18$

	Valid n	Sum of ranks
Minimal	30	812.00
Elaborate	29	958.00

Table 3

Kruskall-Wallis ANOVA by ranks (Warning vs No Warning) Using the Index of Response During the First Session of the Training Phase in Experiment 1

Kruskall-Wallis ANOVA by ranks: Cluster 1-3

Kruskall-Wallis test: $H(1, N = 58) = 0.02$, $p = 0.89$

	Valid n	Sum of ranks
No Warning	27	788.00
Warning	31	923.00

Kruskall-Wallis ANOVA by ranks: Cluster 4-6

Kruskall-Wallis test: $H(1, N = 59) = 0.00$, $p = 0.99$

	Valid n	Sum of ranks
No Warning	28	841.00
Warning	31	929.00

(table continued)

Kruskall-Wallis ANOVA by ranks: Cluster 7-9

Kruskall-Wallis test: $H(1, N = 59) = 0.17, p = 0.68$

	Valid n	Sum of ranks
No Warning	28	813.00
Warning	31	957.00

Kruskall-Wallis ANOVA by ranks: Cluster 10-12

Kruskall-Wallis test: $H(1, N = 59) = 0.12, p = 0.73$

	Valid n	Sum of ranks
No Warning	28	817.00
Warning	31	953.00

Table 4

Means and Standard Deviations of the Index of Response for Each of the Blocks of the Second Session of the Training Phase in Experiment 1

Groups	Blocks				
	13	14	15	16	17
MNW	0.90	0.91	0.91	0.94	0.94
	(0.12)	(0.11)	(0.11)	(0.05)	(0.05)
MW	0.92	0.95	0.96	0.95	0.95
	(0.04)	(0.03)	(0.01)	(0.03)	(0.03)
ENW	0.96	0.94	0.96	0.95	0.95
	(0.02)	(0.03)	(0.01)	(0.04)	(0.03)
EW	0.92	0.93	0.93	0.92	0.90
	(0.14)	(0.10)	(0.10)	(0.18)	(0.25)

(table continued)

Groups	Blocks				
	18	19	20	21	22
MNW	0.94	0.95	0.96	0.96	0.96
	(0.06)	(0.03)	(0.02)	(0.01)	(0.01)
MW	0.95	0.94	0.95	0.95	0.95
	(0.03)	(0.06)	(0.03)	(0.02)	(0.03)
ENW	0.96	0.96	0.96	0.96	0.96
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
EW	0.96	0.96	0.96	0.96	0.96
	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)

Note: Values presented in parentheses are the standard deviations; Minimal Instructions - No warning (MNW), Minimal Instructions - Warning (MW), Elaborate Instructions - No warning (ENW), Elaborate Instructions - Warning (EW). To be included in the sample, participants had to meet a criterion in the Training Phase.

Table 5

Kruskall-Wallis ANOVA by ranks (Minimal vs Elaborate Instructions) Using the Index of Response Across Four Clusters During the Second Session of the Training Phase in Experiment 1

Kruskall-Wallis ANOVA by ranks: Cluster 13-15

Kruskall-Wallis test: $H(1, N = 59) = 3.95$, $p = 0.05$

	Valid n	Sum of ranks
Minimal	30	769.00
Elaborate	29	1001.00

Kruskall-Wallis ANOVA by ranks: Cluster 16-18

Kruskall-Wallis test: $H(1, N = 59) = 0.14$, $p = 0.70$

	Valid n	Sum of ranks
Minimal	30	875.00
Elaborate	29	895.00

(table continued)

Kruskall-Wallis ANOVA by ranks: Cluster 19-22

Kruskall-Wallis test: $H(1, N = 59) = 3.42$, $p = 0.06$

	Valid n	Sum of ranks
Minimal	30	778.00
Elaborate	29	992.00

Table 6

Kruskall-Wallis ANOVA by ranks (Warning vs No Warning) Using the Index of Response During the Second Session of the Training Phase in Experiment 1

Kruskall-Wallis ANOVA by ranks: Cluster 13-15

Kruskall-Wallis test: $H(1, N = 59) = 0.01, p = 0.90$

	Valid n	Sum of ranks
No Warning	28	832.00
Warning	31	938.00

Kruskall-Wallis ANOVA by ranks: Cluster 16-18

Kruskall-Wallis test: $H(1, N = 59) = 1.37, p = 0.24$

	Valid n	Sum of ranks
No Warning	28	763.00
Warning	31	1007.00

(table continued)

Kruskall-Wallis ANOVA by ranks: Cluster 19-22

Kruskall-Wallis test: $H(1, N = 59) = 0.30$, $p = 0.58$

	Valid n	Sum of ranks
No Warning	28	876.00
Warning	31	894.00

Means, Standard Deviations and Number of Participants for Each Block of the Change Phase, Using the Mean Index of Response in Experiment 1

Groups	Blocks					
	23	24	25	26	27	28
MNW	0.65	0.44	0.45	0.63	0.57	0.49
	(0.15)	(0.22)	(0.24)	(0.25)	(0.33)	(0.27)
	n = 14	n = 14	n = 14	n = 14	n = 13	n = 13
MW	0.67	0.52	0.42	0.64	0.55	0.57
	(0.12)	(0.24)	(0.25)	(0.21)	(0.27)	(0.29)
	n = 16	n = 16	n = 16	n = 15	n = 15	n = 14
ENW	0.91	0.74	0.77	0.76	0.70	0.70
	(0.14)	(0.17)	(0.19)	(0.29)	(0.31)	(0.33)
	n = 14	n = 14	n = 14	n = 11	n = 10	n = 10
EW	0.83	0.62	0.74	0.63	0.67	0.63
	(0.17)	(0.27)	(0.27)	(0.32)	(0.35)	(0.41)
	n = 15	n = 15	n = 15	n = 15	n = 14	n = 13

(table continued)

Groups	Blocks					
	29	30	31	32	33	34
MNW	0.50	0.55	0.59	0.66	0.52	0.44
	(0.34)	(0.38)	(0.30)	(0.39)	(0.33)	(0.40)
	n = 13	n = 13	n = 13	n = 11	n = 11	n = 13
MW	0.62	0.54	0.43	0.50	0.58	0.58
	(0.32)	(0.35)	(0.30)	(0.30)	(0.25)	(0.34)
	n = 15	n = 15	n = 16	n = 14	n = 12	n = 13
ENW	0.68	0.46	0.57	0.72	0.59	0.52
	(0.39)	(0.40)	(0.46)	(0.35)	(0.43)	(0.45)
	n = 10	n = 12	n = 10	n = 8	n = 6	n = 7
EW	0.60	0.53	0.65	0.71	0.67	0.91
	(0.44)	(0.46)	(0.41)	(0.38)	(0.43)	(0.16)
	n = 8	n = 10	n = 9	n = 6	n = 8	n = 6

Note: Values presented in parentheses are the standard deviations; Minimal Instructions - No warning (MNW), Minimal Instructions - Warning (MW), Elaborate Instructions - No warning (ENW), Elaborate Instructions - Warning (EW). To be included in the sample, participants had to meet a criterion in the Training Phase.

Table 8

Kruskall-Wallis ANOVA by Ranks (Minimal vs Elaborate Instructions) Using the Index of Response, During the First Three Blocks of the Change Phase in Experiment 1

Kruskall-Wallis ANOVA by ranks: Block 23

Kruskall-Wallis test: $H(1, N = 59) = 20.41, p < 0.0001$

	Valid n	Sum of ranks
Minimal	30	602.00
Elaborate	29	1168.00

Kruskall-Wallis ANOVA by ranks: Block 24

Kruskall-Wallis test: $H(1, N = 59) = 9.47, p = 0.002$

	Valid n	Sum of ranks
Minimal	30	697.00
Elaborate	29	1073.00

(table continued)

Kruskall-Wallis ANOVA by ranks: Block 25

Kruskall-Wallis test: $H(1, N = 59) = 20.97$, $p < 0.0001$

	Valid n	Sum of ranks
Minimal	30	598.00
Elaborate	29	1172.00

Table 9

Kruskall-Wallis ANOVA by ranks (Warning vs No Warning) Using the Index of Response During the First Three of the Change Phase in Experiment 1

Kruskall-Wallis ANOVA by ranks: Block 23

Kruskall-Wallis test: $H(1, N = 59) = 0.67, p = 0.41$

	Valid n	Sum of ranks
No Warning	28	894.00
Warning	31	876.00

Kruskall-Wallis ANOVA by ranks: Block 24

Kruskall-Wallis test: $H(1, N = 59) = 0.14, p = 0.70$

	Valid n	Sum of ranks
No Warning	28	865.00
Warning	31	905.00

(table continued)

Kruskall-Wallis ANOVA by ranks: Block 25

Kruskall-Wallis test: $H(1, N = 59) = 0.23$, $p = 0.63$

	Valid n	Sum of ranks
No Warning	28	871.50
Warning	31	898.50

Table 10

Means and Standard Deviations of the Relative Change in Extinction Index for Each of the Four Clusters of BlocksDuring the Change Phase in Experiment 1

Groups	Clusters			
	23-25	26-28	29-31	32-34
MNW	0.34	0.29	0.17	0.17
	(0.10)	(0.13)	(0.14)	(0.15)
MW	0.37	0.30	0.24	0.26
	(0.19)	(0.21)	(0.22)	(0.24)
ENW	0.62	0.30	0.15	0.12
	(0.15)	(0.29)	(0.24)	(0.22)
EW	0.52	0.30	0.24	0.21
	(0.28)	(0.34)	(0.36)	(0.33)

Note: Values presented in parentheses are the standard deviations; Minimal Instructions - No warning (MNW), Minimal Instructions - Warning (MW), Elaborate Instructions - No warning (ENW), Elaborate Instructions - Warning (EW). To be included in the sample, participants had to meet a criterion in the Training Phase.

Table 11

Kruskall-Wallis ANOVA by ranks (Minimal vs Elaborate Instructions) Using the Relative Change in Extinction Index During the Change Phase in Experiment 1

Kruskall-Wallis ANOVA by ranks: Cluster 23-25

Kruskall-Wallis test: $H(1, N = 59) = 12.80$, $p = 0.0003$

	Valid n	Sum of ranks
Minimal	30	664.00
Elaborate	29	1106.00

Kruskall-Wallis ANOVA by ranks: Cluster 26-28

Kruskall-Wallis test: $H(1, N = 59) = 0.97$, $p = 0.32$

	Valid n	Sum of ranks
Minimal	30	965.00
Elaborate	29	805.00

(table continued)

Kruskall-Wallis ANOVA by ranks: Cluster 29-31

Kruskall-Wallis test: $H(1, N = 59) = 3.99$, $p = 0.05$

	Valid n	Sum of ranks
Minimal	30	1031.00
Elaborate	29	739.00

Kruskall-Wallis ANOVA by ranks: Cluster 32-34

Kruskall-Wallis test: $H(1, N = 59) = 5.83$, $p = 0.02$

	Valid n	Sum of ranks
Minimal	30	1058.00
Elaborate	29	712.00

Table 12

Kruskall-Wallis ANOVA by ranks (Warning vs No Warning) Using the Relative Change in Extinction Index During the Change Phase in Experiment 1

Kruskall-Wallis ANOVA by ranks: Cluster 23-25

Kruskall-Wallis test: H(1, N = 59) = 1.55, p = 0.21

	Valid n	Sum of ranks
No Warning	28	922.00
Warning	31	848.00

Kruskall-Wallis ANOVA by ranks: Cluster 26-28

Kruskall-Wallis test: H(1, N = 59) = 0.10, p = 0.75

	Valid n	Sum of ranks
No Warning	28	861.00
Warning	31	909.00

(table continued)

Kruskall-Wallis ANOVA by ranks: Cluster 29-31

Kruskall-Wallis test: $H(1, N = 59) = 0.12$, $p = 0.73$

	Valid n	Sum of ranks
No Warning	28	817.00
Warning	31	953.00

Kruskall-Wallis ANOVA by ranks: Cluster 32-34

Kruskall-Wallis test: $H(1, N = 59) = 0.24$, $p = 0.62$

	Valid n	Sum of ranks
No Warning	28	808.00
Warning	31	962.00

Table 13

Means and Standard Deviations of the Index of Response for Each of the Twelve Blocks of the First Session of the Training Phase in Experiment 2

Groups	Blocks					
	1	2	3	4	5	6
MNW	0.54	0.55	0.58	0.60	0.67	0.73
	(0.15)	(0.13)	(0.11)	(0.17)	(0.17)	(0.18)
MW	0.57	0.56	0.60	0.62	0.72	0.78
	(0.17)	(0.07)	(0.11)	(0.14)	(0.14)	(0.16)
ENW	0.79	0.80	0.88	0.86	0.88	0.90
	(0.16)	(0.16)	(0.12)	(0.13)	(0.14)	(0.14)
EW	0.77	0.77	0.79	0.87	0.82	0.85
	(0.15)	(0.22)	(0.25)	(0.15)	(0.23)	(0.17)

(table continued)

Groups	Blocks					
	7	8	9	10	11	12
MNW	0.80	0.77	0.84	0.81	0.83	0.86
	(0.17)	(0.24)	(0.17)	(0.17)	(0.21)	(0.17)
MW	0.81	0.85	0.90	0.88	0.95	0.93
	(0.17)	(0.15)	(0.12)	(0.13)	(0.04)	(0.05)
ENW	0.90	0.85	0.90	0.91	0.92	0.92
	(0.14)	(0.22)	(0.11)	(0.13)	(0.09)	(0.08)
EW	0.86	0.89	0.89	0.91	0.89	0.91
	(0.16)	(0.10)	(0.14)	(0.11)	(0.13)	(0.11)

Note: Values presented in parentheses are the standard deviations; Minimal Instructions - No warning (MNW), Minimal Instructions - Warning (MW), Elaborate Instructions - No warning (ENW), Elaborate Instructions - Warning (EW). To be included in the sample, participants had to meet a criterion in the Training Phase.

Table 14

Kruskall-Wallis ANOVA by ranks (Minimal vs Elaborate Instructions) Using the Index of Response Across the Four Clusters of Blocks During the First Session of the Training Phase in Experiment 2

Kruskall-Wallis ANOVA by ranks: Cluster 1-3

Kruskall-Wallis test: $H(1, N = 61) = 24.77$, $p < 0.0001$

	Valid n	Sum of ranks
Minimal	30	585.00
Elaborate	31	1306.00

Kruskall-Wallis ANOVA by ranks: Cluster 4-6

Kruskall-Wallis test: $H(1, N = 61) = 17.74$, $p < 0.0001$

	Valid n	Sum of ranks
Minimal	30	638.00
Elaborate	31	1253.00

(table continued)

Kruskall-Wallis ANOVA by ranks: Cluster 7-9

Kruskall-Wallis test: $H(1, N = 61) = 3.91, p = 0.05$

	Valid n	Sum of ranks
Minimal	30	793.00
Elaborate	31	1098.00

Kruskall-Wallis ANOVA by ranks: Cluster 10-12

Kruskall-Wallis test: $H(1, N = 61) = 2.52, p = 0.11$

	Valid n	Sum of ranks
Minimal	30	820.00
Elaborate	31	1071.00

Table 15

Kruskall-Wallis ANOVA by ranks (Warning vs No Warning) Using the Index of Response Across Four Clusters of Blocks During the First Session of the Training Phase in Experiment 2

Kruskall-Wallis ANOVA by ranks: Cluster 1-3

Kruskall-Wallis test: $H(1, N = 61) = 0.09$, $p = 0.76$

	Valid n	Sum of ranks
No Warning	31	982.00
Warning	30	909.00

Kruskall-Wallis ANOVA by ranks: Cluster 4-6

Kruskall-Wallis test: $H(1, N = 61) = 0.03$, $p = 0.87$

	Valid n	Sum of ranks
No Warning	31	972.00
Warning	30	919.00

(table continued)

Kruskall-Wallis ANOVA by ranks: Cluster 7-9

Kruskall-Wallis test: $H(1, N = 61) = 0.05$, $p = 0.82$

	Valid n	Sum of ranks
No Warning	31	945.00
Warning	30	946.00

Kruskall-Wallis ANOVA by ranks: Cluster 10-12

Kruskall-Wallis test: $H(1, N = 61) = 0.77$, $p = 0.38$

	Valid n	Sum of ranks
No Warning	31	900.00
Warning	30	991.00

Table 16

Means and Standard Deviations of the Index of Response for Each Block of the Second Session of the Training Phase in Experiment 2

Groups	Blocks				
	13	14	15	16	17
MNW	0.80	0.89	0.94	0.91	0.94
	(0.13)	(0.10)	(0.04)	(0.09)	(0.03)
MW	0.85	0.92	0.95	0.92	0.92
	(0.13)	(0.07)	(0.04)	(0.10)	(0.09)
ENW	0.94	0.94	0.94	0.95	0.96
	(0.08)	(0.08)	(0.07)	(0.03)	(0.02)
EW	0.89	0.93	0.93	0.94	0.94
	(0.09)	(0.05)	(0.05)	(0.05)	(0.05)

Groups	Blocks				
	18	19	20	21	22
MNW	0.94	0.94	0.95	0.96	0.95
	(0.03)	(0.06)	(0.03)	(0.01)	(0.02)
MW	0.94	0.91	0.95	0.95	0.95
	(0.05)	(0.11)	(0.03)	(0.03)	(0.02)
ENW	0.96	0.94	0.96	0.96	0.96
	(0.01)	(0.05)	(0.01)	(0.02)	(0.01)
EW	0.94	0.94	0.95	0.96	0.96
	(0.06)	(0.06)	(0.03)	(0.02)	(0.02)

Note: Values presented in parentheses are the standard deviations; Minimal Instructions - No warning (MNW), Minimal Instructions - Warning (MW), Elaborate Instructions - No warning (ENW), Elaborate Instructions - Warning (EW). To be included in the sample, participants had to meet a criterion in the Training Phase.

Table 17

Kruskall-Wallis ANOVA by ranks (Minimal vs Elaborate Instructions) Using the Index of Response Across the Three Clusters of Blocks During the Second Session of the Training Phase in Experiment 2

Kruskall-Wallis ANOVA by ranks: Cluster 13-15

Kruskall-Wallis test: $H(1, N = 61) = 9.98, p = 0.002$

	Valid n	Sum of ranks
Minimal	30	711.00
Elaborate	31	1180.00

Kruskall-Wallis ANOVA by ranks: Cluster 16-18

Kruskall-Wallis test: $H(1, N = 61) = 2.61, p = 0.11$

	Valid n	Sum of ranks
Minimal	30	818.00
Elaborate	31	1073.00

(table continued)

Kruskall-Wallis ANOVA by ranks: Cluster 19-22

Kruskall-Wallis test: $H(1, N = 61) = 0.44$, $p = 0.51$

	Valid n	Sum of ranks
Minimal	30	884.00
Elaborate	31	1007.00

Table 18

Kruskall-Wallis ANOVA by ranks (Warning vs No Warning) Using the Index of Response Across the Three Clusters of Blocks During the Second Session of the Training Phase in Experiment 2

Kruskall-Wallis ANOVA by ranks: Cluster 13-15

Kruskall-Wallis test: $H(1, N = 61) = 0.07, p = 0.80$

	Valid n	Sum of ranks
No Warning	31	979.00
Warning	30	912.00

Kruskall-Wallis ANOVA by ranks: Cluster 16-18

Kruskall-Wallis test: $H(1, N = 61) = 0.75, p = 0.39$

	Valid n	Sum of ranks
No Warning	31	1021.00
Warning	30	870.00

(table continued)

Kruskall-Wallis ANOVA by ranks: Blocks 19-22

Kruskall-Wallis test: $H(1, N = 61) = 0.30$, $p = 0.58$

	Valid n	Sum of ranks
No Warning	31	999.00
Warning	30	892.00

Table 19

Means and Standard Deviations of the Index of Response for Each Block of the Change Phase in Experiment 2

Groups	Blocks					
	23	24	25	26	27	28
MNW	0.54	0.55	0.53	0.49	0.51	0.50
	(0.19)	(0.12)	(0.14)	(0.10)	(0.05)	(0.06)
MW	0.65	0.56	0.53	0.52	0.55	0.52
	(0.18)	(0.15)	(0.13)	(0.13)	(0.12)	(0.14)
ENW	0.90	0.81	0.75	0.71	0.70	0.70
	(0.11)	(0.20)	(0.23)	(0.24)	(0.24)	(0.24)
EW	0.67	0.60	0.59	0.56	0.56	0.56
	(0.26)	(0.19)	(0.19)	(0.16)	(0.17)	(0.18)

(table continued)

Groups	Blocks					
	29	30	31	32	33	34
MNW	0.51	0.51	0.52	0.49	0.51	0.51
	(0.05)	(0.05)	(0.04)	(0.05)	(0.05)	(0.05)
MW	0.55	0.54	0.52	0.52	0.54	0.53
	(0.13)	(0.13)	(0.14)	(0.13)	(0.12)	(0.13)
ENW	0.67	0.64	0.61	0.57	0.58	0.56
	(0.23)	(0.22)	(0.19)	(0.17)	(0.17)	(0.17)
EW	0.56	0.52	0.52	0.53	0.53	0.54
	(0.17)	(0.11)	(0.13)	(0.12)	(0.12)	(0.12)

Note: Values presented in parentheses are the standard deviations; Minimal Instructions - No warning (MNW), Minimal Instructions - Warning (MW), Elaborate Instructions - No warning (ENW), Elaborate Instructions - Warning (EW). To be included in the sample, participants had to meet a criterion in the Training Phase.

Table 20

Kruskall-Wallis ANOVA by ranks (Minimal vs Elaborate Instructions) Using the Index of Response Across the Four Clusters of Blocks During the Change Phase in Experiment 2

Kruskall-Wallis ANOVA by ranks: Cluster 23-25

Kruskall-Wallis test: $H(1, N = 61) = 11.99$, $p = 0.001$

	Valid n	Sum of ranks
Minimal	30	690.00
Elaborate	31	1201.00

Kruskall-Wallis ANOVA by ranks: Cluster 26-28

Kruskall-Wallis test: $H(1, N = 61) = 4.56$, $p = 0.03$

	Valid n	Sum of ranks
Minimal	30	782.00
Elaborate	31	1109.00

(table continued)

Kruskall-Wallis ANOVA by ranks: Cluster 29-31

Kruskall-Wallis test: $H(1, N = 61) = 1.54$, $p = 0.21$

	Valid n	Sum of ranks
Minimal	30	1016.00
Elaborate	31	875.00

Kruskall-Wallis ANOVA by ranks: Cluster 32-34

Kruskall-Wallis test: $H(1, N = 61) = 2.95$, $p = 0.09$

	Valid n	Sum of ranks
Minimal	30	811.00
Elaborate	31	1080.00

Table 21

Kruskall-Wallis ANOVA by ranks (Warning vs No Warning) using the Index of Response Across Four Clusters of Blocks During the Change Phase in Experiment 2

Kruskall-Wallis ANOVA by ranks: Cluster 23-25

Kruskall-Wallis test: $H(1, N = 61) = 2.75$, $p = 0.10$

	Valid n	Sum of ranks
No Warning	31	1076.00
Warning	30	815.00

Kruskall-Wallis ANOVA by ranks: Cluster 26-28

Kruskall-Wallis test: $H(1, N = 61) = 0.12$, $p = 0.73$

	Valid n	Sum of ranks
No Warning	31	985.00
Warning	30	906.00

(table continued)

Kruskall-Wallis ANOVA by ranks: Cluster 29-31		
Kruskall-Wallis test: H(1, N = 61) = 1.33, p = 0.25		
	Valid n	Sum of ranks
No Warning	31	1041.00
Warning	30	850.00

Kruskall-Wallis ANOVA by ranks: Cluster 32-34		
Kruskall-Wallis test: H(1, N = 61) = 0.03, p = 0.86		
	Valid n	Sum of ranks
No Warning	31	949.00
Warning	30	942.00

Table 22

Means and Standard Deviations of the Relative Change Index for the Four Clusters of Blocks During the Change Phase in Experiment 2

Groups	Clusters			
	23-25	26-28	29-31	32-34
MNW	18.12	21.73	20.68	21.08
	(8.54)	(7.57)	(6.71)	(7.56)
MW	17.08	19.13	19.35	18.88
	(8.13)	(8.43)	(8.59)	(8.46)
ENW	8.58	15.82	17.83	21.14
	(9.05)	(13.88)	(11.65)	(9.45)
EW	18.90	22.26	23.37	23.44
	(9.63)	(9.78)	(7.50)	(7.44)

Note: Values presented in parentheses are the standard deviations; Minimal Instructions - No warning (MNW), Minimal Instructions - Warning (MW), Elaborate Instructions - No warning (ENW), Elaborate Instructions - Warning (EW). To be included in the sample, participants had to meet a criterion in the Training Phase.

Table 23

Kruskall-Wallis ANOVA by ranks (Minimal vs Elaborate Instructions) Using the Relative Change Index Across the Four Clusters of the Change Phase in Experiment 2

Kruskall-Wallis ANOVA by ranks: Cluster 23-25

Kruskall-Wallis test: $H(1, N = 61) = 0.88$, $p = 0.35$

	Valid n	Sum of ranks
Minimal	30	995.00
Elaborate	31	896.00

Kruskall-Wallis ANOVA by ranks: Cluster 26-28

Kruskall-Wallis test: $H(1, N = 61) = 0.20$, $p = 0.65$

	Valid n	Sum of ranks
Minimal	30	899.00
Elaborate	31	992.00

(table continued)

Kruskall-Wallis ANOVA by ranks: Cluster 29-31

Kruskall-Wallis test: $H(1, N = 61) = 0.65$, $p = 0.42$

	Valid n	Sum of ranks
Minimal	30	874.00
Elaborate	31	1017.00

Kruskall-Wallis ANOVA by ranks: Cluster 32-34

Kruskall-Wallis test: $H(1, N = 61) = 2.52$, $p = 0.11$

	Valid n	Sum of ranks
Minimal	30	820.00
Elaborate	31	1071.00

Table 24

Kruskall-Wallis ANOVA by ranks (Warning vs No Warning) Using the Relative Change Index During the Four Clusters of the Change Phase in Experiment 2

Kruskall-Wallis ANOVA by ranks: Cluster 23-25

Kruskall-Wallis test: $H(1, N = 61) = 5.33$, $p = 0.02$

	Valid n	Sum of ranks
No Warning	31	801.00
Warning	30	1090.00

Kruskall-Wallis ANOVA by ranks: Cluster 26-28

Kruskall-Wallis test: $H(1, N = 61) = 0.08$, $p = 0.77$

	Valid n	Sum of ranks
No Warning	31	941.00
Warning	30	950.00

(table continued)

Kruskall-Wallis ANOVA by ranks: Cluster 29-31

Kruskall-Wallis test: $H(1, N = 61) = 1.05$, $p = 0.31$

	Valid n	Sum of ranks
No Warning	31	890.00
Warning	30	1001.00

Kruskall-Wallis ANOVA by ranks: Cluster 32-34

Kruskall-Wallis test: $H(1, N = 61) = 0.23$, $p = 0.63$

	Valid n	Sum of ranks
No Warning	31	927.50
Warning	30	963.50

Table 25

Descriptive Statistics for the Index of Response, including Means, Standard Deviations and Number of Participants for the First Session of the Training phase in Experiment 3

	Blocks													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
MS	.57	.59	.67	.69	.71	.77	.79	.82	.86	.90	.88	.89	.86	.91
	(.13)	(.14)	(.19)	(.16)	(.16)	(.18)	(.18)	(.19)	(.17)	(.12)	(.16)	(.13)	(.20)	(.12)
	20	*20*	*20*	*20*	*20*	*20*	*20*	*20*	*19*	*18*	*17*	*12*	*11*	*9*
ML	.58	.55	.61	.71	.71	.76	.83	.81	.83	.87	.87	.83	.85	.85
	(.13)	(.11)	(.23)	(.17)	(.19)	(.18)	(.16)	(.17)	(.14)	(.14)	(.14)	(.24)	(.23)	(.23)
	20	*20*	*20*	*20*	*20*	*20*	*20*	*20*	*20*	*20*	*20*	*20*	*20*	*18*
ES	.79	.85	.85	.89	.91	.92	.90	.94	.95	.93	.97	.89	.95	.96
	(.12)	(.17)	(.19)	(.10)	(.07)	(.07)	(.18)	(.02)	(.02)	(.06)	(.02)	(.08)	(.00)	(.00)
	20	*20*	*20*	*20*	*20*	*20*	*15*	*9*	*8*	*6*	*5*	*2*	*1*	*1*
EL	.78	.87	.89	.89	.90	.92	.91	.92	.94	.94	.93	.93	.96	.96
	(.18)	(.09)	(.09)	(.10)	(.09)	(.08)	(.09)	(.09)	(.07)	(.06)	(.07)	(.07)	(.01)	(.02)
	20	*20*	*20*	*20*	*20*	*20*	*20*	*20*	*20*	*20*	*14*	*11*	*9*	*8*

(table continued)

	Blocks												
	15	16	17	18	19	20	21	22	23	24	25	26	27
MS	.82	.74	.87	.90	.87	.89	.90	.93	.88	.90	.92	.90	.92
	(.18)	(.25)	(.18)	(.08)	(.13)	(.14)	(.10)	(.08)					
	7	*4*	*4*	*3*	*3*	*3*	*3*	*2*	*1*	*1*	*1*	*1*	*1*
ML	.86	.90	.91	.94	.95	.95	.94	.94	.94	.95	.94	.94	.94
	(.24)	(.11)	(.08)	(.04)	(.03)	(.04)	(.04)	(.05)	(.05)	(.03)	(.04)	(.03)	(.03)
	7	*14*	*12*	*12*	*11*	*7*	*6*	*6*	*5*	*4*	*4*	*4*	*4*
ES	.96	.95	.97	.98									
	(.01)												
	7	*1*	*1*	*1*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
EL	.96	.96	.88	.95	.94	.96	.96	.95	.95	.96	.96	.96	.95
	(.01)	(.01)	(.16)	(.02)	(.04)	(.01)	(.01)	(.01)					
	5	*4*	*4*	*4*	*3*	*3*	*3*	*3*	*1*	*1*	*1*	*1*	*1*

<u>Note:</u> Values presented in parentheses are the standard deviations and the values in italics are the numbers of participants; Minimal instructions - Short training (MS), Minimal instructions - Long training (ML), Elaborate instructions - Short training (ES), Elaborate instructions - Long training (EL).

Table 26

Kruskall-Wallis ANOVA by Ranks (Minimal vs Elaborate Instructions) Using the Index of Response During the First Six Blocks of the First Session of the Training Phase in Experiment 3

Kruskall-Wallis ANOVA by ranks: Block 1

Kruskall-Wallis test: $H(1, N = 80) = 32.01, p < .0001$

	Valid n	Sum of ranks
Minimal	40	1032.00
Elaborate	40	2208.00

Kruskall-Wallis ANOVA by ranks: Block 2

Kruskall-Wallis test: $H(1, N = 80) = 46.15, p < .0001$

	Valid n	Sum of ranks
Minimal	40	914.00
Elaborate	40	2326.00

(table continued)

Kruskall-Wallis ANOVA by ranks: Block 3

Kruskall-Wallis test: $H(1, N = 80) = 29.87$, $p < .0001$

	Valid n	Sum of ranks
Minimal	40	1052.00
Elaborate	40	2188.00

Kruskall-Wallis ANOVA by ranks: Block 4

Kruskall-Wallis test: $H(1, N = 80) = 26.70$, $p < .0001$

	Valid n	Sum of ranks
Minimal	40	1083.00
Elaborate	40	2157.00

Kruskall-Wallis ANOVA by ranks: Block 5

Kruskall-Wallis test: $H(1, N = 80) = 24.51$, $p < .0001$

	Valid n	Sum of ranks
Minimal	40	1105.50
Elaborate	40	2134.50

Table 26

Kruskall-Wallis ANOVA by Ranks (Minimal vs Elaborate Instructions) Using the Index of Response During the First Six Blocks of the First Session of the Training Phase in Experiment 3

Kruskall-Wallis ANOVA by ranks: Block 1

Kruskall-Wallis test: $H(1, N = 80) = 32.01, p < .0001$

	Valid n	Sum of ranks
Minimal	40	1032.00
Elaborate	40	2208.00

Kruskall-Wallis ANOVA by ranks: Block 2

Kruskall-Wallis test: $H(1, N = 80) = 46.15, p < .0001$

	Valid n	Sum of ranks
Minimal	40	914.00
Elaborate	40	2326.00

(table continued)

Kruskall-Wallis ANOVA by ranks: Block 3

Kruskall-Wallis test: $H(1, N = 80) = 29.87$, $p < .0001$

	Valid n	Sum of ranks
Minimal	40	1052.00
Elaborate	40	2188.00

Kruskall-Wallis ANOVA by ranks: Block 4

Kruskall-Wallis test: $H(1, N = 80) = 26.70$, $p < .0001$

	Valid n	Sum of ranks
Minimal	40	1083.00
Elaborate	40	2157.00

Kruskall-Wallis ANOVA by ranks: Block 5

Kruskall-Wallis test: $H(1, N = 80) = 24.51$, $p < .0001$

	Valid n	Sum of ranks
Minimal	40	1105.50
Elaborate	40	2134.50

Kruskall-Wallis ANOVA by ranks: Block 6

Kruskall-Wallis test: $H(1, N = 80) = 16.57$, $p < .0001$

	Valid n	Sum of ranks
Minimal	40	1197.00
Elaborate	40	2043.00

Table 27

Kruskall-Wallis ANOVA by Ranks (Short vs Long Training) Using the Index of Response During the First Six Blocks of the First Session of the Training Phase in Experiment 3

Kruskall-Wallis ANOVA by ranks: Block 1

Kruskall-Wallis test: $H(1, N = 80) = 0.001, p = .98$

	Valid n	Sum of ranks
Short	40	1623.00
Long	40	1617.00

Kruskall-Wallis ANOVA by ranks: Block 2

Kruskall-Wallis test: $H(1, N = 80) = 0.07, p = .79$

	Valid n	Sum of ranks
Short	40	1648.00
Long	40	1592.00

(table continued)

Kruskall-Wallis ANOVA by ranks: Block 3

Kruskall-Wallis test: $H(1, N = 80) = 0.003$, $p = .96$

	Valid n	Sum of ranks
Short	40	1625.00
Long	40	1615.00

Kruskall-Wallis ANOVA by ranks: Block 4

Kruskall-Wallis test: $H(1, N = 80) = 0.09$, $p = .76$

	Valid n	Sum of ranks
Short	40	1588.00
Long	40	1652.00

Kruskall-Wallis ANOVA by ranks: Block 5

Kruskall-Wallis test: $H(1, N = 80) = 0.02$, $p = .88$

	Valid n	Sum of ranks
Short	40	1636.00
Long	40	1604.00

(table continued)

Kruskall-Wallis ANOVA by ranks: Block 6

Kruskall-Wallis test: $H(1, N = 80) = 0.001$, $p = .97$

	Valid n	Sum of ranks
Short	40	1624.00
Long	40	1616.00

Table 28

Means, Standard Deviations and the Number of participants Using the Mean Index of Response During the Second Session of the Training Phase in Experiment 3

	Blocks									
	1	2	3	4	5	6	7	8	9	10
MS	.88	.94	.96	.95	.96	.95	.95	.95	.89	.95
	(.08)	(.04)	(.02)	(.03)	(.02)	(.04)	(.04)	(.05)		
	20	*20*	*20*	*20*	*20*	*20*	*20*	*6*	*1*	*1*
ML	.93	.96	.96	.96	.96	.96	.96	.96	.96	.96
	(.06)	(.01)	(.03)	(.02)	(.02)	(.01)	(.01)	(.01)	(.02)	(.02)
	20	*20*	*20*	*20*	*20*	*20*	*20*	*20*	*20*	*20*
ES	.96	.96	.95	.96	.96	.96	.96			
	(.02)	(.01)	(.03)	(.02)	(.01)	(.02)	(.01)			
	20	*20*	*20*	*20*	*20*	*20*	*15*	*0*	*0*	*0*
EL	.95	.96	.96	.96	.95	.96	.96	.96	.94	.96
	(.05)	(.01)	(.01)	(.01)	(.05)	(.01)	(.01)	(.01)	(.06)	(.01)
	20	20	20	20	20	20	20	20	20	20

(table continued)

	Blocks								
	11	12	13	14	15	16	17	18	19
MS	.97	.91	.95	.91					
	1	*1*	*1*	*1*	*0*	*0*	*0*	*0*	*0*
ML	.96	.94	.94						
	(.01)								
	5	*1*	*1*	*0*	*0*	*0*	*0*	*0*	*0*
ES									
	0	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
EL	.96	.96	.96	.95	.93	.95	.96	.96	.96
	(.01)	(.00)	(.01)	(.01)	(.04)				
	2	*2*	*2*	*2*	*2*	*1*	*1*	*1*	*1*

<u>Note:</u> Values presented in parentheses are the standard deviations and the values in italics are the number of participants; Minimal instructions - Short trainig (MS), Minimal instructions - Long training (ML), Elaborate instructions - Short training (ES), Elaborate instructions - Long training (EL).

Table 29

Kruskall-Wallis ANOVA by Ranks (Minimal vs Elaborate Instructions) Using the Index of Response During the First Seven Blocks of the Second Session of the Training Phase in Experiment 3

Kruskall-Wallis ANOVA by ranks: Block 1

Kruskall-Wallis test: $H(1, N = 80) = 9.78$, $p = .002$

	Valid n	Sum of ranks
Minimal	40	1295.00
Elaborate	40	1945.00

Kruskall-Wallis ANOVA by ranks: Block 2

Kruskall-Wallis test: $H(1, N = 80) = 0.45$, $p = .50$

	Valid n	Sum of ranks
Minimal	40	1550.50
Elaborate	40	1689.50

(table continued)

Kruskall-Wallis ANOVA by ranks: Block 3

Kruskall-Wallis test: $H(1, N = 80) = 0.03$, $p = .86$

	Valid n	Sum of ranks
Minimal	40	1638.50
Elaborate	40	1601.50

Kruskall-Wallis ANOVA by ranks: Block 4

Kruskall-Wallis test: $H(1, N = 80) = 0.01$, $p = .93$

	Valid n	Sum of ranks
Minimal	40	1629.50
Elaborate	40	1610.50

Kruskall-Wallis ANOVA by ranks: Block 5

Kruskall-Wallis test: $H(1, N = 80) = 0.31$, $p = .58$

	Valid n	Sum of ranks
Minimal	40	1677.50
Elaborate	40	1562.50

(table continued)

Kruskall-Wallis ANOVA by ranks: Block 6

Kruskall-Wallis test: $H(1, N = 80) = 0.43$, $p = .51$

	Valid n	Sum of ranks
Minimal	40	1551.50
Elaborate	40	1688.50

Kruskall-Wallis ANOVA by ranks: Block 7

Kruskall-Wallis test: $H(1, N = 80) = 0.01$, $p = .93$

	Valid n	Sum of ranks
Minimal	40	1629.50
Elaborate	40	1610.50

Table 30

Kruskall-Wallis ANOVA by Ranks (Short vs Long Training) Using the Index of Response During the First Seven Blocks of the Second Session of the Training Phase in Experiment 3

Kruskall-Wallis ANOVA by ranks: Block 1

Kruskall-Wallis test: $H(1, N = 80) = 1.38$, $p = .24$

	Valid n	Sum of ranks
Short	40	1498.00
Long	40	1742.00

Kruskall-Wallis ANOVA by ranks: Block 2

Kruskall-Wallis test: $H(1, N = 80) = 0.92$, $p = .34$

	Valid n	Sum of ranks
Short	40	1520.50
Long	40	1719.50

(table continued)

Kruskall-Wallis ANOVA by ranks: Block 3

Kruskall-Wallis test: H(1, N = 80) = 2.92, p = .09

	Valid n	Sum of ranks
Short	40	1442.50
Long	40	1797.50

Kruskall-Wallis ANOVA by ranks: Block 4

Kruskall-Wallis test: H(1, N = 80) = 3.02, p = .08

	Valid n	Sum of ranks
Short	40	1439.50
Long	40	1800.50

(table continued)

Kruskall-Wallis ANOVA by ranks: Block 5

Kruskall-Wallis test: $H(1, N = 80) = .94, p = .33$

	Valid n	Sum of ranks
Short	40	1519.00
Long	40	1721.00

Kruskall-Wallis ANOVA by ranks: Block 6

Kruskall-Wallis test: $H(1, N = 80) = 6.31, p = .01$

	Valid n	Sum of ranks
Short	40	1359.00
Long	40	1881.00

Kruskall-Wallis ANOVA by ranks: Block 7

Kruskall-Wallis test: $H(1, N = 80) = 0.80, p = .37$

	Valid n	Sum of ranks
Short	40	1527.00
Long	40	1713.00

Table 31

Descriptive statistics for the Index of Response including the Means, the Standard Deviations and the Number of Participants for Each Block of the Change Phase in Experiment 3

Groups	Blocks					
	1	2	3	4	5	6
MS	0.68	0.58	0.54	0.49	0.50	0.58
	(0.14)	(0.15)	(0.24)	(0.28)	(0.27)	(0.26)
	n = 20	n = 20	n = 20	n = 20	n = 19	n = 19
ML	0.65	0.50	0.46	0.57	0.54	0.44
	(0.15)	(0.18)	(0.19)	(0.26)	(0.25)	(0.26)
	n = 20	n = 20	n = 20	n = 20	n = 20	n = 20
ES	0.93	0.80	0.78	0.82	0.76	0.76
	(0.07)	(0.21)	(0.28)	(0.24)	(0.29)	(0.36)
	n = 20	n = 20	n = 20	n = 19	n = 18	n = 19
EL	0.89	0.88	0.76	0.91	0.86	0.66
	(0.16)	(0.12)	(0.29)	(0.10)	(0.21)	(0.40)
	n = 20	n = 19	n = 19	n = 19	n = 17	n = 19

(table continued)

Groups	Blocks					
	7	8	9	10	11	12
MS	0.56	0.37	0.67	0.64	0.47	0.53
	(0.36)	(0.26)	(0.29)	(0.34)	(0.29)	(0.34)
	n = 19	n = 16	n = 14	n = 16	n = 14	n = 14
ML	0.47	0.53	0.53	0.44	0.48	0.48
	(0.33)	(0.33)	(0.35)	(0.25)	(0.38)	(0.38)
	n = 20	n = 19	n = 19	n = 17	n = 16	n = 16
ES	0.81	0.66	0.77	0.82	0.77	0.85
	(0.27)	(0.39)	(0.33)	(0.29)	(0.32)	(0.30)
	n = 16	n = 14	n = 15	n = 13	n = 13	n = 15
EL	0.86	0.67	0.79	0.81	0.80	0.69
	(0.21)	(0.40)	(0.33)	(0.32)	(0.31)	(0.41)
	n = 17	n = 17	n = 16	n = 15	n = 14	n = 13

Note: Values presented in parentheses are the standard deviations; Minimal Instructions - Short Training (MS), Minimal Instructions - Long Training (ML), Elaborate Instructions - Short Training (ES), Elaborate Instructions - Long Training (EL). To be included in the sample, participants had to meet the Training Criterion.

Table 32

Means and Standard Deviations of the Relative Change in Extinction Index for Each of the Four Clusters of Blocks of the Change Phase in Experiment 3

Groups	Clusters			
	1-3	4-6	7-9	10-12
MS	0.41	0.31	0.24	0.20
	(0.11)	(0.16)	(0.19)	(0.17)
ML	0.36	0.27	0.24	0.14
	(0.20)	(0.15)	(0.20)	(0.11)
ES	0.64	0.49	0.38	0.33
	(0.23)	(0.27)	(0.30)	(0.31)
EL	0.67	0.51	0.44	0.35
	(0.28)	(0.35)	(0.33)	(0.33)

Note: Values presented in parentheses are the standard deviations. Minimal Instructions - Short Training (MS), Minimal Instructions - Long Training (ML), Elaborate Instructions - Short Training (ES), Elaborate Instructions - Long Training (EL). To be included in the sample, participants had to meet the Training Criterion.

Table 33

Kruskall-Wallis ANOVA by Ranks (Elaborate vs Minimal Instructions) Using the Relative Change in Extinction Index During the Four Clusters of the Change Phase in Experiment 3

Kruskall-Wallis ANOVA by ranks: Cluster 1-3

Kruskall-Wallis test: $H(1, N = 80) = 22.23$, $p < .0001$

	Valid n	Sum of ranks
Minimal	40	1130.00
Elaborate	40	2110.00

Kruskall-Wallis ANOVA by ranks: Cluster 4-6

Kruskall-Wallis test: $H(1, N = 80) = 9.30$, $p = .002$

	Valid n	Sum of ranks
Minimal	40	1303.00
Elaborate	40	1937.00

(table continued)

Kruskall-Wallis ANOVA by ranks: Cluster 7-9

Kruskall-Wallis test: $H(1, N = 80) = 5.49$, $p = .02$

	Valid n	Sum of ranks
Minimal	40	1377.00
Elaborate	40	1863.00

Kruskall-Wallis ANOVA by ranks: Cluster 10-12

Kruskall-Wallis test: $H(1, N = 80) = 4.04$, $p = .04$

	Valid n	Sum of ranks
Minimal	40	1412.00
Elaborate	40	1828.00

Table 34

Kruskall-Wallis ANOVA by Ranks (Short vs Long Training) Using the Relative Change in Extinction Index During the Four Clusters of the Change Phase in Experiment 3

Kruskall-Wallis ANOVA by ranks: Cluster 1-3

Kruskall-Wallis test: $H(1, N = 80) = 0.31$, $p = .58$

	Valid n	Sum of ranks
Short	40	1678.00
Long	40	1562.00

Kruskall-Wallis ANOVA by ranks: Cluster 4-6

Kruskall-Wallis test: $H(1, N = 80) = 0.36$, $p = .55$

	Valid n	Sum of ranks
Short	40	1682.00
Long	40	1558.00

(table continued)

Kruskall-Wallis ANOVA by ranks: Block 7-9

Kruskall-Wallis test: $H(1, N = 80) = 0.13$, $p = .71$

	Valid n	Sum of ranks
Short	40	1582.00
Long	40	1658.00

Kruskall-Wallis ANOVA by ranks: Cluster 10-12

Kruskall-Wallis test: $H(1, N = 80) = 0.14$, $p = .71$

	Valid n	Sum of ranks
Short	40	1658.00
Long	40	1582.00

Table 35

Means and Standard Deviations of the Index of Response for Each of the Blocks of the First 20 Minute Training Session in Experiment 4

Groups	Blocks				
	1	2	3	4	5
MS	0.60	0.57	0.64	0.69	0.71
	(0.17)	(0.17)	(0.18)	(0.17)	(0.21)
ML	0.86	0.84	0.84	0.87	0.87
	(0.23)	(0.26)	(0.27)	(0.19)	(0.24)
MVAR	0.84	0.93	0.94	0.95	0.96
	(0.07)	(0.08)	(0.05)	(0.03)	(0.02)
ES	0.68	0.77	0.82	0.84	0.84
	(0.23)	(0.22)	(0.18)	(0.18)	(0.23)
EL	0.97	0.96	0.97	0.97	0.96
	(0.01)	(0.03)	(0.01)	(0.01)	(0.01)
EVAR	0.95	0.95	0.96	0.96	0.96
	(0.03)	(0.03)	(0.03)	(0.01)	(0.01)

(table continued)

Groups	Blocks				
	6	7	8	9	10
MS	0.72	0.81	0.81	0.83	0.87
	(0.23)	(0.17)	(0.17)	(0.17)	(0.15)
ML	0.86	0.90	0.91	0.92	0.93
	(0.23)	(0.13)	(0.13)	(0.12)	(0.10)
MVAR	0.95	0.96	0.96	0.96	0.96
	(0.04)	(0.01)	(0.01)	(0.03)	(0.03)
ES	0.83	0.83	0.89	0.89	0.90
	(0.26)	(0.29)	(0.20)	(0.23)	(0.20)
EL	0.97	0.96	0.97	0.97	0.96
	(0.01)	(0.02)	(0.01)	(0.01)	(0.03)
EVAR	0.95	0.95	0.95	0.96	0.96
	(0.04)	(0.04)	(0.03)	(0.13)	(0.01)

Note. Values presented in parentheses are the standard deviations; MS = Minimal Instructions - Short Training; ML = Minimal Instructions - Long Training; MVAR = Minimal Instructions - Variability Pre-training; ES = Elaborate Instructions - Short Training; EL = Elaborate Instructions - Long Training; EVAR = Elaborate Instructions - Variability Pre-training.

Table 36

Kruskall-Wallis ANOVA by ranks (Minimal vs Elaborate Instructions) Performed on the Index of Response for Each Cluster of the First 20 Minute Training Session in Experiment 4

Kruskall-Wallis ANOVA by ranks: Cluster 1-3

Kruskall-Wallis test: H(1, N = 108) = 14.00, p = 0.0002

	Valid n	Sum of ranks
Minimal	54	2334.00
Elaborate	54	3552.00

Kruskall-Wallis ANOVA by ranks: Cluster 4-6

Kruskall-Wallis test: H(1, N = 108) = 3.79, p = 0.05

	Valid n	Sum of ranks
Minimal	54	2626.00
Elaborate	54	3260.00

(table continued)

Kruskall-Wallis ANOVA by ranks: Cluster 7-10

Kruskall-Wallis test: $H(1, N = 108) = 3.40$, $p = 0.07$

	Valid n	Sum of ranks
Minimal	54	2643.00
Elaborate	54	3243.00

Table 37

Kruskall-Wallis ANOVA by ranks (Short vs Long vs Variability Training) Performed on the Index of Response for Each Cluster of the First 20 Minute Training Session in Experiment 4

Kruskall-Wallis ANOVA by ranks: Cluster 1-3

Kruskall-Wallis test: $H(2, N = 108) = 52.41, p < .0001$

	Valid n	Sum of ranks
Short	36	878.00
Long	36	2714.00
Variability	36	2294.00

Kruskall-Wallis ANOVA by ranks: Cluster 4-6

Kruskall-Wallis test: $H(2, N = 108) = 32.67, p < .0001$

	Valid n	Sum of ranks
Short	36	1085.00
Long	36	2293.00
Variability	36	2408.00

(table continued)

Kruskall-Wallis ANOVA by ranks: Cluster 7-10

Kruskall-Wallis test: $H(2, N = 108) = 22.99$, $p < .0001$

	Valid n	Sum of ranks
Short	36	1230.00
Long	36	2393.00
Variability	36	2263.00

Table 38

Means and Standard Deviations of the Index of Response for Each Block of the Second 20 Minute Training Session in Experiment 4

Groups	Blocks				
	1	2	3	4	5
MS	0.82	0.89	0.91	0.91	0.91
	(0.14)	(0.12)	(0.11)	(0.08)	(0.10)
ML	0.96	0.95	0.95	0.96	0.96
	(0.03)	(0.05)	(0.03)	(0.03)	(0.01)
MVAR	0.88	0.95	0.95	0.97	0.96
	(0.06)	(0.03)	(0.04)	(0.01)	(0.03)
ES	0.95	0.95	0.95	0.95	0.94
	(0.07)	(0.06)	(0.06)	(0.06)	(0.05)
EL	0.97	0.96	0.97	0.96	0.96
	(0.01)	(0.02)	(0.01)	(0.02)	(0.02)
EVAR	0.97	0.96	0.96	0.95	0.96
	(0.02)	(0.03)	(0.01)	(0.03)	(0.01)

(table continued)

Groups	Blocks				
	6	7	8	9	10
MS	0.93	0.93	0.93	0.94	0.93
	(0.07)	(0.05)	(0.09)	(0.05)	(0.06)
ML	0.96	0.96	0.96	0.96	0.97
	(0.03)	(0.01)	(0.02)	(0.01)	(0.01)
MVAR	0.96	0.96	0.96	0.96	0.95
	(0.03)	(0.01)	(0.02)	(0.03)	(0.03)
ES	0.96	0.96	0.96	0.95	0.96
	(0.01)	(0.01)	(0.03)	(0.03)	(0.01)
EL	0.97	0.95	0.97	0.96	0.96
	(0.01)	(0.03)	(0.01)	(0.01)	(0.03)
EVAR	0.95	0.96	0.96	0.96	0.96
	(0.04)	(0.01)	(0.01)	(0.01)	(0.01)

Note: Values presented in parentheses are the standard deviations; MS = Minimal Instructions - Short Training; ML = Minimal Instructions - Long Training; MVAR = Minimal Instructions - Variability Pre-training; ES = Elaborate Instructions - Short Training; EL = Elaborate Instructions - Long Training; EVAR = Elaborate Instructions - Variability Pre-training.

Table 39

Kruskall-Wallis ANOVA by ranks (Minimal vs Elaborate Instructions) Performed with the Index of Response Index Across Three Clusters of the Second 20 Minute Training Session in Experiment 4

Kruskall-Wallis ANOVA by ranks: Cluster 1-3

Kruskall-Wallis test: $H(1, N = 108) = 31.47$, $p < .0001$

	Valid n	Sum of ranks
Minimal	54	2030.00
Elaborate	54	3856.00

Kruskall-Wallis ANOVA by ranks: Cluster 4-6

Kruskall-Wallis test: $H(1, N = 108) = 0.87$, $p = 0.35$

	Valid n	Sum of ranks
Minimal	54	2791.00
Elaborate	54	3095.00

(table continued)

Kruskall-Wallis ANOVA by ranks: Cluster 7-10

Kruskall-Wallis test: $H(1, N = 108) = 1.54, p = 0.21$

	Valid n	Sum of ranks
Minimal	54	2741.00
Elaborate	54	3145.00

Table 40

Kruskall-Wallis ANOVA by ranks (Short vs Long vs Variability Training) Performed with the Index of Response Index Across Three Clusters of the Second 20 Minute Training Session in Experiment 4

Short vs Long Training

Kruskall-Wallis ANOVA by ranks: Cluster 1-3

Kruskall-Wallis test: $H(1, N = 72) = 10.89$, $p = 0.001$

	Valid n	Sum of ranks
Short	36	1021.00
Long	36	1607.00

Kruskall-Wallis ANOVA by ranks: Cluster 4-6

Kruskall-Wallis test: $H(1, N = 72) = 7.06$, $p = 0.01$

	Valid n	Sum of ranks
Short	36	1078.00
Long	36	1550.00

(table continued)

Kruskall-Wallis ANOVA by ranks: Cluster 7-10

Kruskall-Wallis test: $H(1, N = 72) = 7.12, p = 0.01$

	Valid n	Sum of ranks
Short	36	1077.00
Long	36	1551.00

Short vs Variability Training

Kruskall-Wallis ANOVA by ranks: Cluster 1-3

Kruskall-Wallis test: $H(1, N = 72) = 0.77, p = 0.38$

	Valid n	Sum of ranks
Short	36	1236.00
Variability	36	1392.00

Kruskall-Wallis ANOVA by ranks: Cluster 4-6

Kruskall-Wallis test: $H(1, N = 72) = 4.02, p = 0.05$

	Valid n	Sum of ranks
Short	36	1136.00
Variability	36	1492.00

(table continued)

Kruskall-Wallis ANOVA by ranks: Cluster 7-10		
Kruskall-Wallis test: $H(1, N = 72) = 6.25$, $p = 0.01$		
	Valid n	Sum of ranks
Short	36	1092.00
Variability	36	1536.00

Long vs Variability Training

Kruskall-Wallis ANOVA by ranks: Cluster 1-3		
Kruskall-Wallis test: $H(1, N = 72) = 8.84$, $p = 0.003$		
	Valid n	Sum of ranks
Long	36	1578.00
Variability	36	1050.00

Kruskall-Wallis ANOVA by ranks: Cluster 4-6		
Kruskall-Wallis test: $H(1, N = 72) = 0.43$, $p = 0.51$		
	Valid n	Sum of ranks
Long	36	1372.00
Variability	36	1256.00

(table continued)

Kruskall-Wallis ANOVA by ranks: Cluster 7-10

Kruskall-Wallis test: $H(1, N = 72) = 0.11, p = 0.74$

	Valid n	Sum of ranks
Long	36	1343.00
Variability	36	1285.00

Table 41

Means and Standard Deviations of the Index of Response For Each Block of the Change Phase in Experiment 4

Groups	Blocks				
	1	2	3	4	5
MS	0.69	0.56	0.47	0.60	0.59
	(0.10)	(0.21)	(0.19)	(0.24)	(0.32)
	n=18	n=18	n=18	n=17	n=17
ML	0.71	0.58	0.56	0.56	0.61
	(0.19)	(0.20)	(0.24)	(0.29)	(0.28)
	n=18	n=18	n=18	n=17	n=16
MVAR	0.50	0.54	0.57	0.55	0.62
	(0.13)	(0.25)	(0.30)	(0.27)	(0.28)
	n=18	n=18	n=18	n=17	n=16
ES	0.91	0.82	0.85	0.83	0.66
	(0.09)	(0.11)	(0.23)	(0.23)	(0.33)
	n=18	n=18	n=18	n=17	n=17
EL	0.94	0.79	0.72	0.80	0.82
	(0.07)	(0.26)	(0.27)	(0.26)	(0.19)
	n=18	n=18	n=18	n=18	n=14
EVAR	0.81	0.76	0.80	0.76	0.84
	(0.23)	(0.28)	(0.27)	(0.26)	(0.25)
	n=18	n=18	n=18	n=18	n=17

(table continued)

Groups	Blocks				
	6	7	8	9	10
MS	0.51	0.55	0.59	0.54	0.61
	(0.32)	(0.32)	(0.28)	(0.25)	(0.26)
	n=16	n=16	n=16	n=14	n=14
ML	0.45	0.64	0.59	0.50	0.54
	(0.29)	(0.33)	(0.31)	(0.22)	(0.31)
	n=15	n=16	n=14	n=12	n=14
MVAR	0.43	0.60	0.44	0.57	0.51
	(0.30)	(0.25)	(0.33)	(0.30)	(0.33)
	n=15	n=14	n=15	n=11	n=13
ES	0.77	0.65	0.89	0.68	0.79
	(0.34)	(0.41)	(0.14)	(0.36)	(0.34)
	n=14	n=14	n=13	n=14	n=14
EL	0.52	0.74	0.63	0.64	0.65
	(0.43)	(0.37)	(0.41)	(0.38)	(0.45)
	n=13	n=13	n=10	n=8	n=10
EVAR	0.72	0.69	0.72	0.67	0.71
	(0.37)	(0.41)	(0.35)	(0.43)	(0.40)
	n=17	n=15	n=15	n=16	n=14

Note: Values presented in parentheses are the standard deviations; MS = Minimal Instruction - Short Training; ML = Minimal Instructions - Long Training; MVAR = Minimal Instructions - Variability Pre-training; ES = Elaborate Instructions - Short Training; EL = Elaborate Instructions - Long Training; EVAR = Elaborate Instructions - Variability Pre-training.

Table 42

Kruskall-Wallis ANOVA by ranks (Minimal vs Elaborate Instructions) Performed with the Index of Response During the First Three Blocks of the Change Phase in Experiment 4

Kruskall-Wallis ANOVA by ranks: Block 1

Kruskall-Wallis test: $H(1, N = 108) = 44.53$, $p < .0001$

	Valid n	Sum of ranks
Minimal	54	1857.00
Elaborate	54	4029.00

Kruskall-Wallis ANOVA by ranks: Block 2

Kruskall-Wallis test: $H(1, N = 108) = 28.12$, $p < .0001$

	Valid n	Sum of ranks
Minimal	54	2080.00
Elaborate	54	3806.00

(table continued)

Kruskall-Wallis ANOVA by ranks: Block 3

Kruskall-Wallis test: $H(1, N = 108) = 27.86, p < .0001$

	Valid n	Sum of ranks
Minimal	54	2084.00
Elaborate	54	3802.00

Table 43

Kruskall-Wallis ANOVA by ranks (Short vs Long vs Variability Training) Performed with the Index of Response During the First Three Blocks of the Change Phase in Experiment 4

Kruskall-Wallis ANOVA by ranks: Block 1

Kruskall-Wallis test: $H(2, N = 108) = 11.06$, $p = 0.004$

	Valid n	Sum of ranks
Short	36	2100.50
Long	36	2318.00
Variability	36	1467.50

Kruskall-Wallis ANOVA by ranks: Block 2

Kruskall-Waliis test: $H(2, N = 108) = 0.06$, $p = 0.97$

	Valid n	Sum of ranks
Short	36	1941.00
Long	36	1998.00
Variability	36	1947.00

(table continued)

Kruskall-Wallis ANOVA by ranks: Block 3

Kruskall-Wallis test: $H(2, N = 108) = 1.18, p = 0.55$

	Valid n	Sum of ranks
Short	36	1952.00
Long	36	1823.00
Variability	36	2111.00

Table 44

Means and Standard Deviations of the Relative Change in Extinction Index Across Three Clusters of Blocks During the Change Phase in Experiment 4

Groups	Clusters		
	1-3	4-6	7-9
MS	0.53	0.39	0.36
	(0.29)	(0.38)	(0.41)
ML	0.42	0.27	0.24
	(0.16)	(0.17)	(0.21)
MVAR	0.28	0.18	0.13
	(0.11)	(0.17)	(0.14)
ES	0.64	0.36	0.31
	(0.22)	(0.28)	(0.29)
EL	0.59	0.33	0.16
	(0.20)	(0.22)	(0.21)
MVAR	0.62	0.45	0.25
	(0.25)	(0.30)	(0.28)

Note: Values presented in parentheses are the standard deviations; MS = Minimal Instruction - Short Training; ML = Minimal Instructions - Long Training; MVAR = Minimal Instructions - Variability Pre-training; ES = Elaborate Instructions - Short Training; EL = Elaborate Instructions - Long Training; EVAR = Elaborate Instructions - Variability Pre-training.

Table 45

Kruskall-Wallis ANOVA by ranks (Minimal vs Elaborate Instructions) Performed with the Relative Change in Extinction Index, Across Three Clusters of Blocks During the Change Phase in Experiment 4

Kruskall-Wallis ANOVA by ranks: Cluster 1-3

Kruskall-Wallis test: $H(1, N = 108) = 24.83, p < .0001$

	Valid n	Sum of ranks
Minimal	54	2132.00
Elaborate	54	3754.00

Kruskall-Wallis ANOVA by ranks: Cluster 4-6

Kruskall-Wallis test: $H(1, N = 108) = 4.89, p = 0.03$

	Valid n	Sum of ranks
Minimal	54	2583.00
Elaborate	54	3303.00

(table continued)

Kruskall-Wallis ANOVA by ranks: Cluster 7-9

Kruskall-Wallis test: $H(1, N = 108) = 0.12$, $p = 0.73$

	Valid n	Sum of ranks
Minimal	54	3000.00
Elaborate	54	2886.00

Table 46

Kruskall-Wallis ANOVA by ranks (Short vs Long vs Variability Training) Performed with the Relative Change in Extinction Index, Across Three Clusters of Blocks During the Change Phase in Experiment 4

Kruskall-Wallis ANOVA by ranks: Cluster 1-3

Kruskall-Wallis test: $H(2, N = 108) = 5.89$, $p = 0.05$

	Valid n	Sum of ranks
Short	36	2273.00
Long	36	1984.00
Variability	36	1629.00

Kruskall-Wallis ANOVA by ranks: Cluster 4-6

Kruskall-Wallis test: $H(2, N = 108) = 0.86$, $p = 0.65$

	Valid n	Sum of ranks
Short	36	2103.00
Long	36	1906.00
Variability	36	1877.00

(table continued)

Kruskall-Wallis ANOVA by ranks: Cluster 7-9

Kruskall-Wallis test: $H(2,\ N = 108) = 3.83,\ p = 0.15$

	Valid n	Sum of ranks
Short	36	2257.00
Long	36	1858.00
Variability	36	1771.00

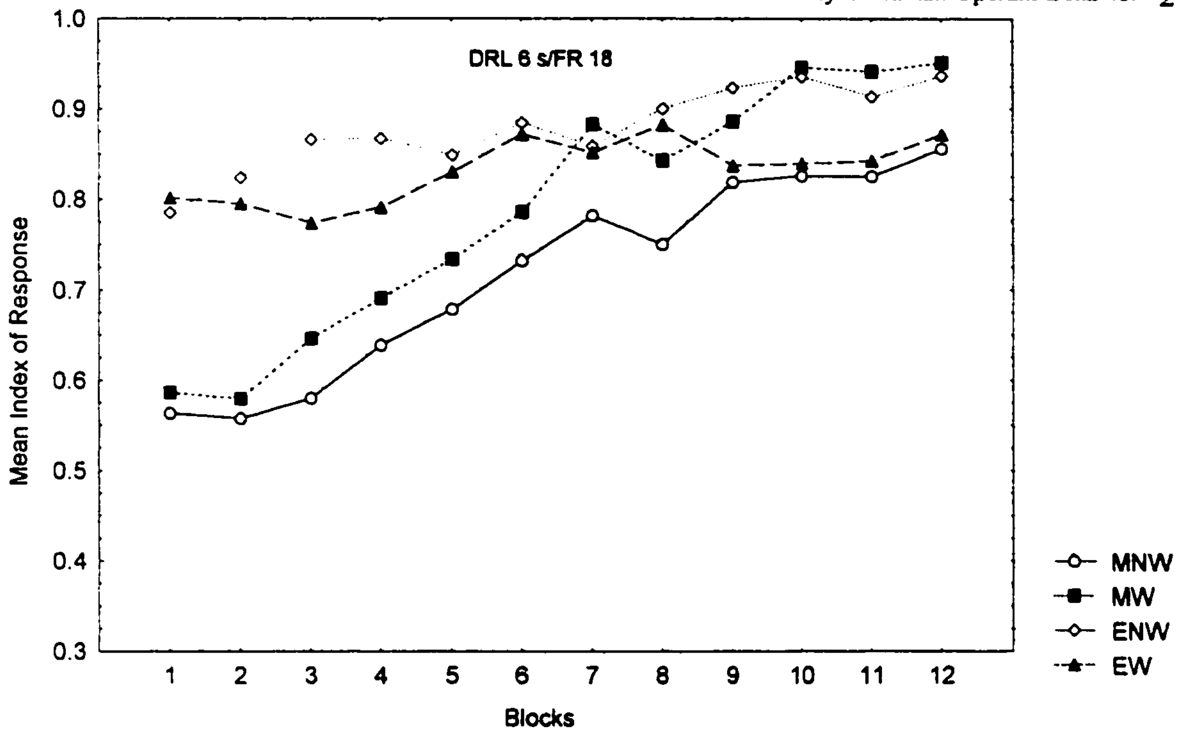

Figure 1. Mean Index of Response during the first session of the Training Phase in Experiment 1.

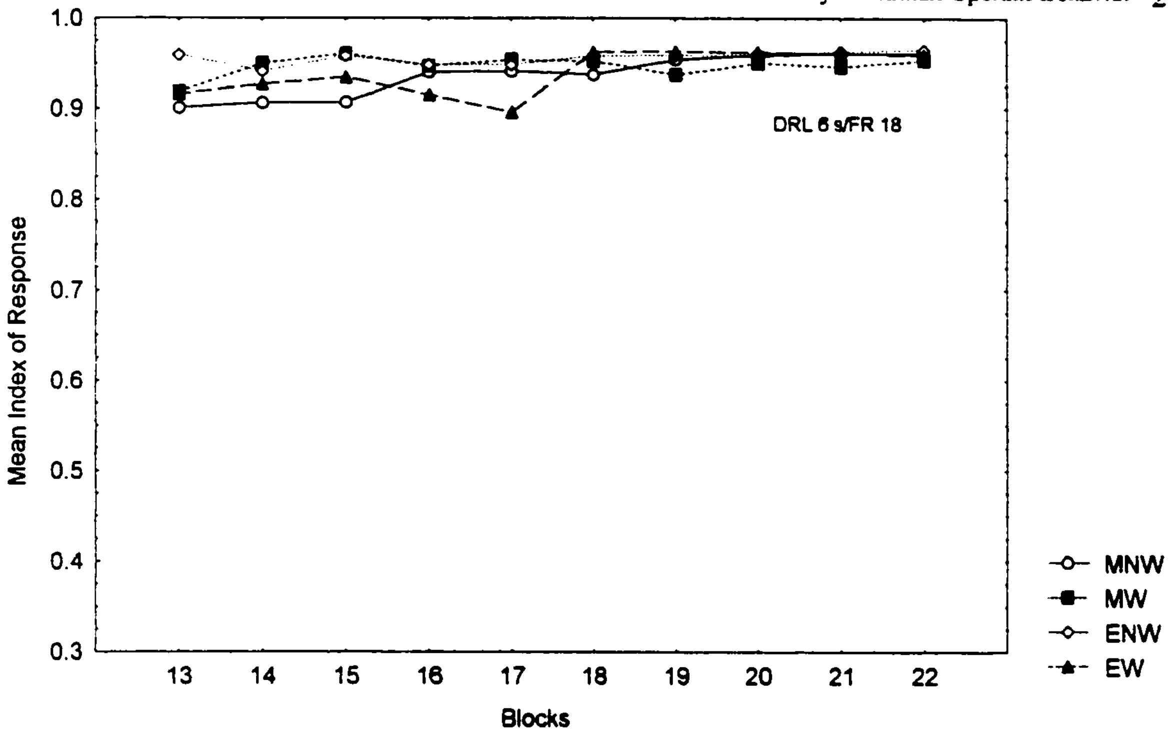

Figure 2. Mean Index of Response during the second session of the Training Phase in Experiment 1.

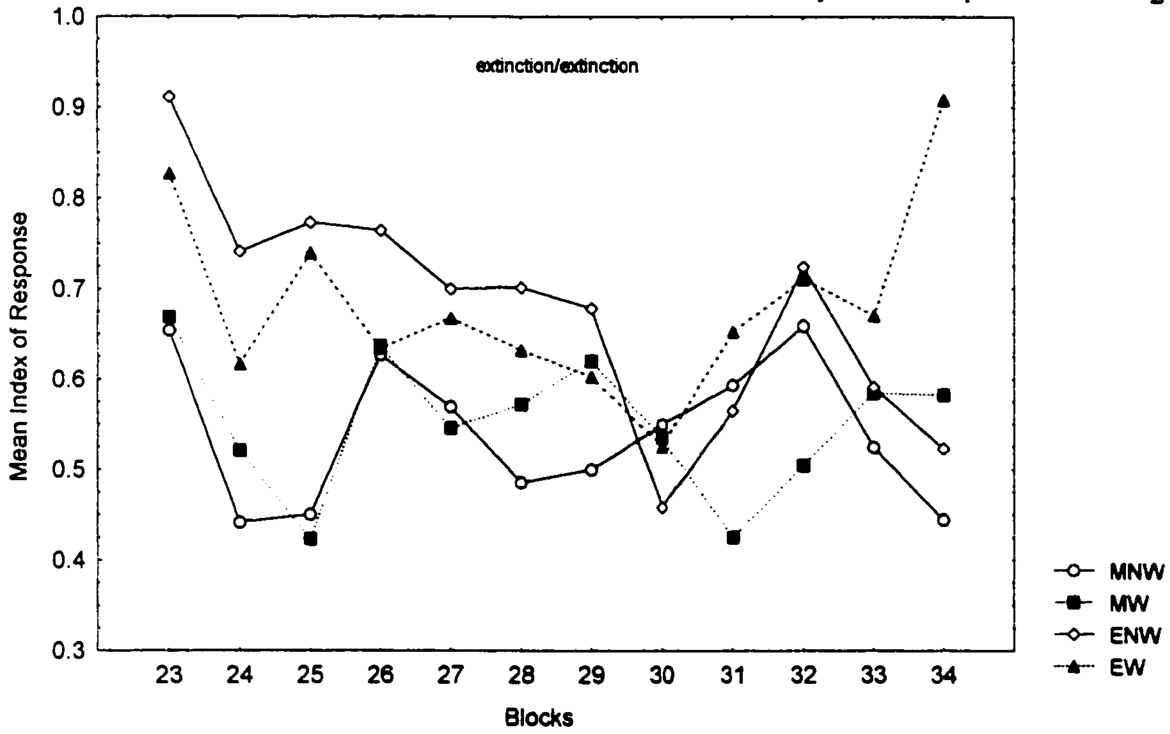

Figure 3. Mean Index of Response during the Change Phase in Experiment 1.

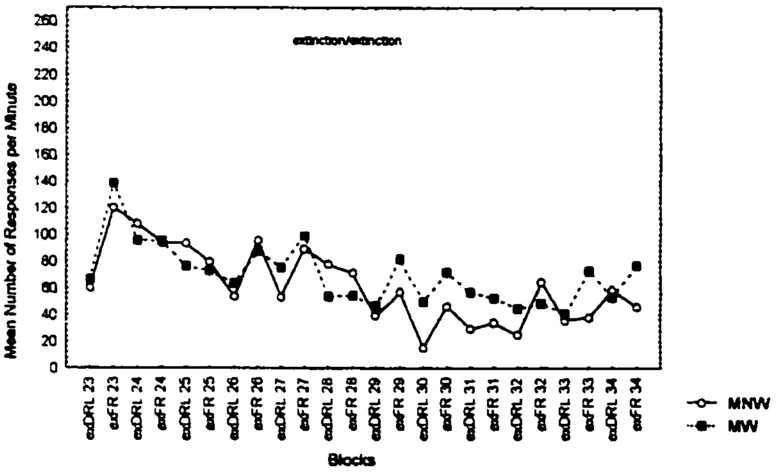

Figure 4. Mean Number of Responses per Minute for the Minimal Instructions groups During the Change Phase in Experiment 1.

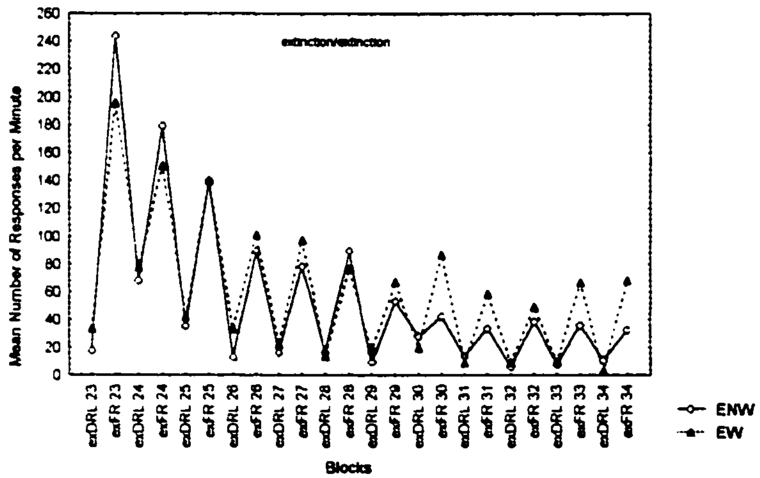

Figure 5. Mean Number of Responses per Minute for the Elaborate Instructions groups During the Change Phase in Experiment 1.

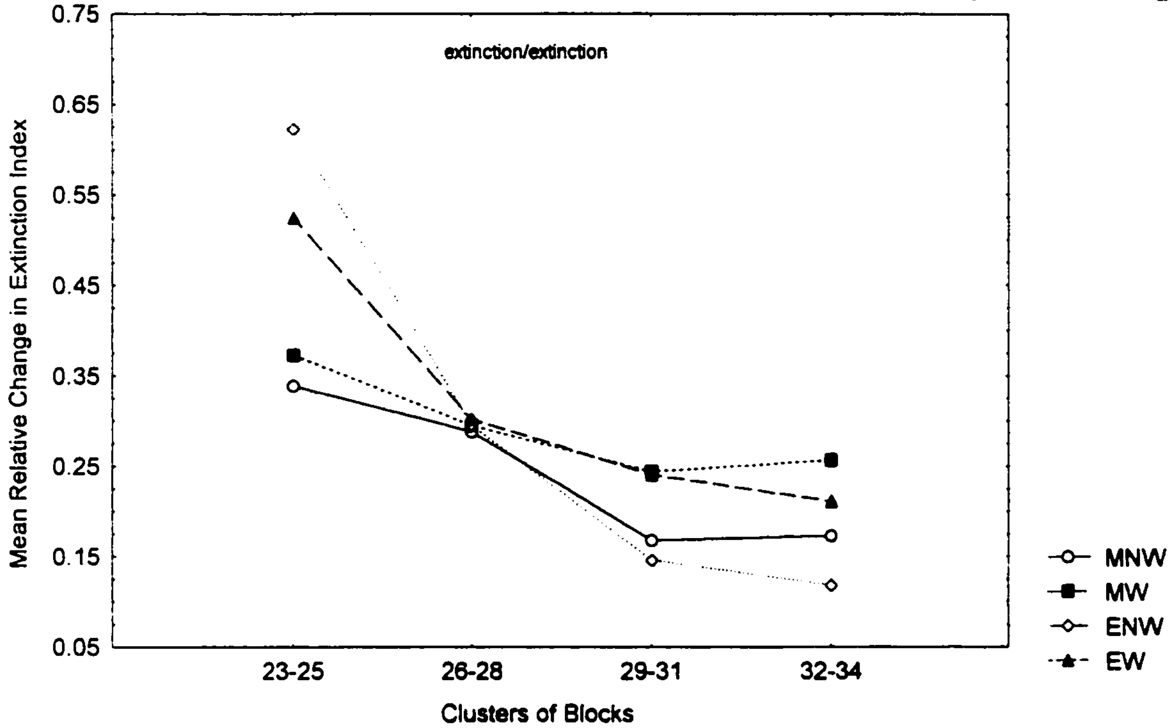

Figure 6. Mean Relative Change in Extinction Index during the Change Phase in Experiment 1.

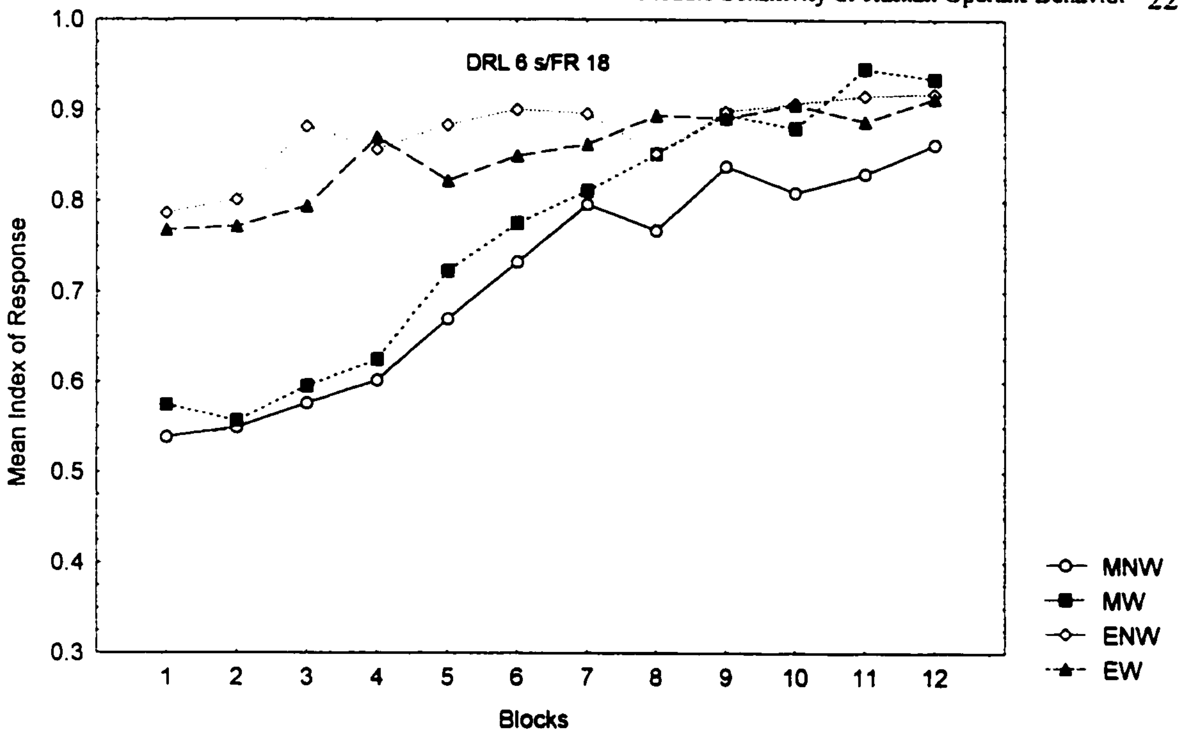

Figure 7. Mean Index of Response during the first session of the Training Phase in Experiment 2.

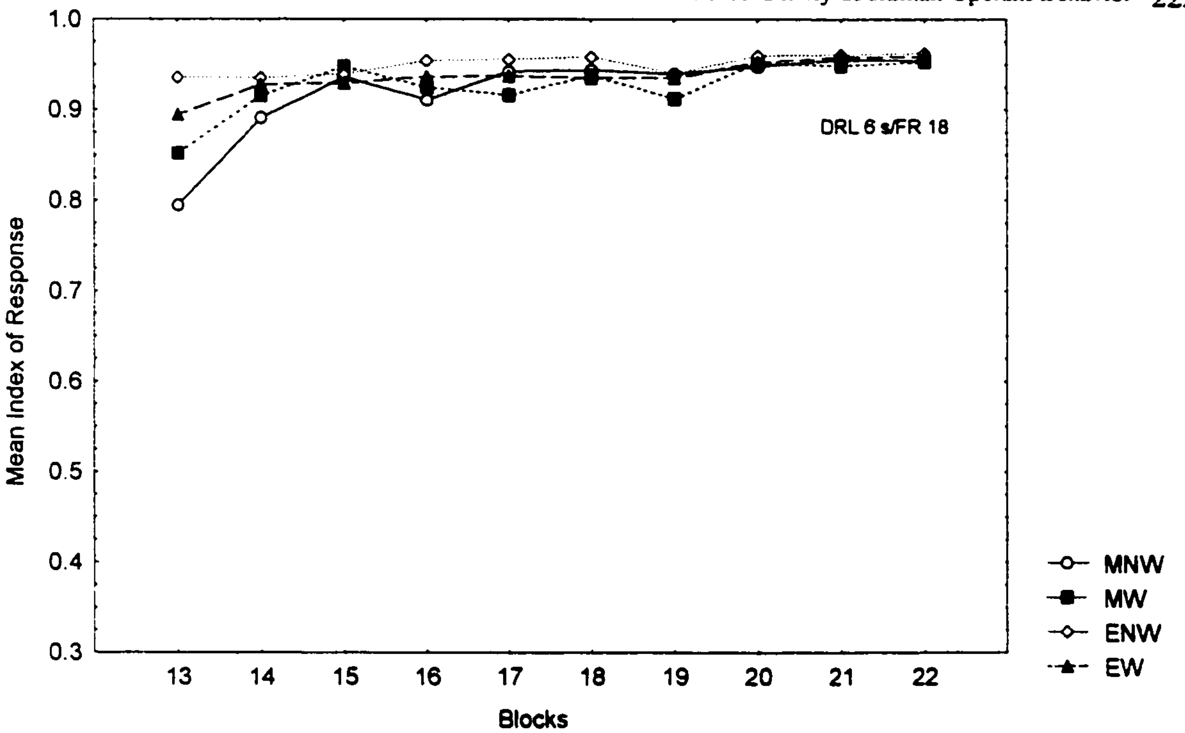

Figure 8. Mean Index of Response during the second session of the Training Phase in Experiment 2.

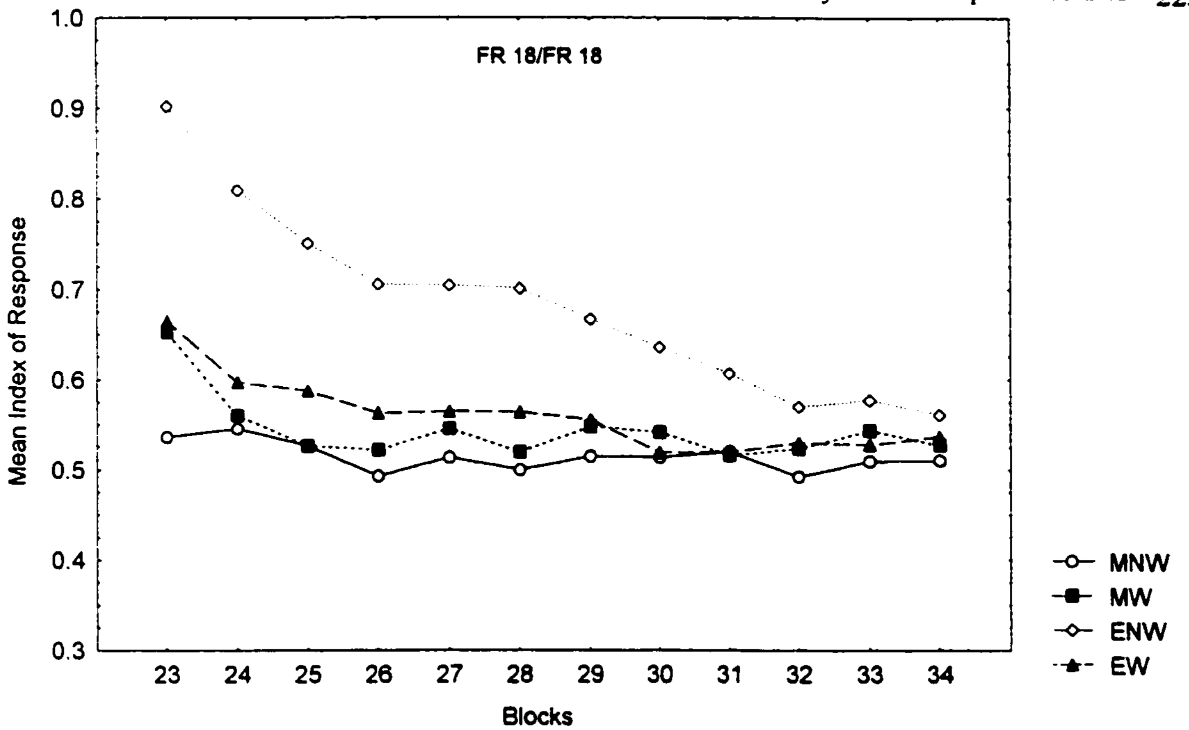

Figure 9. Mean Index of Response during the Change Phase in Experiment 2.

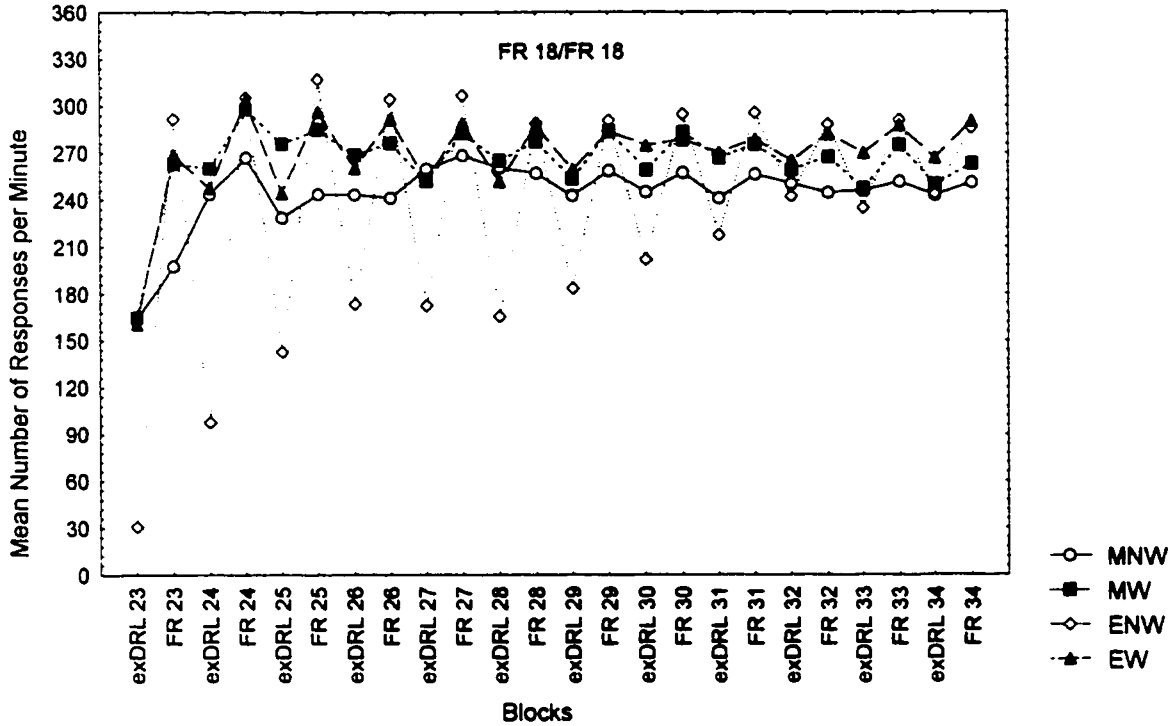

Figure 10. Mean Number of Responses per minute during the Change Phase in Experiment 2.

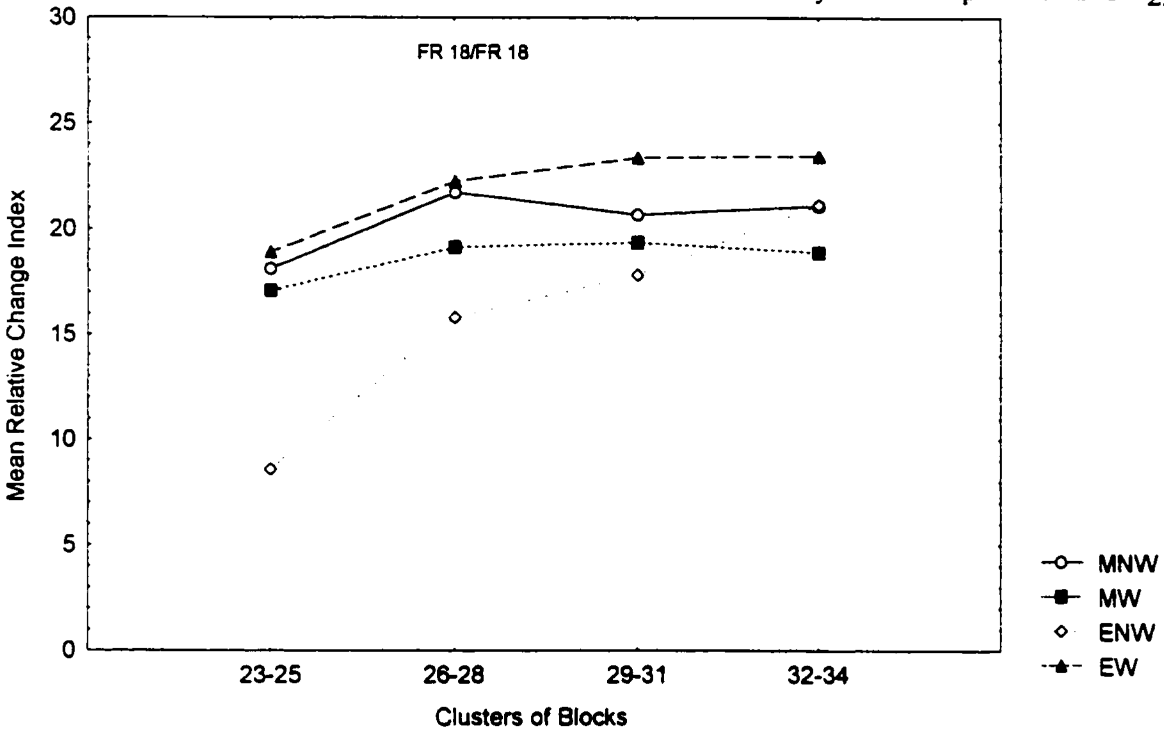

Figure 11. Mean Relative Change Index during the Change Phase in Experiment 2.

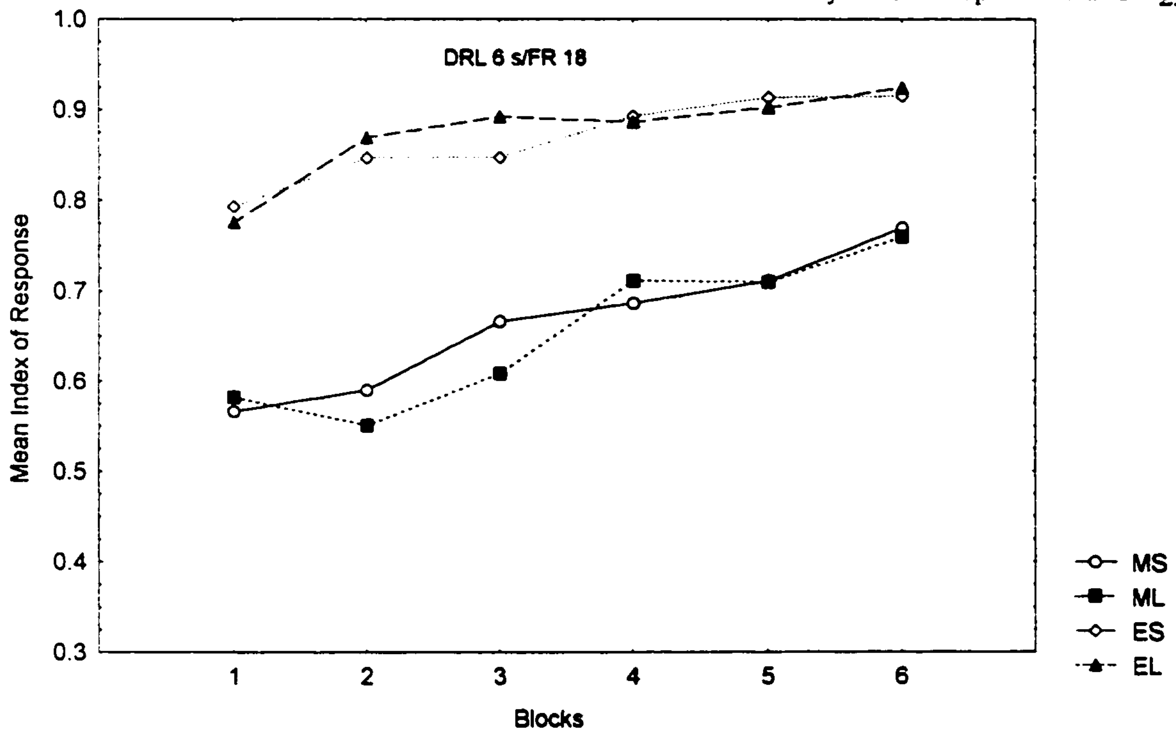

Figure 12. Mean Index of Response during the first six blocks of the first 20 minute Training Session in Experiment 3.

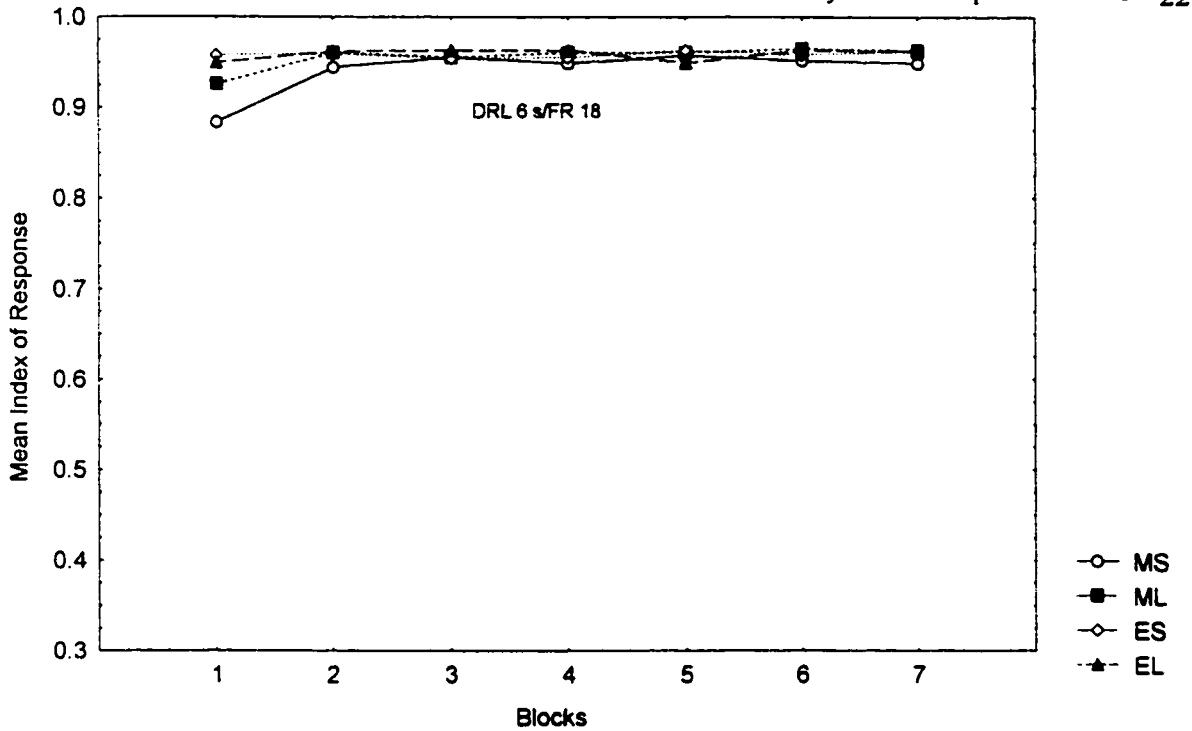

Figure 13. Mean Index of Response during the first seven blocks of the second 20 minute Training Session in Experiment 3.

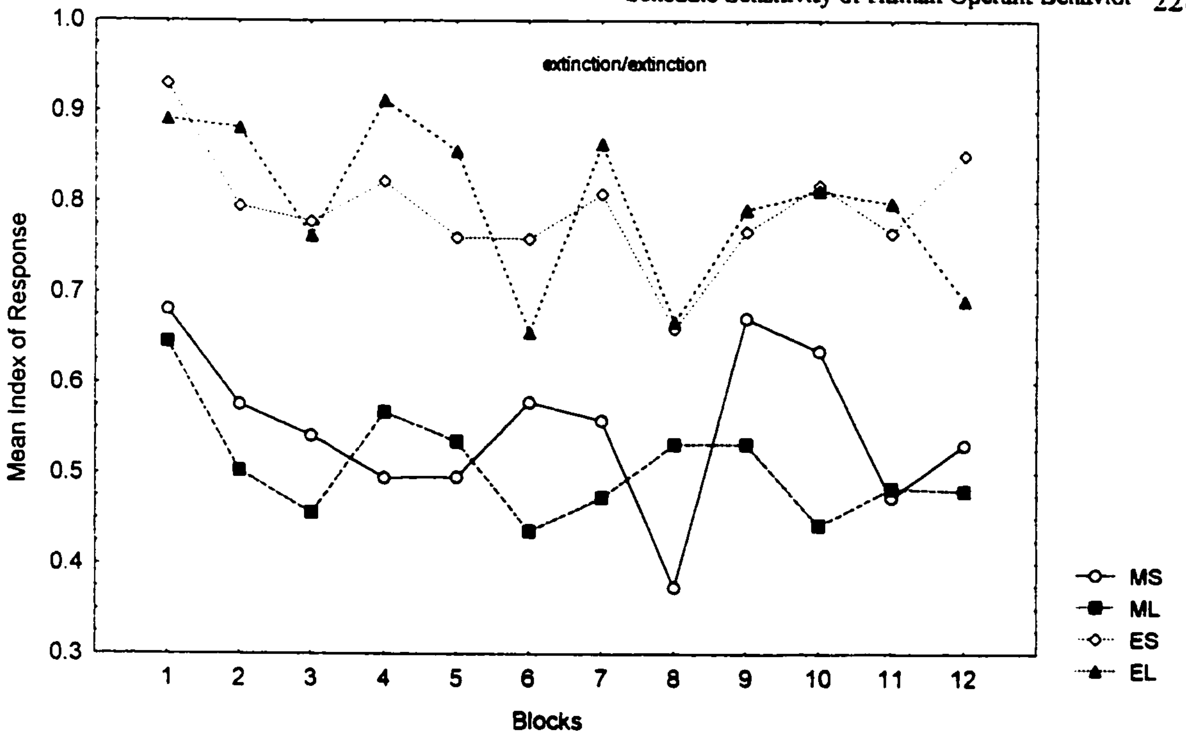

Figure 14. Mean Index of Response during the Change Phase in Experiment 3.

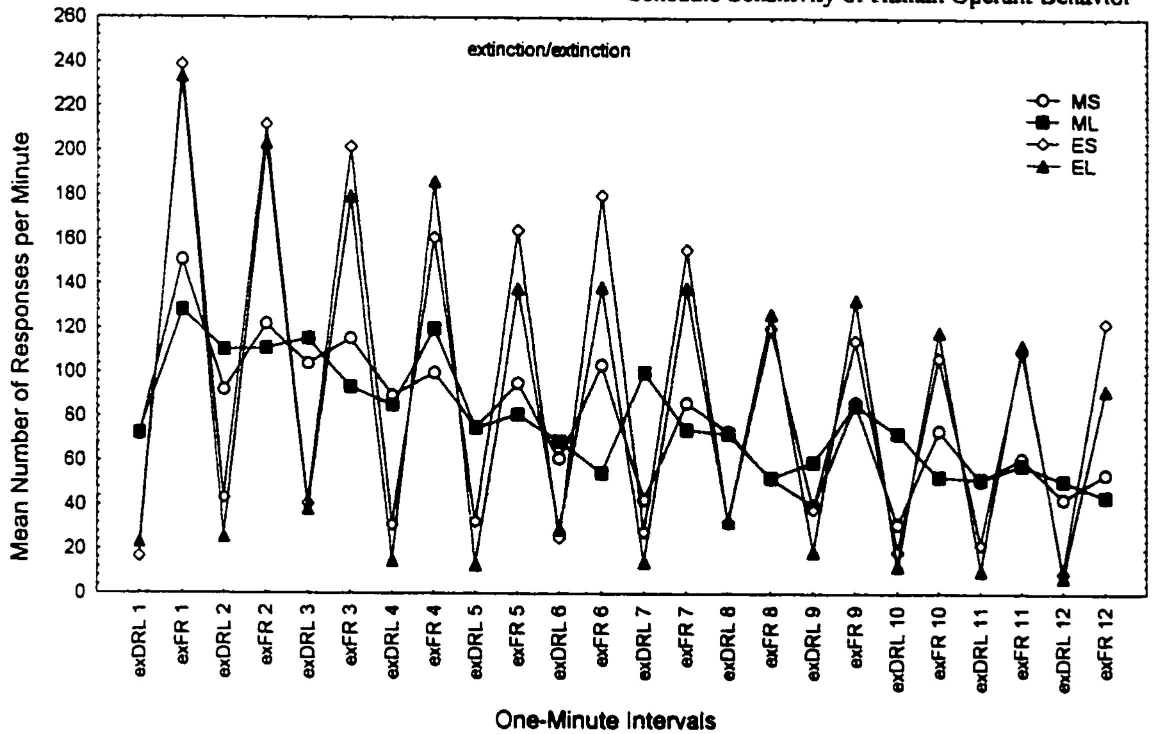

Figure 15. Mean Number of Responses per minute during the Change Phase in Experiment 3.

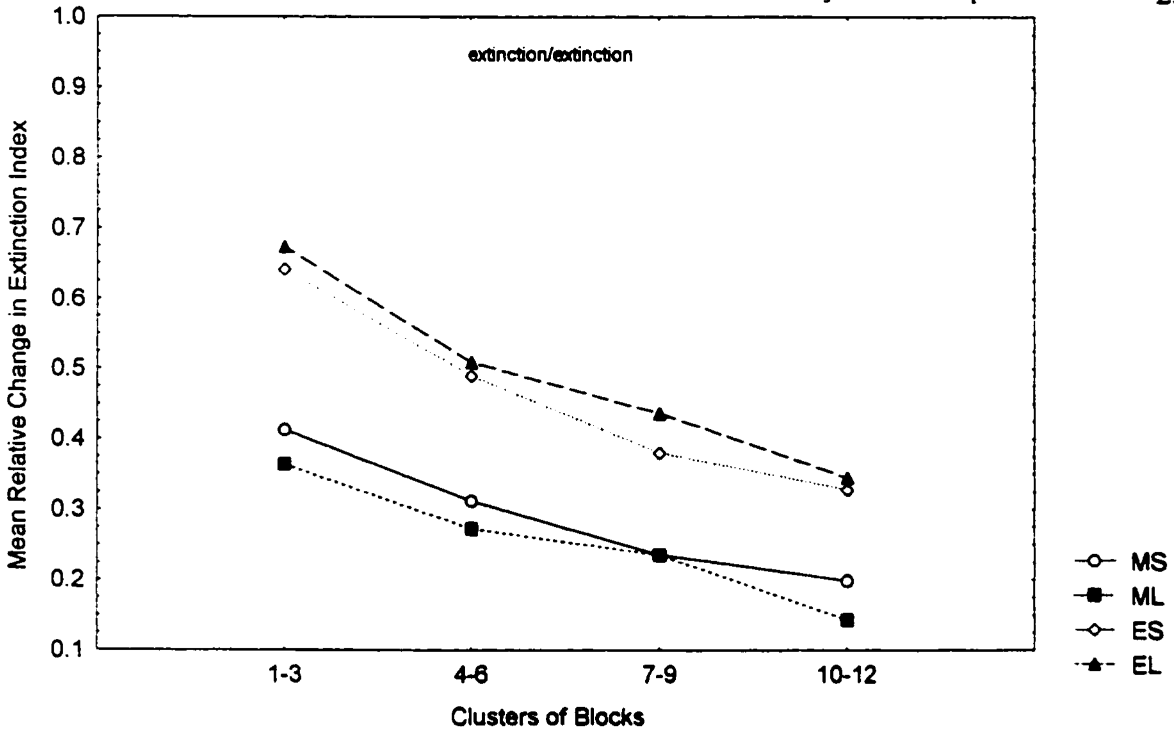

Figure 16. Mean Relative Change in Extinction Index during the Change Phase in Experiment 3.

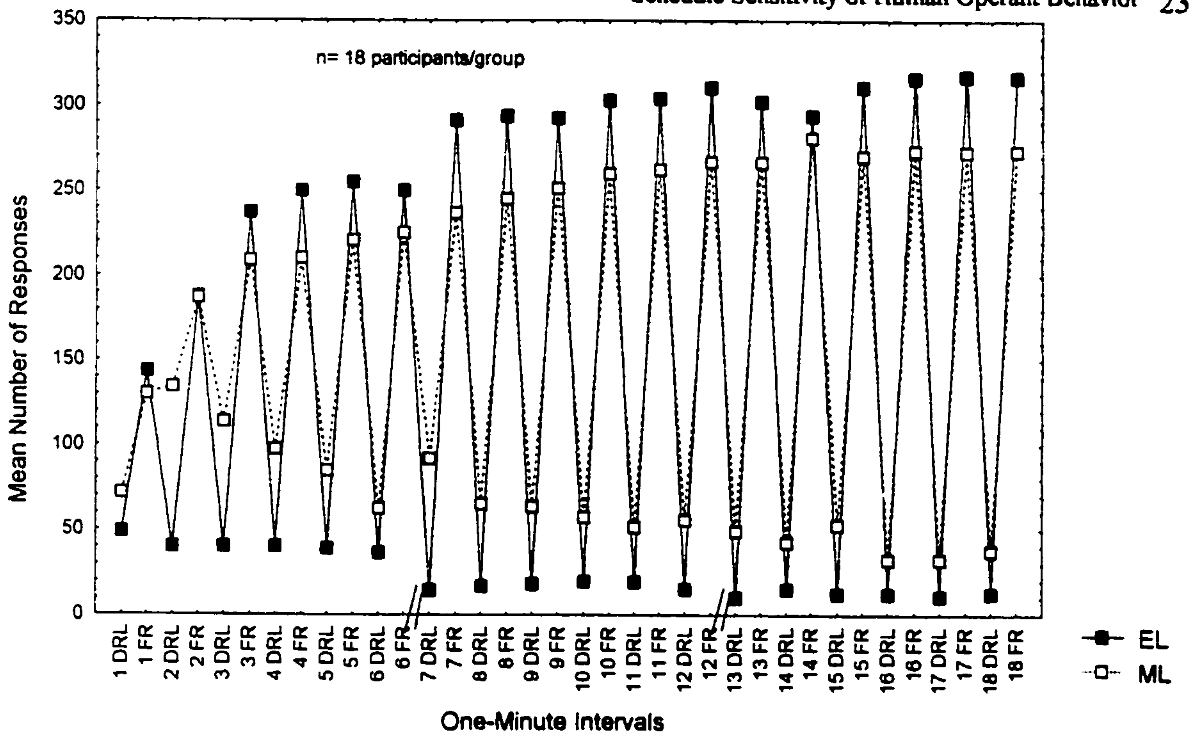

Figure 17. Mean Number of Responses per minute for the ML and EL groups during the Prolonged Training Session in Experiment 4. The oblique bars on the x-axis refer to the pauses in the session related to a change in schedule.

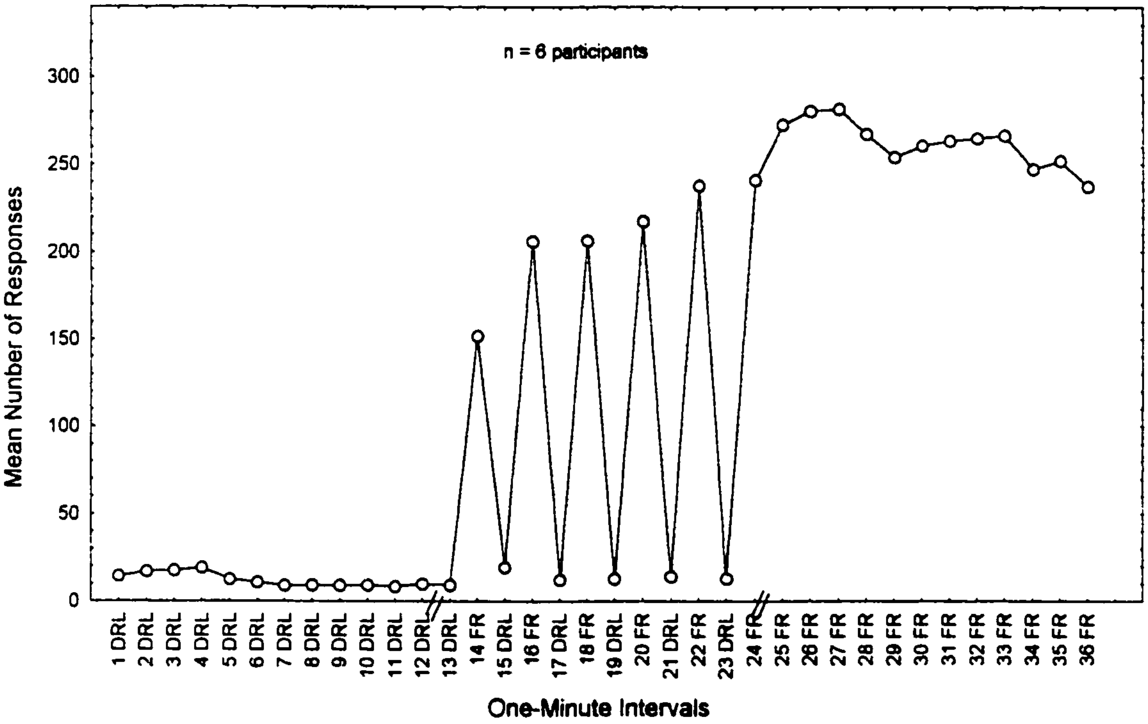

Figure 18. Mean Number of Responses per minute for the Variability Pre-Training Order I groups during the Variability Pre-training Session Experiment 4.

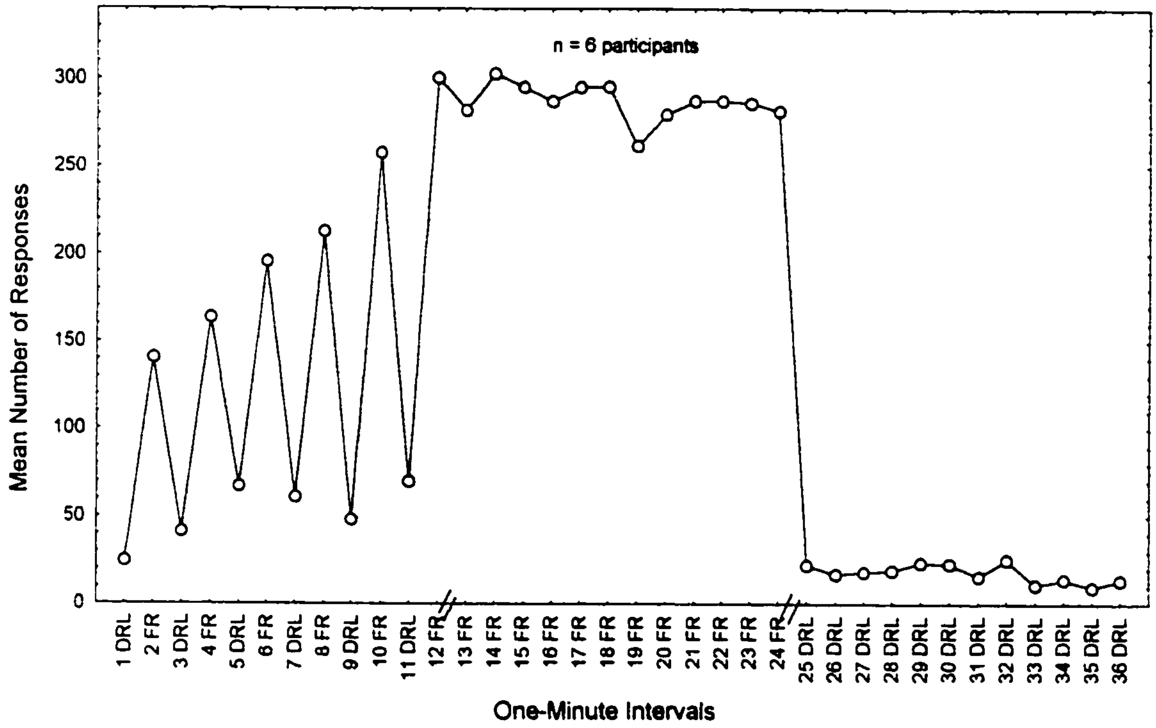

Figure 19. Mean Number of Responses per minute for the Variability Pre-Training Order II groups during the Variability Pre-training Session in Experiment 4.

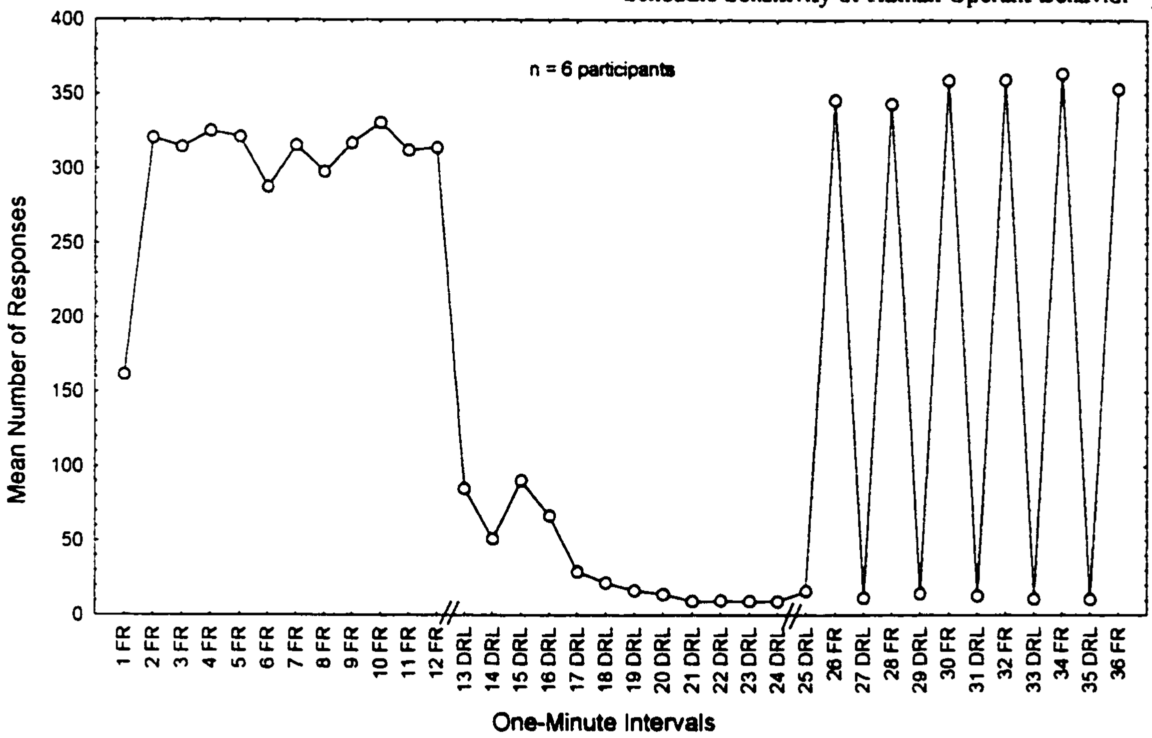

Figure 20. Mean Number of Responses per minute for the Variability Pre-Training Order III groups during the Variability Pre-training Session in Experiment 4.

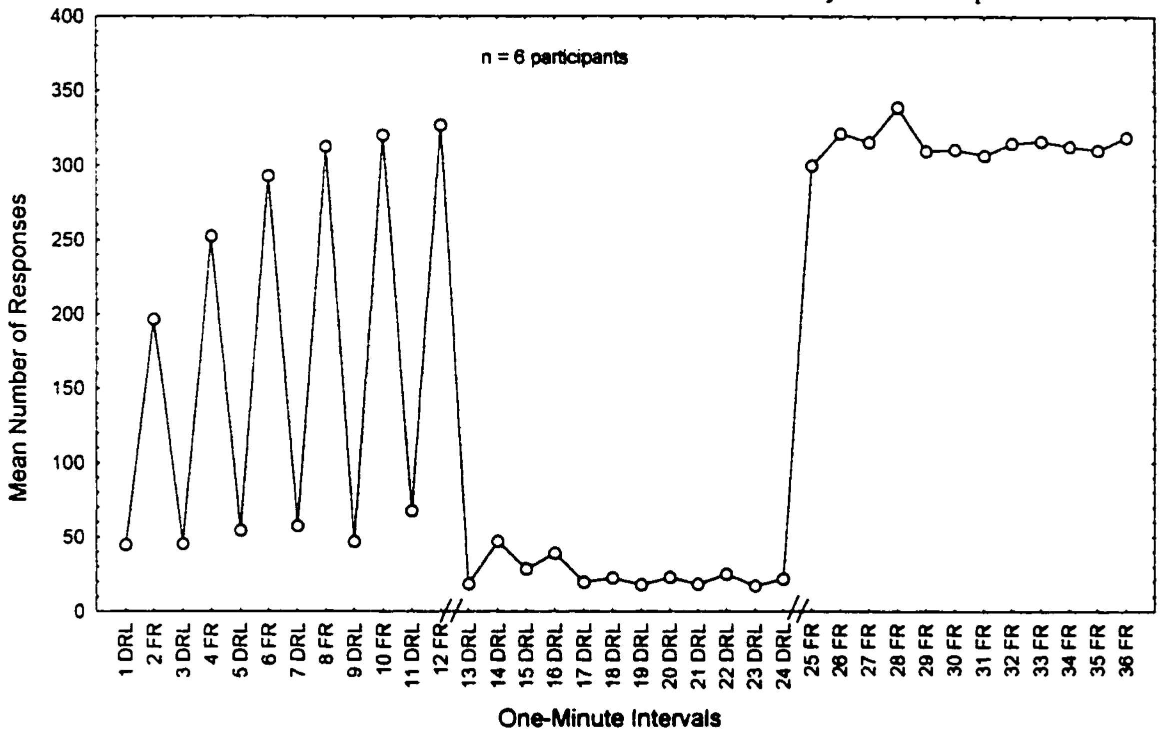

Figure 21. Mean Number of Responses per minute for the Variability Pre-Training Order IV groups during the Variability Pre-training Session in Experiment 4.

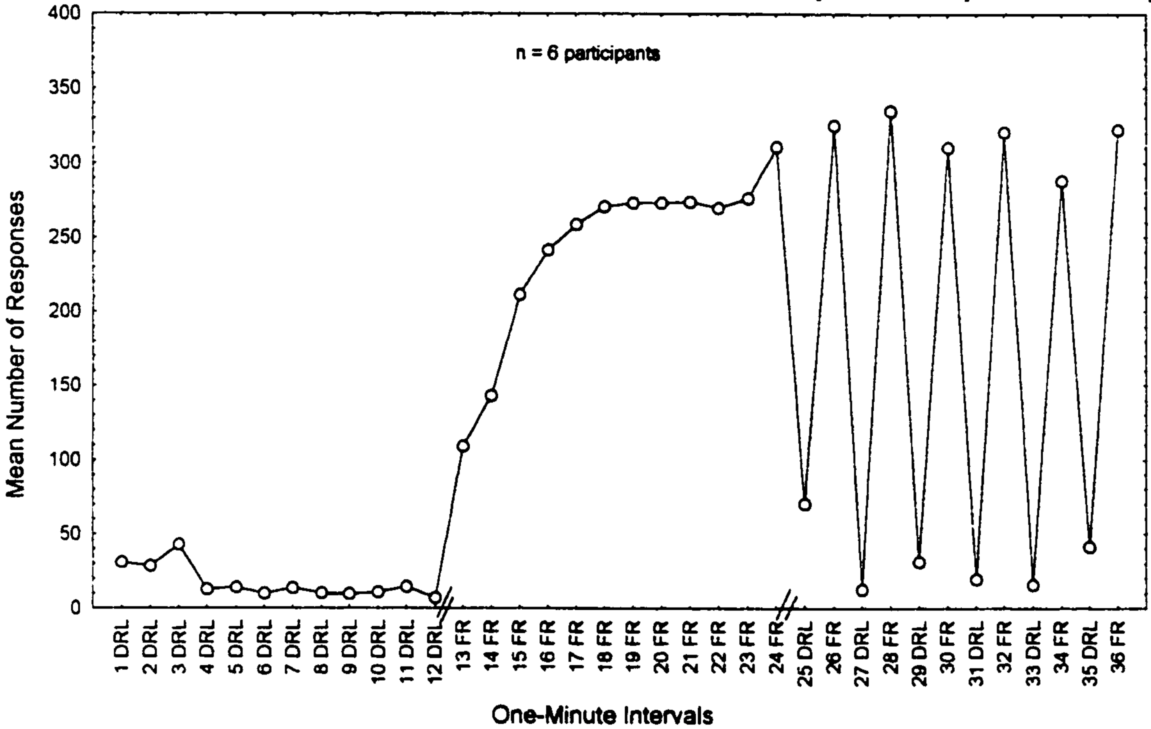

Figure 22. Mean Number of Responses per minute for the Variability Pre-Training Order V groups during the Variability Pre-training Session in Experiment 4.

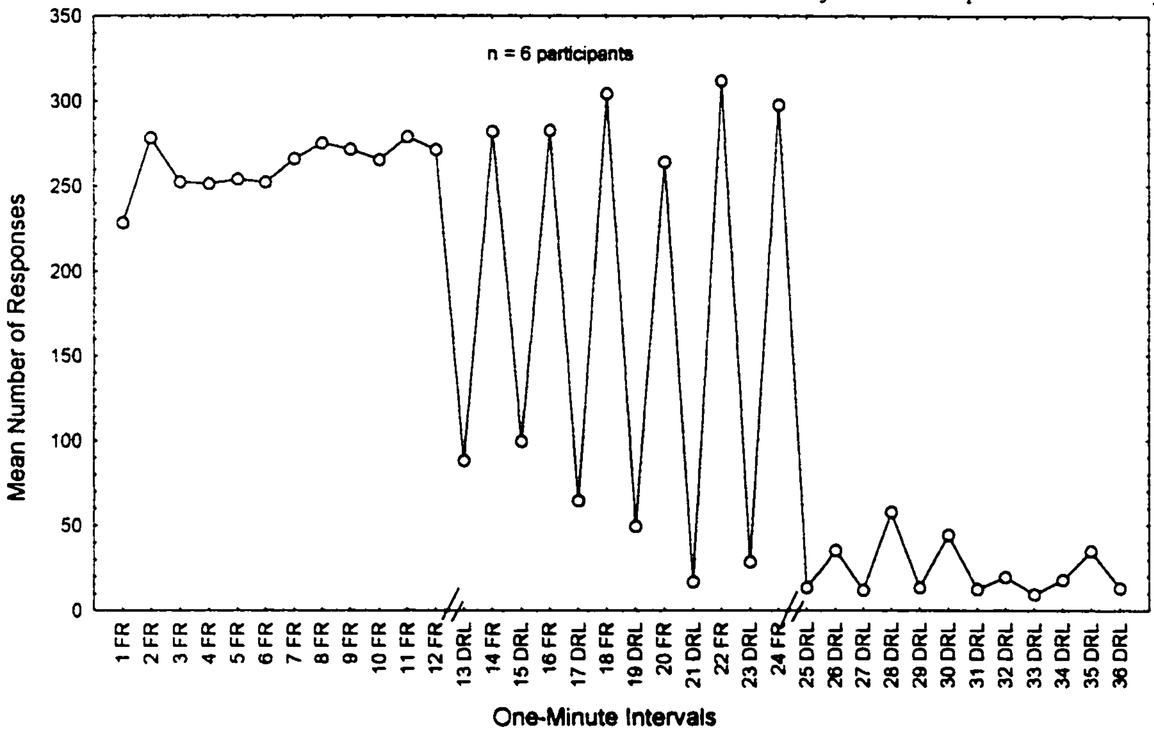

Figure 23. Mean Number of Responses per minute for the Variability Pre-Training Order VI groups during the Variability Pre-training Session in Experiment 4.

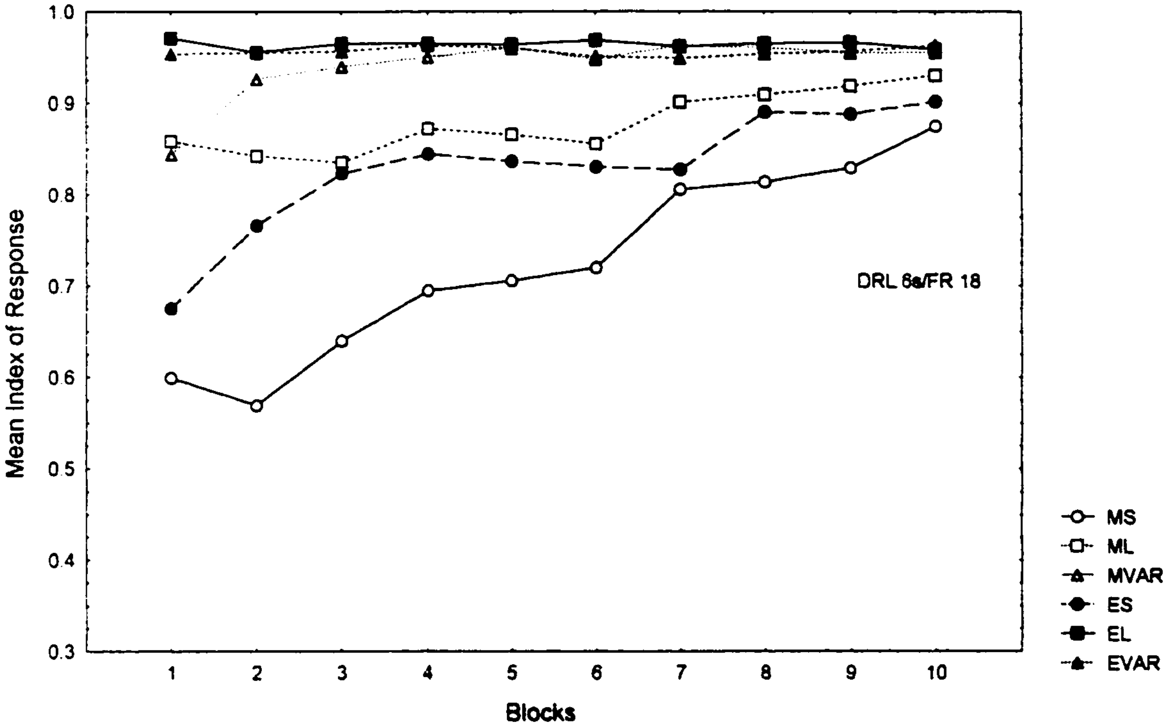

Figure 24. Mean Index of Response during the first 20 minute Training Session in Experiment 4.

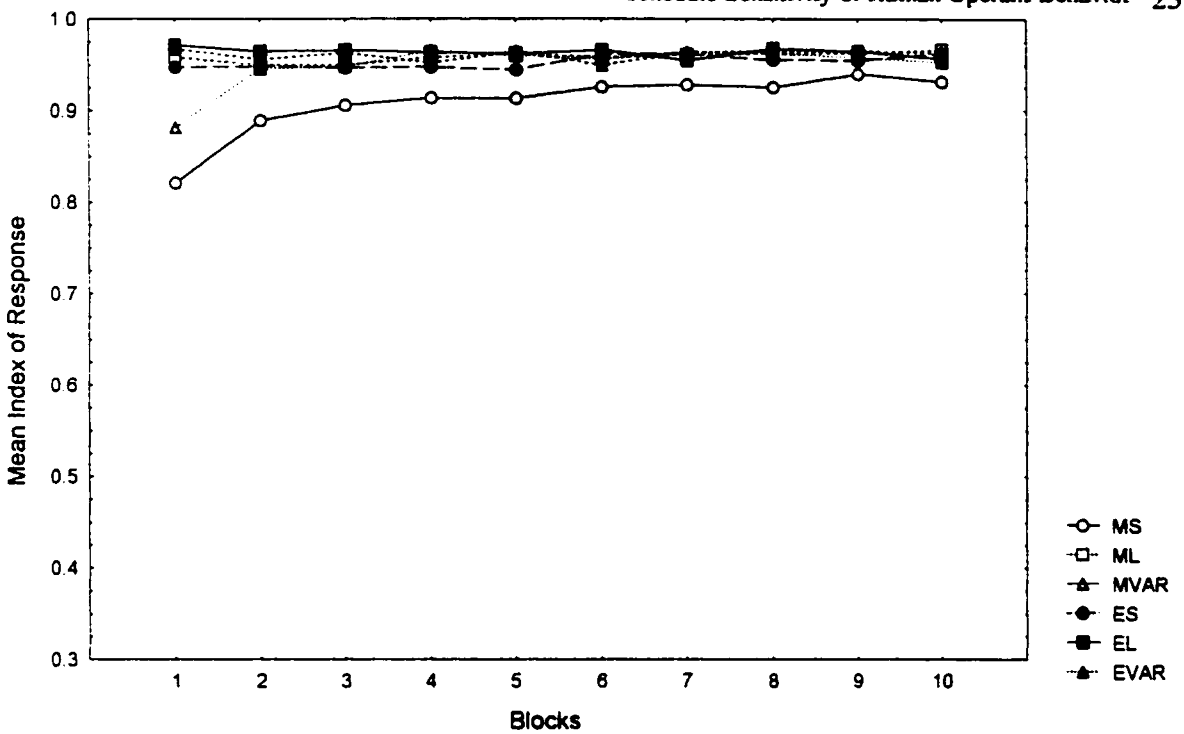

Figure 25. Mean Index of Response during the second 20 minute Training Session in Experiment 4.

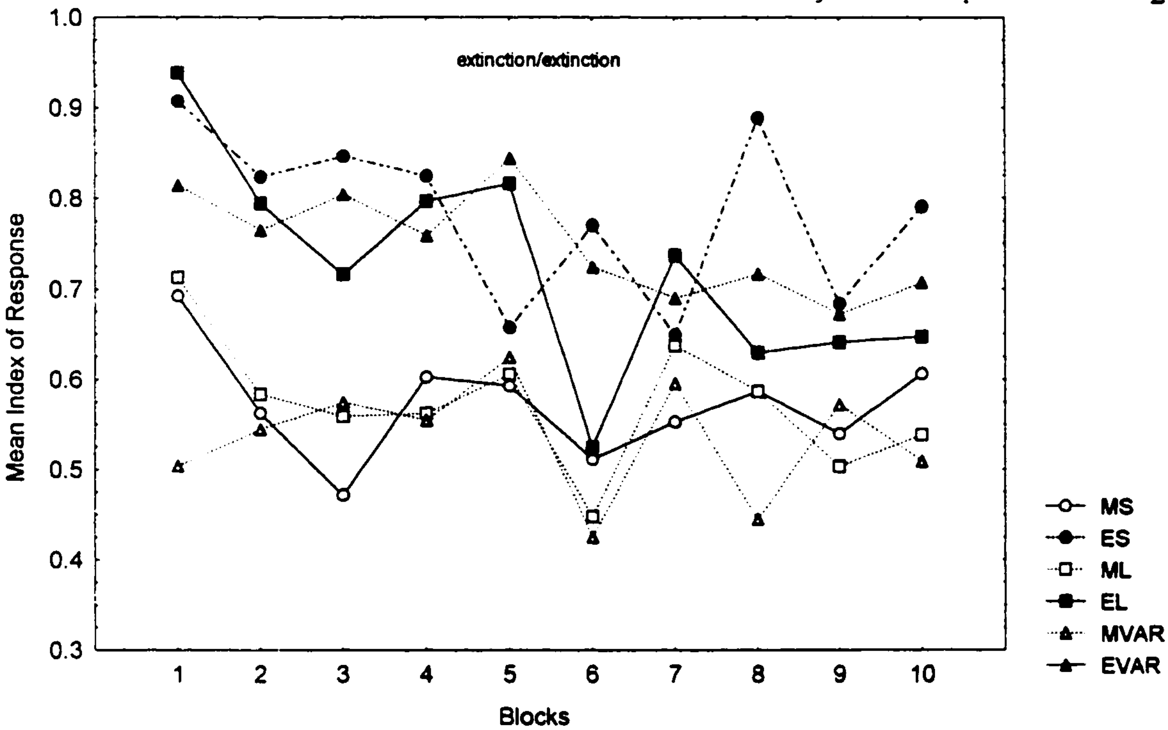

Figure 26. Mean Index of Response during the Change Phase in Experiment 4.

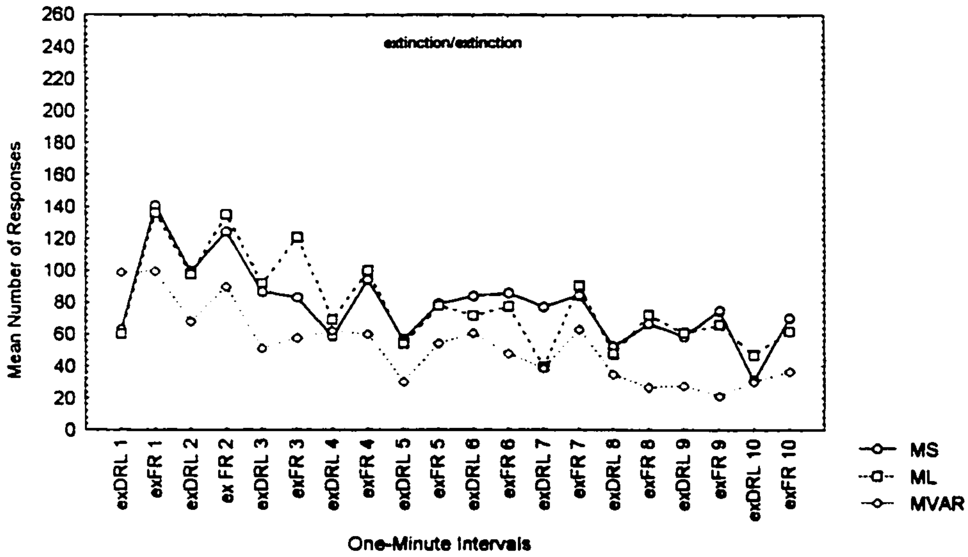

Figure 27. Mean Number of Responses per Minute for the Minimal Instructions groups during the Change Phase in Experiment 4.

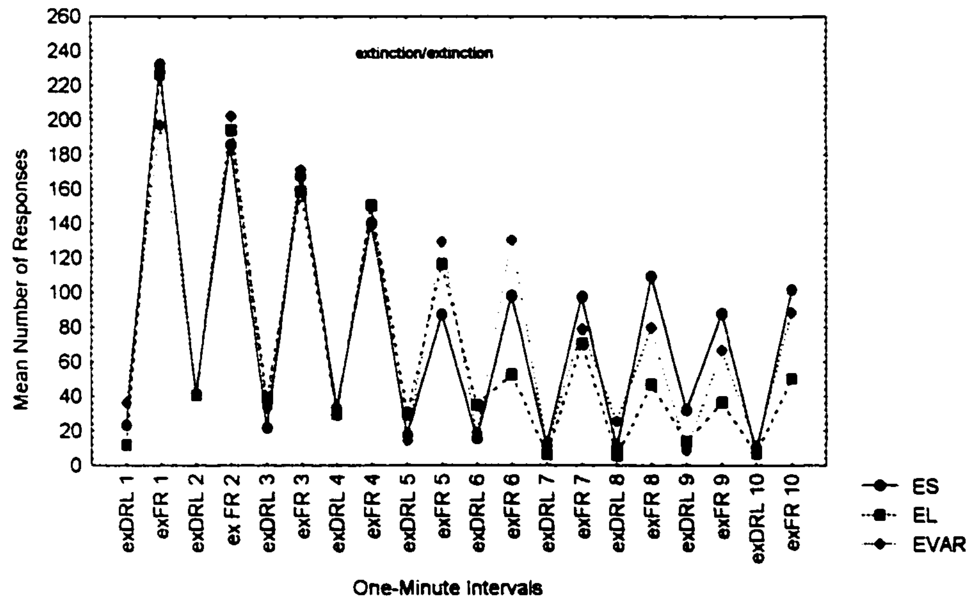

Figure 28. Mean Number of Responses per Minute for the Elaborate Instructions groups during the Change Phase in Experiment 4.

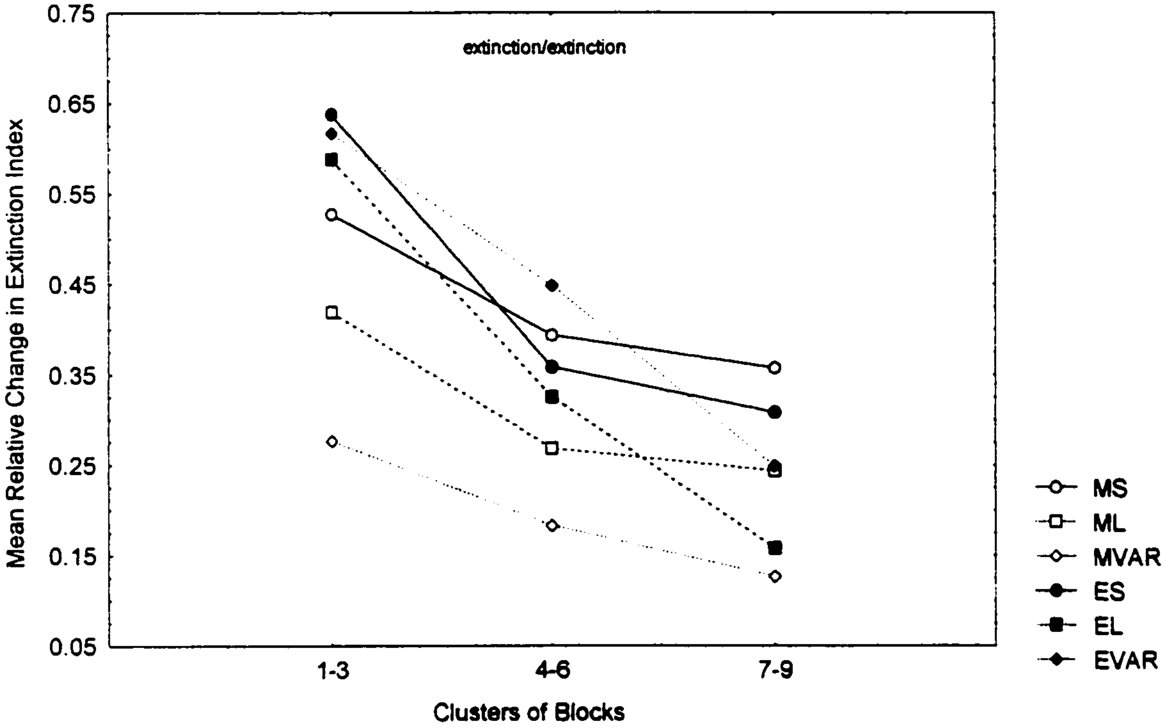

Figure 29. Mean Relative Change in Extinction during the Change Phase in Experiment 4.

APPENDIX A

CONSENT FORM

I have listened to a description of the experiment and I wish to participate. From the description of the experiment I understand that:

a) The experiment is concerned with learning.

b) I will be required to press keys on a computer keyboard.

c) There is no known discomfort or risk associated with the procedure.

d) My name will not be used in connection with the analysis or reporting of the data.

e) The session will last between 1 and 2 hours.

f) I may, without any necessity of giving an explanation, discontinue my participation at any time and such action will not affect my class marks.

g) A summary of the results will be available when the study is completed.

DATE:____

PARTICIPANT'S NAME (print):______________________________

PARTICIPANT (signature):______________________________

EXPERIMENTER (signature):______________________________

APPENDIX B

RECRUITMENT SCRIPT

I am here to recruit volunteer subjects to participate in an experiment in the field of learning. It is a straightforward study concerning learning processes and more specifically on how adults learn a new task. It is a not a psychological test and it does not involve deception.

The experiment is run by Carole St-Denis, a student completing her Ph.D. in clinical psychology at the University of Ottawa, under the supervision of Dr. Robert Watters, professor at the School of Psychology. Participation in the experiment would take about one hour to two hours of your time.

Confidentiality will be respected at all times. We are only interested in group results. Your name would appear nowhere, except on the consent form that you would fill out. I will circulate sign up sheets and if interested you may write down your name and phone number and we will call you back to set up an appointment. Any questions?

Thank you for you attention.