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Contingency-Shaped Behavior and Rule-Governed Behavior: A Comparison in Terms of Speed of Acquisition, Generalization and Maintenance

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CONTINGENCY-SHAPED BEHAVIOR AND RULE-GOVERNED BEHAVIOR: A COMPARISON IN TERMS OF SPEED OF ACQUISITION, GENERALIZATION AND MAINTENANCE

by

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CONTINGENCY-SHAPED BEHAVIOR AND RULE-GOVERNED BEHAVIOR: A COMPARISON IN TERMS OF SPEED OF ACQUISITION, GENERALIZATION AND MAINTENANCE

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According to Skinner (1969, 1974), operant behavior can be acquired through two major processes, direct contact between the behavior and its environmental consequences and antecedents in a process referred to as contingency-shaped behavior (CSB) and through verbal mediation by rules and instructions in a process referred to as rule-governed behavior (RGB). CSB and RGB were compared in terms of the speed of acquisition of complex problem skills, the generalization of those skills to new stimuli, and their maintenance. Forty-four college students, 13 males and 31 females, with an average age of 21.5 years, participated in four sessions of approximately 1 hour each.

Subjects were presented with a series of complex, visual problems drawn from the Standard and Advanced Progressive Matrices of Raven (Raven, 1983, 1986). These problems were arranged into five series of similar difficulty. The first four series of problems were used for training complex problem-solving skills under one of four experimental conditions. Subjects received no training on the final series of problems which was used to assess generalization of problem-solving skills to novel test items.

On the basis of pretest scores on a short version of the Raven Standard Matrices (Raven, 1986), subjects were assigned to one of four matched groups. These groups were randomly assigned to one of four training conditions. Group one (n = 11), the CSB group, received immediate feedback regarding the correctness of each answer on the four series of training problems. Group two (n = 10), the RGB group, received a set of instructions on useful problem-solving strategies. Group three (n = 11), the CSB + RGB group, received both the instructions and the feedback. Finally, a control group (n = 12), received neither instructions nor feedback.

In general, all the groups obtained gains through the sessions, but visual and statistical analysis (ANOVA) revealed no significant differences between the groups on speed of acquisition as indicated by the number of correct answers, generalization, and maintenance of problem-solving skills. These results are discussed with respect to limits on the generality of prior theoretical distinctions between CSB and RGB suggesting the superiority of RGB for the efficient and effective acquisition of certain behavioral repertoires.

DEDICATION

**To my wife, Maria Luisa, and my mother,
my main sources of strength and support.**

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Ronald Ramirez-Henderson

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INTRODUCTION

Skinner (1969, 1974) draws a distinction between two major categories of operant behavior based on their control by direct contact with reinforcement contingencies versus control by a variety of verbal descriptions of those contingencies. In his words,

> We refer to contingency-shaped behavior alone when we say that an organism behaves in a given way with a given probability because the behavior has been followed by a given kind of consequences in the past. We refer to behavior under the control of prior contingency-specifying stimuli when we say that an organism behaves in a given way because it expects a similar consequence to follow in the future. (Skinner, 1969, p. 147)

Skinner refers to these two categories of operant behavior as contingency-shaped behavior (CSB) and rule-governed behavior (RGB), respectively.

The nature of the contingency specifying stimuli (CSS) may vary, ranging from simple descriptions of reinforcement contingencies and stimulus functions to detailed instructions about sequences of behavior and the appropriate antecedent and consequence conditions. The CSS may be visual or auditory and may include those that are self-generated by a verbal subject. Additionally, the completeness of the contingency description or instructions may vary, but in its most complete form "a rule may state the time, place, and other antecedent conditions appropriate for the behavior; the topography, rate, duration, and other features of the responses; and the type, quantity, quality, and schedule of the consequence" (Poppen, 1989,

p. 335).

While the initial occurrence of a particular behavior may be clearly and solely under the control of either a rule or contact with a contingency, the distinction between contingency-shaped and rule-governed behavior often becomes ambiguous with repeated occurrences of the behavior. More specifically, behavior that was initially established under control of a rule contacts existing or contrived reinforcement contingencies and thus has the potential to come under some mixture of rule and contingency control. For contingency-shaped behavior a similar shift to multiple control may also occur as behaving organisms generate verbal descriptions (CSS) that describe their perception of the reinforcement contingencies. In spite of the potential (perhaps inevitability) of multiple control, the distinction between contingency-shaped and rule-governed behavior remains a useful conceptual distinction.

There has been some controversy as to the behavioral processes that operate in rule-governed behavior. Skinner (1969) defined rule based on topographical elements (i.e., they have the form of contingency-specifying stimuli [CSS]) and functionally by noting that they act as discriminative stimuli for the behavior stipulated in the rule. Skinner's functional definition has been accepted by a significant number of behavior analysts (Baldwin & Baldwin, 1981; Catania, 1989; Catania, Shimoff, & Matthews, 1989; Cerutti, 1989; Galizio, 1979; Zettle & Hayes, 1982). However, several behavior analysts have recently questioned this definition. For instance, Blakely and Schlinger (1987) and Schlinger and Blakely (1987) reject the

supposition that rules act primarily or solely as discriminative stimuli. These behavior analysts argue that the critical component of contingency-specifying stimuli is their ability to alter the function of other stimuli.

> Although contingency-specifying stimuli (CSSs) have most often been classified as discriminative stimuli (SDs) (e.g., Galizio, 1979; Skinner, 1969), many CSSs seem to function differently. Specifically, they do not evoke (i.e., immediately strengthen) behavior as do SDs rather they alter the function of other stimuli and thus, the strength of relations among those stimuli and behavior. It is these "function-altering" effects that may be relevant to the complex verbal stimuli called rules, instructions, or relational-autoclitics, and that therefore make them worthy of explication. (Schlinger & Blakely, 1987, p. 41).

This controversy about the conceptualization of rules and their behavioral functions has yet to be resolved.

Nevertheless, the distinction between contingency-shaped and rule-governed behavior is thought to be important for a variety of reasons. At one level it provides a conceptual model in which cognitive and verbal processes that affect human behavior are observable and thus open to scientific verification. This is especially important because many disciplines (e.g., cognitive psychology, neural sciences) seek to explain the influence of verbal and cognitive variables by reference to hypothesized cognitive processes (e.g., neural networks, storage and retrieval errors). In most situations, these putative causal variables are not subject to direct observation and are often inferred only from the observations that they are purported to explain. Rule-governed behavior offers a heuristic model in which the primary causal variables exist independent of the phenomenon and are open for observation and experimental

confirmation.

Furthermore, the distinction between contingency-shaped and rule-governed behavior is important because these are two basic processes by which operant behavior can be established or modified. At the applied level, this distinction is important because a thorough understanding of the difference between contingency-shaped and rule-governed behavior could increase the effectiveness of interventions based on each process. Skinner (1974), described several advantages of rule-governed behavior relative to contingency-shaped behavior. First, behavior described by rules can be acquired faster than similar behavior shaped solely by exposure to contingencies. Second, rules facilitate learning when there are similarities between contingencies. Third, rules have special value when the contingencies are complex, not clear and as a result, difficult to understand. In addition, Catania et al. (1989) say that rules are useful when the contingencies are too weak or too remote to shape behavior effectively, when the contingencies are dangerous, or when we try to override competing natural contingencies. Furthermore, Skinner (1969) states that:

> Even fragmentary descriptions of contingencies speed the acquisition of effective terminal behavior, help to maintain the behavior over a period of time, and reinstate it when forgotten. Moreover, they generate similar behavior in others not subjected to the contingencies they specified. (p. 143)

The sizeable list of advantages attributed to rule-governed behavior has created recent interest in research on the distinctions and relative merits of RGB and CSB. There are a number of potentially important distinctions between contingency-shaped and

rule-governed behavior. Skinner (1969) describes four basic elements that form the basis for the distinction: a system that establishes certain contingencies of reinforcement, the behavior that is shaped and maintained by those contingencies, the rules describing those contingencies, and finally, the behavior evoked by those rules.

Under this model, contingency-shaped behavior may differ both topographically and functionally from seemingly similar behavior that was established by a verbal description of the observed contingencies. This may occur because the verbal descriptions and instructions that operate to establish RGB may differ from the actual contingencies that are operating to establish and maintain CSB. In some situations, the actual contingencies may be either unknown or too complex to be accurately and completely described. As a result, CSB and RGB may differ topographically and functionally in spite of efforts to use RGB as a short cut to establishing behavior shaped by extensive exposure to contingencies. In addition, RGB and CSB could come under control of different motivational variables (Skinner, 1969), or establishing operations (Michael, 1982). While CSB would by definition come under the control of natural and contrived consequences reflecting the contingencies of reinforcement under which the behavior was acquired, RGB, at least the initial instances, would be controlled by the subject's reinforcement history for a generic response class that might be called "rule-following behavior." As a result, the controlling variables for CSB and its corresponding RGB may be different.

Another potentially important distinction between CSB and RGB

concerns their sensitivity to contingency changes that would seemingly alter the behavior. Catania et al. (1989) claimed that contingency-shaped behavior is necessarily sensitive to the consequences of behavior because of its direct contact with them. In contrast, rule-governed behavior would presumably be sensitive to response consequences only if the rules or CSSs are consistent with the contingencies (e.g., the rules change to accurately reflect changed contingencies). Otherwise, RGB would be insensitive to reinforcement contingencies to the extent that rule control overrides the influences of the consequences of that behavior.

The importance of this area of research has become evident during the last two decades. Several studies have focused on elucidating differences between contingency-specifying stimuli (CSS) and contingency-shaped behavior (Baron & Galizio, 1983; Catania, Lowe, & Horne, 1990; Catania, Matthews, & Shimoff, 1982; Catania et al., 1989; Galizio, 1979; Hayes, Brownstein, Hass, & Greenway, 1986; Kaufman, Baron, & Kopp, 1986; Lippman & Meyer, 1967; Lowe, Beasty, & Bentall, 1983; Matthews, Catania, & Shimoff, 1985; Perez & Pereira, 1986; Perez & Pereira, 1987; Pereira & Perez, 1987; Pilgrin & Johnston, 1988; Shimoff, Catania, & Matthews, 1981; Shimoff, Matthews, & Catania, 1986; Takahashi & Iwamoto, 1986). In addition, several theoretical articles dealing with rule-governed behavior (RGB) and its practical significance have appeared (see Hayes, 1989).

Most of the research comparing contingency-shaped behavior and rule-governed behavior has been focused primarily on the differential sensitivity to schedules of reinforcement (Catania et al., 1982;

Catania et al., 1989; Galizio, 1979; Hayes et al., 1986; Matthews et al., 1985; Matthews, Shimoff, Catania, & Sagvolden, 1977; Shimoff et al., 1981; Shimoff et al., 1986). Vaughan (1989) gives a synthesis of this line of research:

> Experimenter instructions facilitate stimulus control but are likely to establish insensitivity to changes in contingencies unless there are conspicuous consequences (i.e., punishment) for following outdated or inaccurate instructions. Moreover, if subjects are shaped to respond in a certain way rather than instructed, they show greater sensitivity to changes in the experimental contingencies. Subjects' verbal behavior can also be shaped regarding experimental contingencies and this, too, seems to generate more sensitivity but only if this shaped verbal behavior is performance-specific. But such performance may be in reality rule-governed behavior despite the apparent contingency-shaping procedure. (p. 110)

Other important areas of research emanating from the RGB conceptualization include several studies within the stimulus equivalence area on the role of verbal stimuli in establishing and altering the function of stimuli (e.g., Devaney, Hayes, & Nelson, 1986; Hayes, Thompson, & Hayes, 1989). Others have studied the emergence of rule control as a function of age and language development (e.g., Bentall, Lowe, & Beasty, 1985; Lowe et al., 1983; Vaughan, 1985).

Several studies have compared the efficacy and efficiency of RGB and CSB for the acquisition of simple behavioral repertoires. In an effort to study the influence of rules on learning, Vaughan (1985) used a repeated acquisition procedure to teach five preschool children a series of four-response chains. She demonstrated that "instructional" stimuli in the form of lights over the correct response buttons produced more rapid acquisition with fewer errors than simple exposure to the contingencies. In a second experiment, subjects were

taught to verbalize the contingencies of reinforcement as a substitution of the instructional stimuli, which resulted in errorless performance when the subjects were exposed to the same procedure, but errors occurred when the subjects were exposed to the experimental conditions in the absence of the instructional stimuli. Vaughan concluded that:

> The results reported here suggest that self-generated instructions can be taught and can be effective discriminative stimuli for subsequent behavior. In addition, they support the notion that rules can be learned more quickly than the contingencies they describe and can have the effect of evoking appropriate behavior more rapidly than the acting contingencies from which the rules were derived. However, in the present situation this appears to have been true only when the stimulus conditions were identical. The children did not seem to profit from the rules when the stimulus conditions were slightly altered (the I/L-I/R comparison). (1985, p. 183)

This study is important in its demonstration of the applicability of RGB to the development of conditional discriminations and provided support for the assumption that contingency-specifying stimuli produces more rapid acquisition than exposure to the contingencies being described by the contingency-specifying stimuli.

Perez and Pereira (1987) also worked with children to determine the relative efficacy of contingency exposure versus rule control in the acquisition of complex discriminations, in this case classification of geometric objects according to intra and extra dimensional changes. Like Vaughan (1985), Perez and Pereira also concluded that RGB is more effective in problem solving with simple tasks than prolonged exposure to the contingencies.

While the above research provides at least modest support for the efficacy of RGB, additional research is needed to assess the

reliability and generality (Johnston & Pennypacker, 1980) of the above observations and to evaluate additional advantages of RGB over CSB described by Skinner (1969, 1974). For example, it is assumed that behavior is acquired more rapidly as RGB than through contingency shaping and that contingency-specifying stimuli help to maintain behavior over a period of time. Unfortunately, these assumptions have yet to be evaluated using a range of subjects (e.g., adults) and behaviors more complex than performance on simple reinforcement schedules. Of particular interest is the absence of research comparing CSB and RGB with fully verbal adults (e.g., college students) using complex stimulus discriminations that more closely approximate advance problem-solving skills. The study reported herein attempts to compare the relative benefits of RGB and CSB using college students and the acquisition of complex problem solving, in this case the geometric problems used in the Raven Standard and Advanced Progressive Matrices Tests (Raven, 1983, 1986), an intelligence test that is supposedly free of language and cultural biases. Spearman (1964) described the matrices as "perhaps the best of all non-verbal tests" (cited by Berker & Smith, 1988, p. 267).

Kendall and Norton-Ford (1982) state that the Raven Test evaluates the relationship among abstract figures which "is accomplished by providing a design with a missing part and requiring the subject to choose from the alternatives the insert that would correctly complete the pattern" (p. 283). Correct answers require the subject to emit complex stimulus discriminations among the relevant features of the design, while ignoring the irrelevant characteristics.

The purpose of this research is to determine if there are significant differences between rule-governed behavior and contingency-shaped behavior in terms of speed of acquisition of a complex stimulus discrimination required to solve the problems of the Raven Standard and Advanced Progressive Matrices Tests (Raven, 1983, 1986). In addition, rule-governed behavior and contingency-shaped behavior will be compared with respect to generalization of those problem-solving skills to novel problems, and maintenance of those skills. It extends prior research on CSB and RGB by studying verbal adults rather than children, the predominant subjects in this literature, and using complex problem-solving skills rather than sensitivity to simple schedules of reinforcement.

METHOD

Subjects

Forty-five college students, 13 males and 32 females that were taking courses in the Psychology Department at Western Michigan University during Winter of 1992 were recruited for this study. Their average age was 21.5 years with a range from 18-34. Ten were freshmen, five sophomores, 11 juniors, 15 seniors, and 3 graduate students.

Students were solicited as subjects by telling them about the opportunity to learn complex problem skills and to earn money for their participation in this experiment.

The participation of each student was voluntary and prior to the beginning of the session, they signed informed consent forms which explained the possible risks for participating in the research and their right to withdraw from the research at any moment (see Appendix B). Of 45 subjects who began the study, only one female subject decided not to continue.

Setting

The experiment took place in four rooms: three auditoriums with capacity for 100 students, and a classroom with capacity for 40 students. With the exception of the first session, the pretest, the groups worked independently from each other.

Instruments

There were two assessment protocols. A pretest was constructed from 30 items sampled for the "Standard Progressive Matrices" (Raven, 1986) by selecting the odd numbered problems from each of the five series of 12 items that comprised the original test. It is referred to herein as the "Pretest."

The second protocol was composed of the even numbered items of the five series of the Standard Progressive Matrices plus the first 35 items of the Advanced Progressive Matrices of Raven (Raven, 1983). These items were divided into five series (A, B, C, D, E) each series containing 13 items. To make these series as equivalent as possible with respect to the level of difficulty, the items were divided as shown in Appendix D. The order of difficulty within each series progressed from the easiest to the hardest problems, as in the original tests. This rearrangement of the Raven Tests were named the Modified Raven Test. As described later, only the first four series (A, B, C, and D) of the Modified Raven Test were used as the training series. Series E was used to assess Generalization.

Dependent Variables

There were three dependent variables, speed of acquisition, generalization, and maintenance. In all cases these measures were calculated from each subject's written responses to a series of geometric problems as described above.

Speed of Acquisition

Speed of acquisition was reflected in improvements in the number of items correct across repeated administrations of the training series (Series A, B, C, and D) of the Modified Raven Test. It was assumed that acquisition of the complex stimulus discriminations required to solve each problem would result in fewer mistakes as the subjects advanced through the series.

Generalization

Generalization of the problem-solving skills to an untrained series of problems was assessed through the number of correct answers on Series E of the Modified Raven Test. This series is referred to herein as the "Generalization Series." Prior to the generalization assessment at the end of the third training session, subjects had never been exposed to the problems in the Generalization Series.

Maintenance

Maintenance was assessed in a posttest administered 3 days after completion of the final training session. To the degree that optimal performance (number of correct responses) demonstrated during the training sessions continued at the 3 day posttest, evidence of maintenance was present.

Reliability

The tests were scored independently by two observers. There was a 100% agreement between observers regarding categorization of

answers as correct or incorrect.

The answers to the questionnaires in which the statement of self-rules was assessed at the end of the experiment were also scored independently by two observers. In these questionnaires each subject was asked to provide a written explanation of the rationale for their answer to the final problem of each one of the series of the Modified Raven Test. Their answers were classified in one of four possible alternatives: appropriate, inappropriate, guess, or no response. An answer was classified as "appropriate" if the subject's rationale had correspondence with the correct solution strategy specified for that particular problem. An answer was classified as "inappropriate" if there was no correspondence between the subject's rationale and the solution strategy specified for that particular problem, especially if the subject justified the answer based on memorization of the correct answer as a result of the feedback that was given to those subjects in the CSB and the CSB + RGB groups. An answer was classified as a "guess" if the subject explicitly stated that they guessed the answer. Finally, the answer was classified as "no response," if the subject gave no response to this questionnaire. There was an exact interobserver agreement when the independent observers categorized an answer in the same of the four categories specified above. This interobserver agreement was 87.49% with a range of 83.33% to 93.33%.

Independent Variables

The independent variable of this study was training contingencies to which each of the four separate groups were exposed. There were three experimental groups and a control group.

Contingency-Shaped Behavior (CSB) Group

In the CSB group, subjects received feedback regarding the accuracy of their answers during Training Sessions 1 and 2. This was implemented by allowing subjects to view the correct answer for a given problem immediately after the subject had written their answer for that problem. This was implemented by writing the correct answer for each problem on the back of each page and instructing subjects to view that answer only after they had written their response to that item.

Rule-Governed Behavior

Subjects in the RGB group were given a written set of strategies or rules (contingency-specifying stimuli) during Training 1 and 2. This list, titled "Information to Facilitate Performance" (see Appendix G) described nine different strategies that could be applied to the solution of any one of the complex discriminations included in the Modified Raven Test. Strategies 3, 4, 6, 8, and 9 are based on Carpenter, Just, and Shell (1990). In addition to the statement of a general strategy, examples were given of the application of that strategy. None of the examples corresponded with items in any of the assessments.

Prior to the experiment, the validity of these strategies was assessed through two mechanisms. First, one expert in neuropsychological assessment who is familiar with the Raven Test (Standard and Advanced) verified that each of the written strategies was appropriate as a potential solution strategy to one or more of the assessment items. Second, the set of rules or instructions were tested in a pilot study with 10 subjects. Each subject answered Series A and B of the Modified Raven Test under standard conditions, without feedback or instructions. Then, each subject completed Series C and D after reading the Information to Facilitate Performance and with those instructions available in printed form while completing Series C and D. All the subjects who participated in the pilot study reported that the instructions facilitated their responding during Series C and D. In addition, they obtained 76.2% of the items of series C and D correct, as opposed to 65.4% of the items correct in series A and B. This represented an improvement of 10.8% when they received the instructions (see Table 1). Given the efforts to equate the difficulty of the various series, it is likely that these differences in performance between Series A and B versus Series C and D were a result of the provision of problem-solving strategies.

Contingency-Shaped Behavior Plus Rule-Governed Behavior Group

In this experimental condition, the subjects were exposed to a combination of the contingencies for the CSB and RGB groups as described above. Subjects in the CSB + RGB group had access to the Information to Facilitate Performance and also received differential

reinforcement (feedback about correctness) after each one of the protocols described above. Similarly to the other experimental groups, these contingencies were implemented only during the second and third training sessions.

Table 1

Results of the Pilot Study

	Series				Percentage Correct	
Subject	A	B	C	D	% (A + B)	% (C + D)
1	7	2	10	8	35	69
2	10	6	9	11	62	77
3	10	11	11	9	81	77
4	6	7	8	9	50	65
5	10	10	10	9	77	73
6	9	9	9	11	69	77
7	9	10	9	11	73	77
8	9	8	11	10	65	81
9	10	9	11	9	73	77
10	9	9	13	10	69	88
Total	89	81	101	97	Ave.=65.4%	Ave.=76.2%

Control Group

These subjects received the Modified Raven Test under standard testing conditions, which means that they did not receive feedback about the correctness of their responses nor a set of rules to

facilitate their responding.

Procedure

The 45 subjects were matched according to their scores on the Pretest. In other words, they were rank ordered from the highest to the lowest Pretest score. Then, the subject with the highest score was assigned to the first group, the second highest to the second group. This procedure continued following the same order until all the subjects were assigned to one of the groups. Once the groups were formed, the experimental and control conditions were randomly assigned to the groups resulting in three groups of 11 subjects and one group of 12 subjects.

General Procedure

After being informed about the purpose of the experiment and reviewing and signing the Informed Consent all subjects received some common information regardless of group assignment.

At the beginning of the first session, all the subjects received written instructions about how to take the test (see Appendix F). These instructions are distinctly different from the Information to Facilitate Performance in that it included no information on problem-solving strategies but simply generic instructions as to how the test items functioned. These instructions were available for the subjects throughout the four sessions.

During all the sessions, the subjects received a test booklet, an answer sheet (see Appendix I) on which they recorded their

responses, and a pencil without an eraser. At the beginning of each assessment session, all subjects were told to answer the questions to the best of their ability and that there were no time limits on the assessment. Subjects were allowed to ask procedural questions prior to the test administration. Questions were not allowed during the test administration.

The subjects received a lottery ticket for each five correct answers obtained during the four sessions. Three prizes were used as establishing operations (EO) (Michael, 1982) to increase the probability of getting the best performance possible out of the subjects. The first prize was $50. There were two second prizes of $20 and a third prize of $10. Subjects were also informed that their participation provided the opportunity to learn complex problem-solving skills that could generalize to other academic and intellectual assessments.

Pretest

This was the only session in which all the subjects worked together in the same auditorium. During this session the subjects answered the Pretest under standard conditions (no feedback or instructions to facilitate performance).

Training Sessions 1 and 2

During these sessions the subjects answered the Series A, B, C, and D of the Modified Raven Test according to the contingencies explained above for each of the experimental groups.

Generalization

Generalization was assessed at the end of Training Session 2. During this assessment, all the subjects answered the Generalization Series, Series E of the Modified Raven Test, under standard conditions.

Posttest

In this session the subjects answered Series A, B, C, and D of the Modified Raven Test under the same conditions as the Pretest (i.e., no feedback on accuracy of answers and no instructions or rule sheets available).

Testing for Self-Rules

Because subjects in any of the four experimental groups could have generated their own rules regarding problem-solving strategies (Catania et al., 1989; Hayes et al., 1986; Shimoff et al., 1986), after the final assessment session (posttest) all the subjects were asked to describe how they solved a sample (the last problem of Series A, B, C, and D) of problems from the Modified Raven Test. The extent to which subjects generated their own solution "rules" and the accuracy of those rules was assessed in this way. In addition, they were asked for information about the way in which they used either the feedback, the strategies or both (see Appendix H for a complete version of such questionnaires).

Experimental Design

The experimental design was a between-subject design with repeated measures. Table 2 graphically illustrates the design, which represents the conditions of the third session. The first session was used for the pretest, the second only for training, the third for training and assessment of generalization, and finally, the fourth session for the assessment of maintenance.

Table 2

Experimental Design of Third Session

Group	Series A	Series B	Series C	Series D	Series E
I	Control	Control	Control	Control	TEST
II	C.S.B.	C.S.B.	C.S.B.	C.S.B.	TEST
III	R.G.B.	R.G.B.	R.G.B.	R.G.B.	TEST
IV	CSB + RGB	CSB + RGB	CSB + RGB	CSB + RGB	TEST

Data Analysis

The data were analyzed, both visually and statistically. First, group averages of the number of items correct was calculated for each series within each of the four experimental sessions. These data were graphically displayed to address questions about speed of acquisition, generalization, and maintenance.

Second, the group averages on each of the series were statistically analyzed using ANOVA TESTS. The Statistical Analysis Software, SAS System, Release 6.06 program (SAS Institute, Inc., 1989) and The

Student Edition of Minitab, Release 1.1 (Minitab Ink Contributors, 1989) were used to perform the statistical analysis.

RESULTS

Three dependent variables were studied in this research: speed of acquisition of complex solving problem skills as indicated by the increases in the number of correct answers within each series of the Modified Raven Test, generalization, and maintenance of those skills.

Speed of Acquisition

The results indicate that there is no significant difference among the contingency-shaped behavior, rule-governed behavior, control, and the contingency-shaped plus rule-governed behavior groups in terms of the speed of acquisition of the complex solving skills that are necessary to solve the problems of the Modified Raven Test. Figure 1 presents the average scores of correct answers per series and sessions across the four groups. Within each series of problems, most groups obtained gains in accuracy from session to session. These accuracy increments ranged from 9.18 correct answers in Training 1 to 11.73 correct answers in Posttest. When subjected to an ANOVA, the magnitude of gains from session to session did not achieve statistical significance (alpha = 0.05) for any of the four experimental groups (see Tables 5 to 12, pages 30-33).

One potential explanation for the lack of significant differences in speed of acquisition among groups is the existence of ceiling effects in the experiment as evidenced by high scores in the

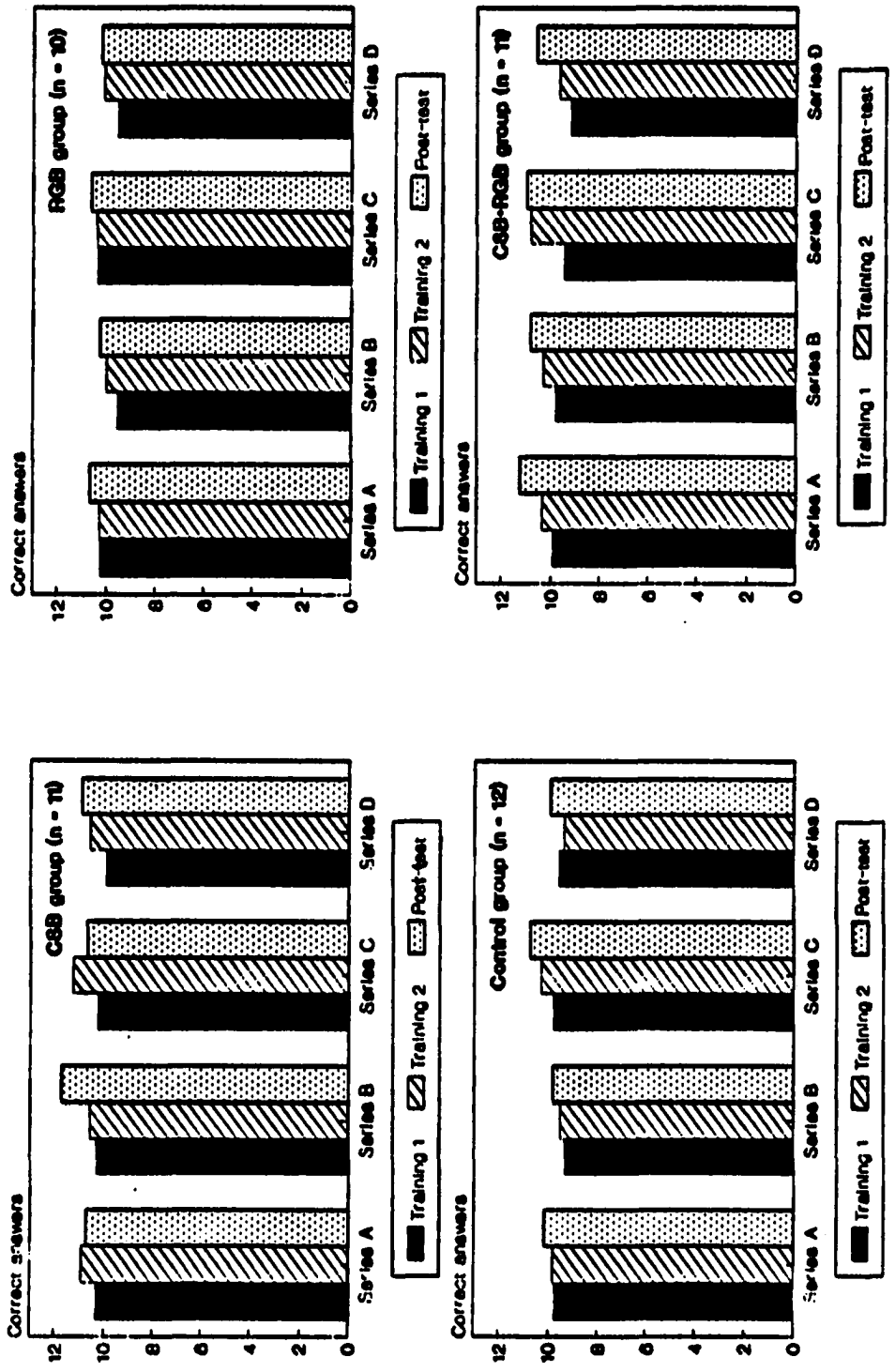

Figure 1. Performance Accuracy Per Group. Average Number of Correct Answers Per Series.

Pretest data displayed in Figures 3 and 4. To assess the viability of this explanation, those subjects obtaining high scores, 29 or 30 correct answers out of 30 problems contained in the Pretest, were eliminated from a second analysis. This resulted in group sizes of 6, 6, 7, and 7, for the CSB, RGB, the Control, and the CSB + RGB groups respectively. Figure 2 presents the average scores of correct answers per series and sessions among the four groups excluding the high prettest subjects. The overall group averages declined only slightly from the analysis that included subjects who performed at or near maximum levels on the Pretest. Again, most of the groups obtained gains from session to session but these improvements were not statistically significant with alpha = 0.05.

Between Group Comparisons

An indirect indicator of speed of acquisition is the comparability of performance across groups at each of the various assessments. To the extent that all groups started with equivalent Pretest measures and group differences subsequently emerge in later assessments, then the author would assume that the group differences were a result of differential speed of acquisition associated with each group. Figure 3 presents the overall scores across groups and sessions and Figure 4 presents the same data excluding the high pretest subjects. The group performances during the Pretest were almost identical because the groups were matched according to the obtained scores in this session. Surprisingly, the CSB group obtained the highest average score during Training 1, followed by the RGB group.

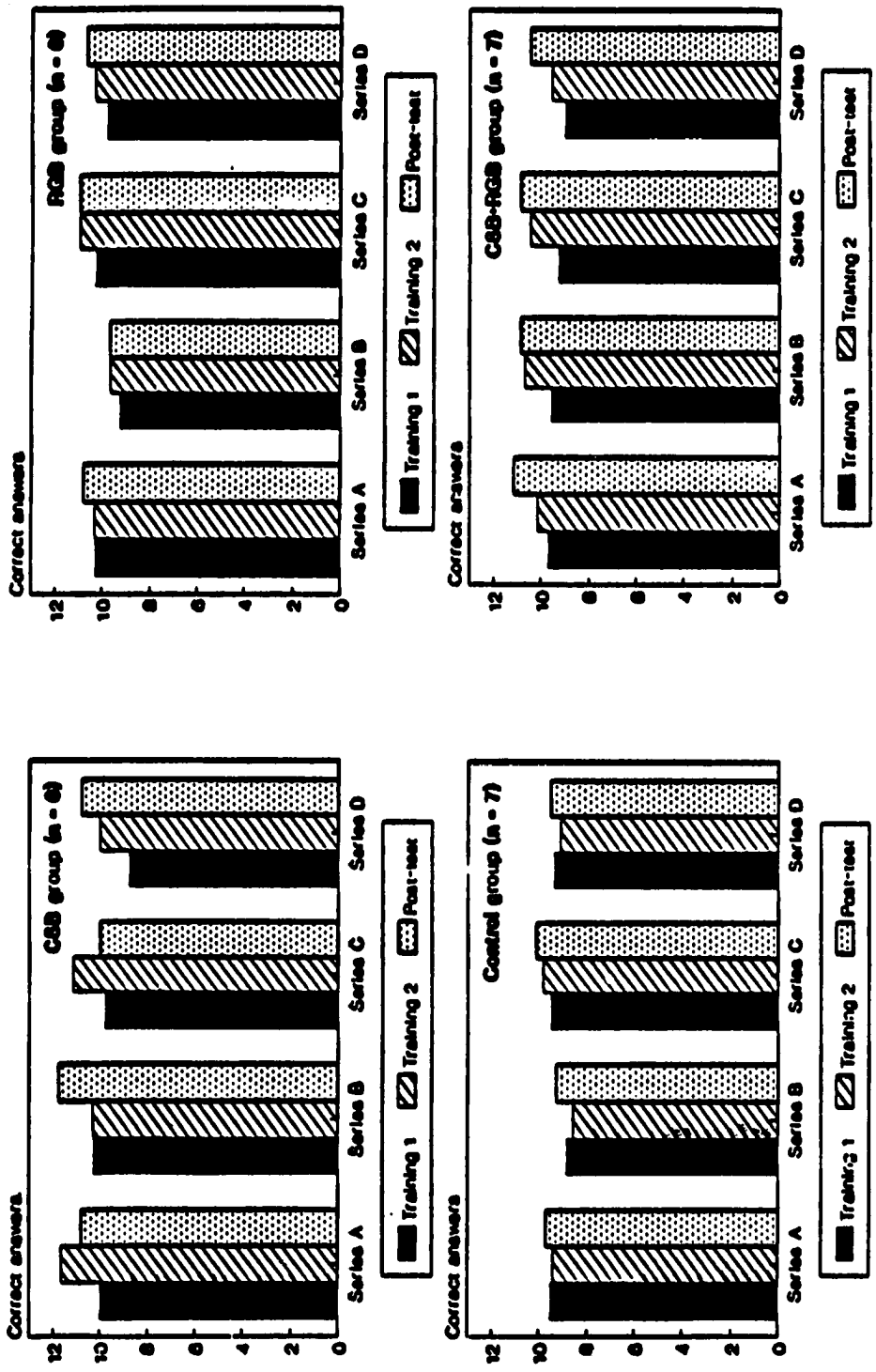

Figure 2. Performance Accuracy Per Group Excluding High Pretest Subjects. Average Number of Correct Answers Per Session.

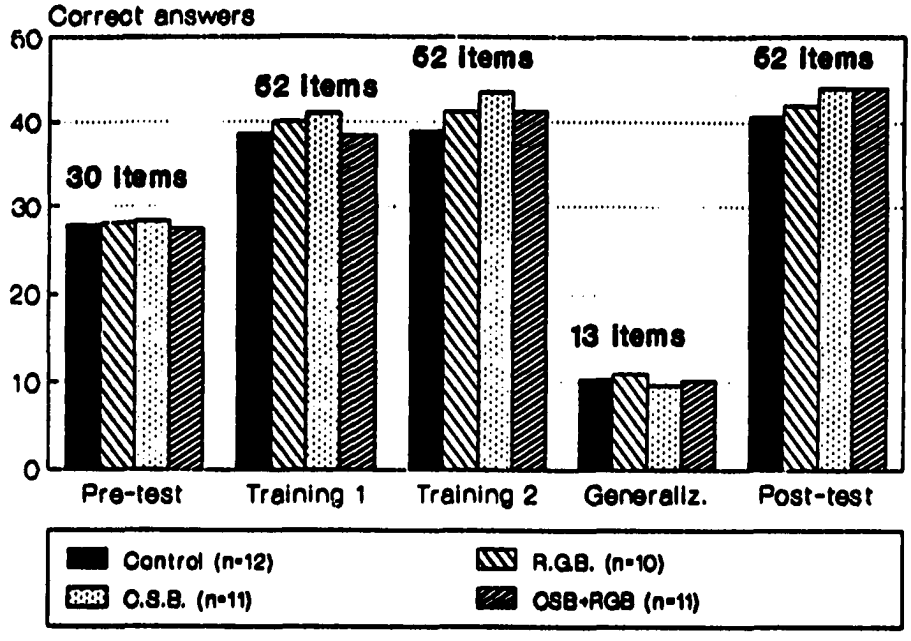

Figure 3. Overall Performance Accuracy Per Group. Average Number of Correct Answers Across Sessions.

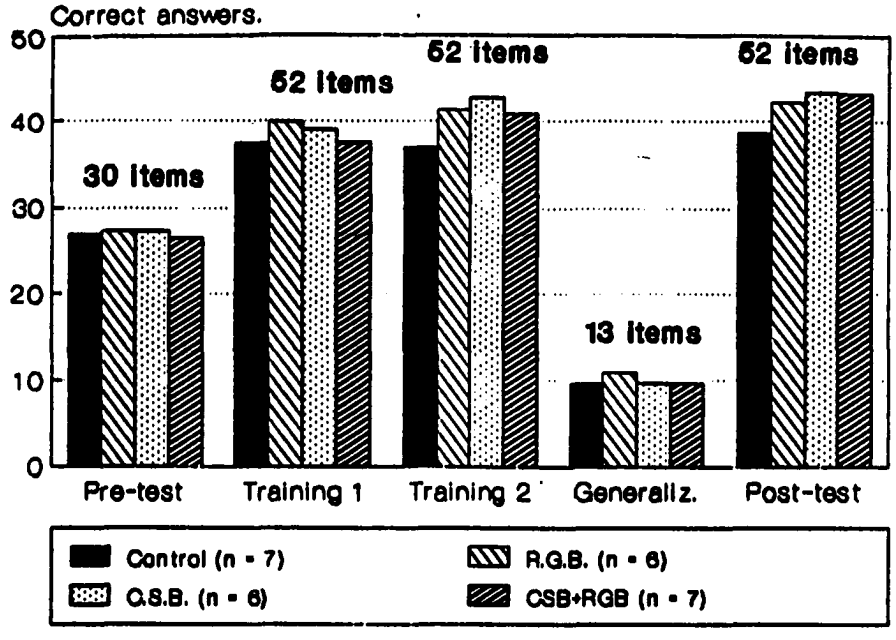

Figure 4. Overall Performance Accuracy Per Group Excluding High Pretest Subjects. Average Number of Correct Answers Across Sessions.

In Training 2, all the experimental groups obtained higher scores than the Control group, with the CSB group having the highest average score. Finally, in the Posttest in which the maintenance of behavior was assessed, all the experimental groups obtained higher scores than the Control group. None of the between-group differences at any of the Training, Generalization, and Posttest measures obtained statistical significance. The lack of statistical significance continued even when the high performing subjects (on the Pretest) were excluded from the analysis. These results and the corresponding statistical analysis are summarized in Tables 3 and 4. Table 3 presents the analysis for all subjects whereas Table 4 presents the results excluding the high Pretest subjects.

Table 3

Results of the Analysis of Variance for Overall Scores Across Sessions and Groups

	Group Average					
Session	CSB	RGB	Control	CSB + RGB	*F*	*Pr* > *F*
Pretest	28.27	28.10	27.83	27.45	0.50	0.686
Training 1	40.91	39.90	38.50	38.36	0.52	0.674
Training 2	43.36	41.10	38.92	41.09	1.54	0.219
Generalization	9.55	10.90	10.33	10.09	2.24	0.098
Posttest	44.00	41.80	40.70	43.64	1.31	0.284

Table 4

Results of the Analysis of Variance for Overall Scores Excluding High Pretest Subjects

	Group Average					
Session	CSB	RGB	Control	CSB + RGB	F	Pr > F
Pretest	27.33	27.33	27.86	26.43	0.53	0.664
Training 1	39.00	39.83	37.43	37.57	0.31	0.815
Training 2	42.67	41.33	37.00	40.86	1.50	0.242
Generalization	9.67	10.83	9.71	9.71	1.06	0.386
Posttest	43.33	42.17	38.71	43.29	1.51	0.240

Data in Tables 5 through 12 show the results of the ANOVA test for Series A through D across groups. Each table presents the average scores for each one of the groups, the magnitude of the F value and its level of significance. As it can be seen in the tables, there was only one statistically significant between group differences, this occurring on the Posttest for Series B where the CSB group was substantially higher than the other groups. In this particular session the CSB group had the biggest improvement with an average of 11.73 correct answers for the complete groups and 11.67 for the reduced group. The smallest improvement in this session was in the Control group which obtained an average score of 9.83 for the complete group and 9.29 for the reduced group. In both the complete and the reduced groups, the CSB + RGB group obtained a bigger average than the RGB group which was in the middle following the CSB group.

Table 5

Results of the Analysis of Variance for Series A

	Group Average					
Session	CSB	RGB	Control	CSB + RGB	F	Pr > F
Pretest	6.00	6.00	5.92	5.91	0.61	0.613
Training 1	10.36	10.30	9.75	9.91	0.49	0.693
Training 2	10.91	10.30	9.83	10.36	0.90	0.452
Posttest	10.73	10.70	10.17	11.27	1.00	0.405

Table 6

Results of the Analysis of Variance for Series A, Excluding High Pretest Subjects

	Group Average					
Session	CSB	RGB	Control	CSB + RGB	F	Pr > F
Pretest	6.00	6.00	5.86	5.86	0.56	0.644
Training 1	10.00	10.33	9.57	9.71	0.28	0.837
Training 2	11.17	10.33	9.43	10.14	1.09	0.376
Posttest	10.83	10.83	9.71	11.14	1.00	0.410

Table 7

Results of the Analysis of Variance for Series B

	Group Average					
Session	CSB	RGB	Control	CSB + RGB	F	Pr > F
Pretest	6.00	6.00	5.83	5.91	1.14	0.346
Training 1	10.36	9.60	9.33	9.82	1.32	0.280
Training 2	10.55	10.00	9.50	10.27	0.92	0.440
Posttest	11.73	10.30	9.83	10.82	3.64	0.021*

*$p < 0.05$

Table 8

Results of the Analysis of Variance for Series B, Excluding the High Pretest Subjects

	Group Average					
Session	CSB	RGB	Control	CSB + RGB	F	Pr > F
Pretest	6.00	6.00	5.71	5.86	1.18	0.340
Training 1	10.33	9.33	8.86	9.58	1.51	0.239
Training 2	10.33	9.67	8.57	10.71	2.80	0.064
Posttest	11.67	9.67	9.29	10.86	3.06	0.049*

*$p < 0.05$

Table 9

Results of the Analysis of Variance for Series C

Session	Group Average				F	Pr > F
	CSB	RGB	Control	CSB + RGB		
Pretest	5.91	5.80	5.67	5.55	0.92	0.438
Training 1	10.27	10.40	9.83	9.45	0.47	0.706
Training 2	11.27	10.70	10.25	10.82	0.92	0.440
Posttest	10.64	10.60	10.75	11.00	0.14	0.938

Table 10

Results of the Analysis of Variance for Series C, Excluding the High Pretest Subjects

Session	Group Average				F	Pr > F
	CSB	RGB	Control	CSB + RGB		
Pretest	5.83	5.67	5.43	5.29	0.91	0.453
Training 1	9.83	10.33	9.57	9.28	0.34	0.794
Training 2	11.17	11.00	9.86	10.43	1.12	0.362
Posttest	10.00	11.00	10.14	10.86	0.77	0.524

Table 11

Results of the Analysis of Variance for Series D

	Group Average					
Session	CSB	RGB	Control	CSB + RGB	F	Pr > F
Pretest	5.45	5.50	5.50	5.64	0.18	0.906
Training 1	9.91	9.60	9.58	9.18	0.27	0.848
Training 2	10.64	10.10	9.33	9.64	1.43	0.249
Posttest	10.91	10.20	9.92	10.55	0.80	0.499

Table 12

Results of the Analysis of Variance for Series D, Excluding the High Pretest Subjects

	Group Average					
Session	CSB	RGB	Control	CSB + RGB	F	Pr > F
Pretest	5.00	5.17	5.29	5.27	1.05	0.391
Training 1	8.83	9.83	9.43	9.00	0.55	0.650
Training 2	10.00	10.33	9.14	9.57	0.77	0.525
Posttest	10.83	10.67	9.57	10.43	1.11	0.367

Within Group Comparisons

Data displayed in Tables 13 and 14 show within-group comparisons across sessions. Table 13 presents the data for all the subjects whereas Table 14 presents the data excluding the high Pretest

subjects. As can be seen, all the groups obtained improvements in their overall average scores from session to session. The biggest improvement was obtained by the CSB + RGB group that went from an average of 38.36 in Training 1 to 43.64 in the Posttest. However, these differences in performance across sessions were statistically significant only for the Control and the CSB + RGB groups with alpha = 0.05 and alpha = 0.01, respectively. When the high Pretest subjects were excluded from the statistical analysis (ANOVA), the results were significant only for the CSB + RGB group (alpha = 0.05).

Table 13

Results of the Analysis of Variance for Overall Scores Per Groups Across Sessions

	Session Average				
Group	Training 1	Training 2	Posttest	*F*	*Pr* > *F*
CSB	40.92	43.36	44.00	2.86	0.081
RGB	39.90	41.10	41.80	1.67	0.216
Control	38.25	39.08	40.67	4.27	0.027*
CSB + RGB	38.36	41.09	43.64	7.11	0.005+

*$p < 0.05$
+$p < 0.01$

Table 14

Results of the Analysis of Variance for Overall Scores Per Groups Across Sessions Excluding the High Pretest Subjects

	Session Average				
Group	Training 1	Training 2	Posttest	F	Pr > F
CSB	39.00	42.67	43.33	2.09	0.174
RGB	39.83	41.33	42.17	1.03	0.391
Control	37.00	37.29	38.71	1.76	0.213
CSB + RGB	37.57	40.86	43.29	4.31	0.039*

*$p < 0.05$

Generalization

Generalization of the complex problem-solving skills to novel problems was assessed by performance of all groups on the 13 items in Series E of the Modified Raven Test. This assessment occurred after all subjects had completed the second training session. Group averages are presented in Figure 5 and in Table 15. These results reveal that the RGB group performed at higher levels on the generalization test followed by the Control, CSB + RGB and the CSB groups in that order. Statistical analysis revealed no significant differences between the performance of these four groups on the generalization test. The nature of the results (or lack thereof) did not change when the subjects performing high on the Pretest were excluded from the analysis.

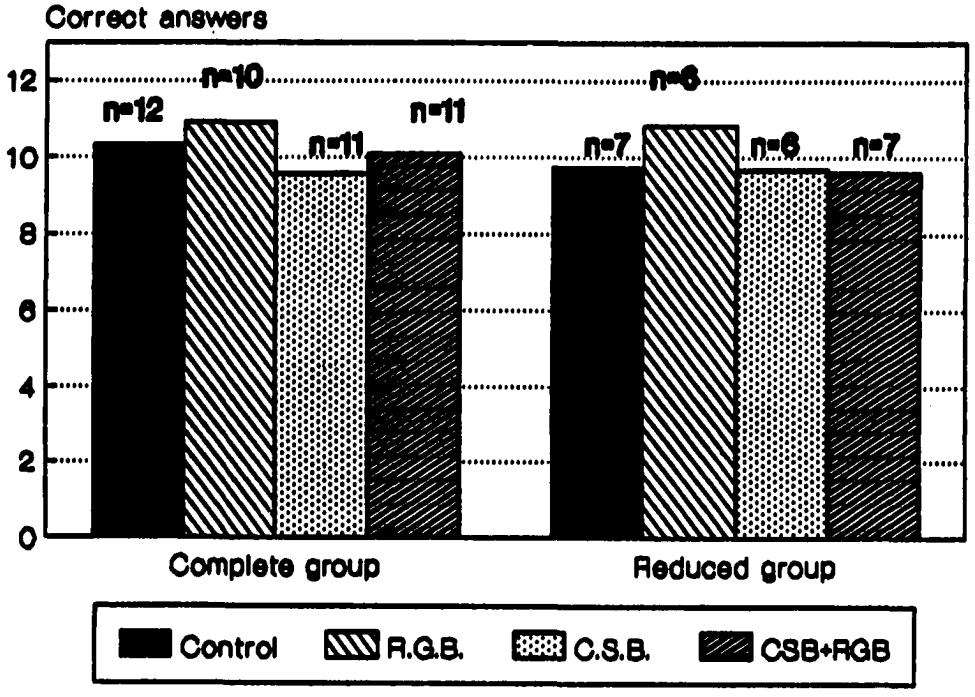

Figure 5. Performance Accuracy on the Generalization Series (E) for Both the Complete Groups and the Groups Excluding the High Pretest Subjects (Reduced Groups). Average Number of Correct Answers per Group.

Table 15

Results of the Analysis of Variance for the Generalization Series (E) for Both Complete and Reduced Groups

	Group Average					
Condition	CSB	RGB	Control	CSB + RGB	F	Pr > F
Compl. Group	9.55	10.90	10.33	10.09	2.24	0.098
Reduc. Group	9.67	10.83	9.71	9.57	1.22	0.326

Maintenance of Behavior

To assess the level of maintenance, the average score of each series in the two training sessions was compared with its average score in the Posttest for each one of the groups. Comparison of the levels of performance across the groups is displayed in Figures 6 and 7. Figure 6 presents the data for all the subjects whereas Figure 7 presents the results excluding the high performing subjects in the Pretest. These results showed consistent improvements in performance between the average of the two training tessions and the subsequent Posttest performance for all the groups. However, comparison of performance levels between groups using an ANOVA revealed no significant differences between the four groups in terms of their performance in the Maintenance assessment (see Tables 3 and 4).

Self-Generated Rule Statement

Because subjects of this experiment were college students capable of generating their own rules (contingency-specifying stimuli) regarding the solution strategies for the problems, each subject was asked to provide a written explanation of the rationale for their answer to the final problem of Series A through E of the Modified Raven Test at the conclusion of the experiment (see the different questionnaires in Appendix H). This set of problems was selected because the final problem is considered to be the most difficult of each series. As described in the Methods section, their written rationales were classified by two independent observers as "appropriate," "inappropriate," "guess" or "no response" based on Figure 6

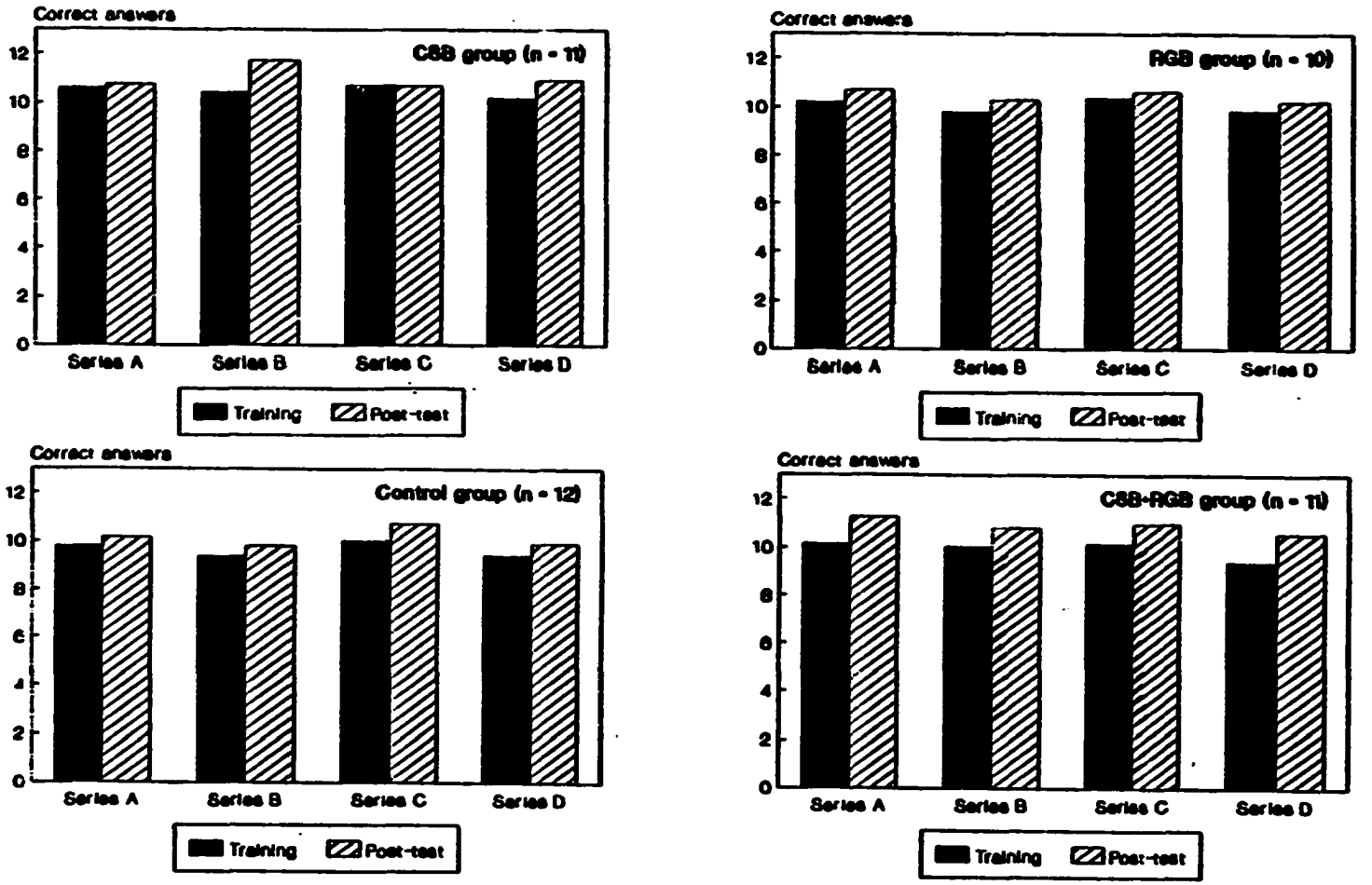

Figure 6. Average Performance Accuracy for Training and Posttest Across Groups and Series.

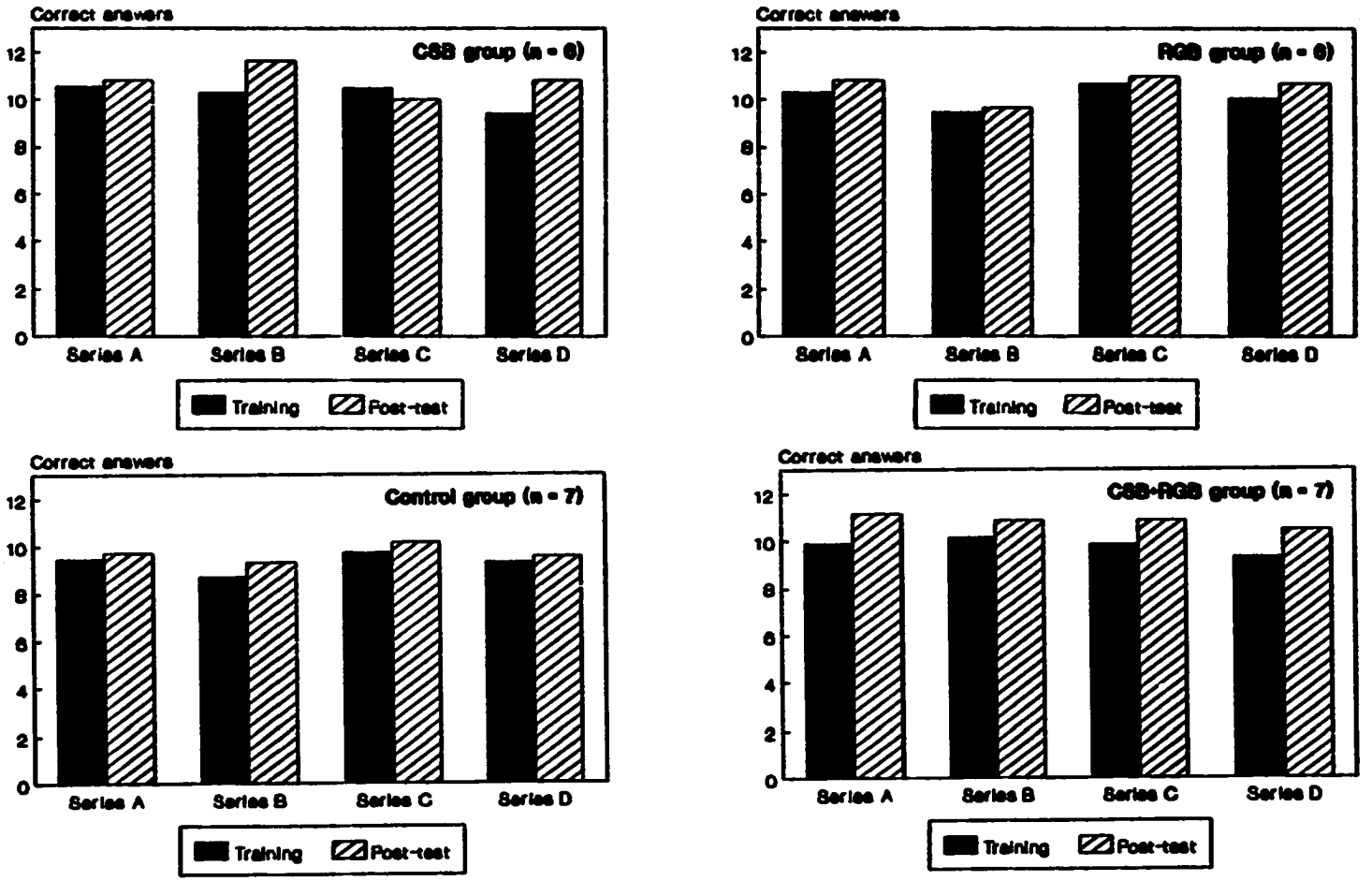

Figure 7. Average Performance Accuracy for Training and Posttest Across Groups and Series Excluding the High Pretest Subjects.

correspondence with the correct solution strategy for each of these problems and their self reports (i.e., "I guessed"). Interobserver agreement scores for the independent classification of these reports was 87.49% with a range of 83.33% to 93.33%. The results of this analysis are presented in Figure 8 and in Tables 16 through 19.

As can be seen in Figure 8, the experimental groups obtained more correct answers than the control group on this set of problems with the RGB group scoring highest (64%), followed by the CSB group (63.64%) and the CSB + RGB group (56.37%). The control group, on the other hand, obtained only 46.67% of correct answers. In spite of the relatively poor performance accuracy of the control group, this group attained the highest accuracy with respect to their written explanation of the rules by which each problem could be solved (49.99% correct rules). Ironically, the accuracy of their rule derivation exceeded the accuracy of their answers. The RGB group correctly identified rules for 44% of the problems whereas the CSB + RGB group obtained 41.81% and the CSB group obtained 25.45%.

Evaluation of the Experimental Contingencies

A set of questions regarding the integrity of the experimental contingencies was also included in the questionnaire that all the subjects answered at the end of the experiment. There were four different questionnaires, one for each group reflecting the variations of the experimental contingencies (see Appendix H). The data from these questionnaires are summarized below for each one of the groups.

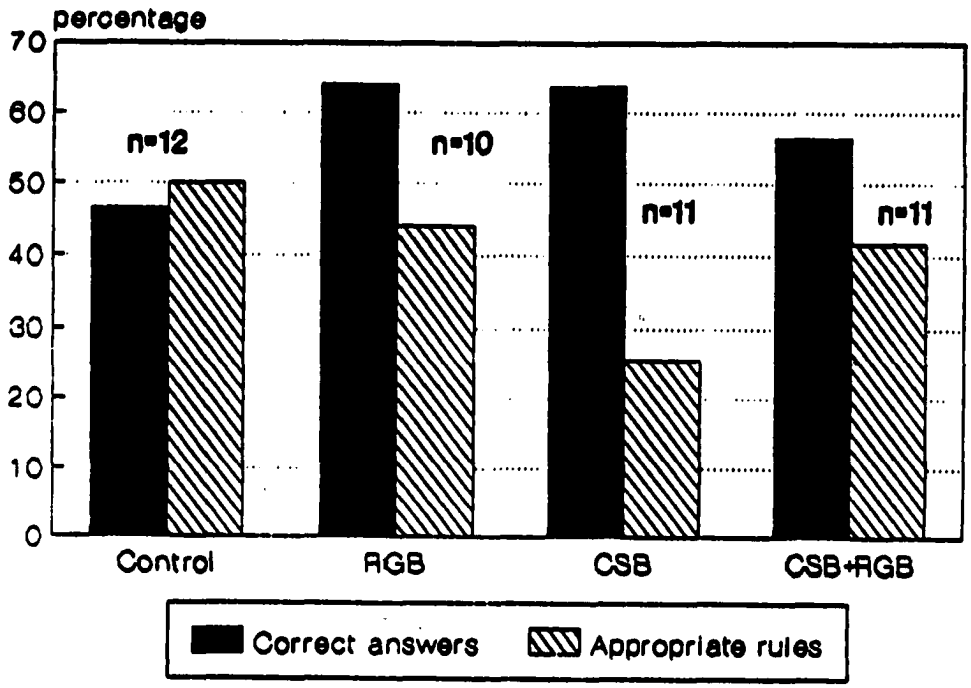

Figure 8. Pattern of Responding to the Last Problems of Each Series of the Raven Modified Test. Percentage of Correct Answers and Appropriate Rules Across Groups.

Contingency-Shaped Behavior Group

According to reports of the subjects in the CSB group, the feedback about the accuracy of their answers was not utilized consistently. For example, only 45.45% of the subjects in this group reported that they "always" utilized the feedback, 18.18% reported that they "usually" did it, 18.18% reported that they did it "sometimes," and finally, 18.18% gave no answer. In relation to the understanding of their mistakes, 36.36% reported that they "always" tried to understand why their answer was wrong after they had received the feedback about the correctness of their answers; 18.18%

reported that they "usually" tried to understand their mistakes, 18.18% "sometimes," 9.09% "rarely," and 18.18% gave no answer.

Other variables included in this questionnaire were: how helpful the feedback was, their preference for the use of feedback and if they wish to have received instructions to facilitate their performance in the test. Of the subjects, 18.18% reported that the feedback was very helpful; 36.36% gave 4 of 5 points in a Likert-like scale to indicate how helpful was the feedback; 18.18% gave 3 of 5 points, 9.09% gave 2 of 5 points, and 18.18% gave no answer. Finally, 54.54% reported that they wished to have instructions to facilitate their performance during the experiment, 18.18% said that they did not wish to have received instructions and 27.27% gave no response.

Table 16

Pattern of Responding for Subjects in the Contingency-Shaped Group

	Type of Answer		Classification of Answers			
Item	Right	Wrong	App. Rule	Inapp. Rule	Guess	No Response
A 13	7	4	1	5	3	2
B 13	8	3	4	3	2	2
C 13	8	3	5	1	3	2
D 13	7	4	2	4	3	2
E 13	5	6	2	5	2	2
X %	63.64	54.55	25.45	32.72	23.63	18.68

$\underline{n}$ = 11
Interobserver agreement: 28/30 = 93.33%

Table 17

Pattern of Responding for Subjects in the Rule-Governed Behavior

	Type of Answer		Classification of Answers			
Item	Right	Wrong	App. Rule	Inapp. Rule	Guess	No Response
A 13	8	2	6	1	3	0
B 13	6	4	4	3	3	0
C 13	4	6	3	3	4	0
D 13	6	4	4	3	3	0
E 13	8	2	5	4	1	0
X %	64	36	44	28	28	0

n = 10
Interobserver agreement: 25/30 = 83.33%

Rule-Governed Behavior Group

A similar analysis of the pattern of responding of the RGB group indicates that 100% of the subjects reported that they understood the set of instructions that they received to facilitate their performance in the test. In relation to the utilization of these instructions, 10% reported that they "always" used the instructions during the experiment, 50% reported that they "usually" utilized them, and 40% said that they "sometimes" used them. Twenty percent of the subjects considered that the instructions were very helpful during the test (5 out of 5 points in a Likert-like scale), 30% gave 4 of 5 points in this scale, 30% said that they would have preferred not to

use them, and 40% reported no preference at all. Finally, 100% of the subjects in this group reported that they would have preferred to receive feedback about the correctness of their answers during the experiment.

Table 18

Pattern of Responding for Subjects in the Control Group

	Type of Answer		Classification of Answers			
Item	Right	Wrong	App. Rule	Inapp. Rule	Guess	No Response
A 13	6	6	9	2	0	1
B 13	3	9	2	8	2	0
C 13	8	4	7	2	3	0
D 13	6	6	7	1	4	0
E 13	5	7	5	5	2	0
X %	46.67	58.33	49.99	29.99	18.33	1.67

n = 12
Interobserver agreement: 26/30 = 86.66%

Control Group

The results of the control group indicate that 33.33% of the subjects reported that the simple repetition of the test during the experiment was helpful, 41.67% said that the repetition was not helpful, and 25% reported a neutral opinion. In addition, 83.33% of the subjects in this group reported that they would have preferred to receive instructions to facilitate their performance during the test,

and only 16.67% did not express such a preference. Finally, 91.67% reported that they would have preferred to receive feedback about the correctness of their answers during the experiment, and only 8.33% reported no wish to have received the feedback.

Table 19

Pattern of Responding for Subjects in the CSB and RGB Group

	Type of Answer		Classification of Answers			
Item	Right	Wrong	App. Rule	Inapp. Rule	Guess	No Response
A 13	6	5	6	2	3	0
B 13	7	4	3	5	3	0
C 13	7	4	6	2	3	0
D 13	7	4	5	3	3	0
E 13	4	7	3	5	3	0
X %	56.37	43.63	41.81	30.92	27.27	0

n = 11
Interobserver agreement: 26/30 = 86.66%

CSB + RGB Group

Finally, the results of the CSB + RGB group indicate that 45.44% of the subjects reported that they "always" utilized the feedback during the experiment, 27.27% said that they "usually" used the feedback, and 9.09% reported that they "sometimes" used it, 9.09% "rarely" use it and finally, 9.09% "never" used it. In relation to their understanding of the mistakes they made during the experiment,

45.45% reported that they "always" tried to understand why they were wrong, 36.36% said that they tried to "usually" understand their mistakes, 9.09% "sometimes" tried to understand their mistakes, and 9.09% "rarely" tried to do it. In addition, 36.36% reported that the feedback was very helpful (5 out of 5 points in a Likert-like scale), 36.36% gave 4 of 5 points in that scale, 18.18% gave 3 points in the scale, and 9.09% gave only 2 points in the scale. Interestingly enough, 90.90% of the subjects reported that they preferred to have feedback during the experiment, and only 9.09% did not report such preference.

Additional information reported by the subjects of the CSB + RGB group indicates that 100% of the subjects understood the instructions that they received to facilitate their performance during the test. Two of the subjects, 18.18%, reported that they "always" utilized those instructions during the experiment, 54.54% said that they "usually" used them, and 27.27 reported that they "rarely" used the instructions. In relation to how helpful the instructions were, 18.18% reported that they were very helpful, 45.45% gave 4 of 5 points in the Likert-like scale the assess this variable, 18.18% gave 3 of the 5 points, and 18.18% gave only 2 points in this scale. Finally, 81.82% of the subjects of this group reported that they preferred to receive the instructions during the experiment, and only 18.18% did not report such preference.

DISCUSSION

The results indicate that there were no significant differences between the contingency-shaped behavior group (CSB), the cule-governed behavior group (RGB), the control group and the contingency-shaped and rule-governed group (CSB + RGB) in any of the three dependent variables: speed of acquisition of complex skills that are required to adequately solve the problems of the Modified Raven Test, the generalization of those skills to novel problems of the same test, and the maintenance of those skills. This means that at least with the particular subjects and type of problems studied in this research, the training contingencies under which subjects operated were equally effective in developing the behavioral skills that are required to adequately solve the problems of the Modified Raven Test. In addition, the training contingencies did not differ with respect to generalization of the skills to novel stimuli of the Modified Raven Test (Series E). Finally, the training contingencies were also equally effective in maintaining the learned skills. These results are not consistent with the findings of Peterson (1980/1981), Ozuzu (1982), Danforth (1983), and Vaughan (1985) who found evidence that instructions facilitated learning using the repeated acquisition procedure with children, but that the subjects were not able to transfer the learning to new conditions. Moreover, the results contrast with Perez and Pereira (1987) who found evidence that

rule-governed behavior was more effective than contingency-shaped behavior in the development of conditional discriminations with children.

Skinner (1969) claimed that "Even fragmentary descriptions of contingencies speed the acquisition of effective terminal behavior, help to maintain the behavior over a period of time" (p. 143). As a result, my initial expectation was to verify that those subjects who were exposed to instructions (RGB group and CSB + RGB group) would learn the problem-solving skills faster than those who received the feedback about the correctness of their response to (CSB group) and those who received neither feedback nor rules (control group).

The discrepancy between the actual results of the research and the initial expectation of the researcher might be explained by the fact that the subjects were highly verbal college students. Therefore, it is safe to assume that all of them had a relatively long history of problem-solving behavior which might have facilitated the performance of those subjects who did not receive instructions (CSB group and the control group) while interfering with those who did receive those instructions (RGB group and CSB + RGB group). Interestingly enough, informal reports of the proctors who worked with the RGB, CSB, and the CSB + RGB groups indicated that some subjects were overly concerned (stressed) with matching their responses to either the strategies or to the feedback (or both) that they received during the training sessions. The proctors who worked with the control group did not report such concern and usually the subjects of this group finished before the subjects of the other groups. The above

assumption is at least partially supported by the finding that the subjects in the control group showed the highest percentage of appropriate rules to a set of problems drawn from the last problem of each of the series of the Modified Raven Test (see Figure 8).

In addition, the distinction between rule-governed behavior and contingency-shaped behavior is very difficult to establish with highly verbal subjects because they are able to generate self-rules or contingency-specifying stimuli (Catania et al., 1989) even during the first occurrence of a particular behavior. To this extent, it might well be the case that such a distinction can not be applied to highly verbal subjects who are exposed to complex stimulus discriminations in which they have to apply complex problem-solving skills which might be similar to those skills they apply to complex problems in their lives. Thus, the author might have generated few real differences between the groups in spite of the best efforts to do so.

A related explanation concerns a methodological limitation of the study. The integrity of the independent variable (Peterson, Homer, & Wonderlich, 1982) could not be assured during the research in spite of the certainty that the subjects did make contact with the different level of the independent variable. In other words, even though 100% of the subjects who received the set of instructions to facilitate performance reported that they understood them and that most of them checked the feedback according to the experimental design, there is no conclusive evidence that they did so. On the contrary, none of the groups that were exposed to the instructions obtained at least 50% of appropriate rules to the last problem of

each of the series of the Modified Raven Test.

As it is true for any single study, the results of this research are not conclusive. Nevertheless, the author obtained no evidence for any advantages of RGB over CSB or with respect to a control group. As a result, it is important to point out that we should be cautious whenever the comparison between rule-governed behavior and contingency-shaped behavior arises. It has been shown that the generality of some of the advantages (speed of acquisition, generalization, and maintenance of behavior) of RGB over CSB are not absolute and should be qualified in terms of the type of behaviors to which it is applied, especially when dealing with highly verbal subjects.

This study could be improved in several ways. For instance, the research could be replicated using individual sessions as opposed to group sessions which would increase the experimental control. In addition, the researcher could assess the subject's ability to apply each rule or strategy correctly to a set of problems prior to the training sessions. This would assure the integrity of the independent variable. Another improvement would be the utilization of the Wechsler Adult Intelligence Scale to assess the intellectual capacity of the subjects prior to the experiment and then use the assessment in a covariance analysis. In this way, the influence of intellectual capacity would be under statistical control. Finally, the period of time that it takes to answer the Modified Raven Test could be used as an additional dependent variable to determine if there are differential effects of the experimental conditions in terms of efficiency.

There are several potential areas for follow-up research. First

of all, a replication of the study could be conducted with younger subjects (i.e., junior high school students) in order to partially control the influence of prior history of problem-solving behavior. In addition, research should be conducted with a wide range of behavior (both verbal and nonverbal) and subjects, including highly verbal subjects, to determine whether there are any differences between rule-governed behavior and contingency-shaped behavior and the conditions under which such differences occur. In particular, research would have to be developed to determine under what conditions RGB is actually more effective than CSB in terms of speed of acquisition, generalization and maintenance of behavior. It will be interesting to develop parametric studies to assess the extent to which both RGB and CSB are able to maintain behavioral changes through time. For instance, what would happen if the subjects are taught a specific skill and then they are assessed 1, 2, and 3 weeks/months after without any practice in between? Would RGB be more effective than CSB? Finally, it would be interesting to see if there are significant differences between different types of instructions such as oral/written instructions versus modeling of behavior (Poling, Schlinger, Starin, & Blakely, 1990).

APPENDICES

Appendix A

Letter of Approval From HSIRB

Human Subjects Institutional Review Board

Kalamazoo, Michigan 49008-3899

WESTERN MICHIGAN UNIVERSITY

Date: January 22, 1992

To: Ronald Ramirez-Henderson

From: Mary Anne Bunda, Chair Mary Anne Bunda

Re: HSIRB Project Number 91-11-11

This letter will serve as confirmation that your research protocol, "Contingensy-shaped behavior and rule governed behavior; a comparison in terms of speed of acquisition, generalization and maintenance" has been approved after expedited review by a subcommittee of the HSIRB. The conditions and duration of this approval are specified in the Policies of Western Michigan University. You may now begin to implement the research as described in the approval application.

You must seek reapproval for any change in this design. You must also seek reapproval if the project extends beyond the termination date.

The Board wishes you success in the pursuit of your research goals.

xc: Fuqua, Psychology

Approval Termination: January 22, 1993

Appendix B

Informed Consent

INFORMED CONSENT.

Description of the Project and your Involvement.

This experiment has been design to compare the effectiveness of three different strategies to facilitate the acquisition, generalization and maintenance of complex problem solving skills or abstract thinking. It is conducted by Ronald Ramirez-Henderson as a partial requirement for his Ph.D. in Clinical Psychology.

You will be asked to solve a series of non-verbal problems. Some of the participants will be given one of three different types of training on these tasks prior of a retest to your problem solving skills. Some of the participants will receive no additional training but will nevertheless repeat their performance of the problem solving test.

This research involves neither physical nor psychological risk since the instruments that will be used are not invasive and the procedure represents minimal stress. There will be only four sessions of work, each one of them lasting approximately one hour. There is going to be either two or three days between sessions. After the four sessions, there will be a lottery which will include four cash prizes. First prize will be $50. Two second prizes, of $20 will be awarded and the third prize will be $10.

For those who complete all four sessions of this experiment, you will receive one ticket for entry into the lottery drawing for every five correct answers during each of the sessions. If you withdraw from the experiment prior to the completion of all four sessions, you forfeit your eligibility for the lottery.

Any information obtained in this study will be confidential. The data will be stored in a locked file cabinet accessible only by the researcher and his academic advisor, Dr. Wayne Fuqua. Furthermore, you will be given a unique code so that your name can not be attached to performance on the test without access to the code sheet. As is true for all dissertations, these results will be published. Results will be presented in such a manner that it is impossible to identify the individuals whose results are presented. After the research is finished, all the information that can be used to identify the subjects will be destroyed.

If you have any questions, please feel free to ask. You

are free to withdraw from this study at any time without affecting your relationship with Western Michigan University or the Psychology Department. Your participation will have no bearing on your Psy.100 Introduction to Psychology final grade.

Questions or complaints regarding this research or your rights may be directed to Dr. Wayne Fuqua at 387-4474. If the solution is unsatisfactory, you may contact Dr. Richard Tsegaye-Spates, Chairman of Psychology Department, at 387-4500.

We hope that you will find participating in the study exceedingly interesting and enjoyable.

YOUR CONSENT.

Please read and sign the following statement if you wish to participate in this experiment.

The project in which I am about to participate has been explain to me and all of my questions have been answered satisfactorily. I voluntarily agree to participate in this project. I understand that I can withdraw from the project at any time and that I can decline to participate in any of it or decline to answer any questions without prejudice to me.

Name (print)	Signature	Date	Time

Signature of Investigator	Date	Time

Appendix C

Copyright Authorization

Campbell Thomson & McLaughlin Limited Subsidiary: Peter Janson-Smith Limited
AUTHORS' AGENTS

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via FAX 616 375 7359

Mr Ronald Ramirez-Henderson,
1521 Ojibwa Trail,
Kalamazoo,
MI 49006,
USA.

13 March 1992

Dear Mr Ramirez-Henderson,

Thank you for your fax of 28th February.

I can now give you permission to use a modified form of the Raven Standard and Advanced Progressive Matrices to test not more than fifty subjects in connection with your dissertation subject to the following conditions:-

1) that each item must be used in your test exactly as it is originally printed in the current edition of the relevant test booklet.

2) that before your use of the Matrices a fee of $50 must be paid in US dollars into account number 4505020174510 at the Clydesdale Bank plc, 57 Queen Street, Glasgow G1 3ER, Scotland.

3) that a copy of your dissertation relating to your application of the Raven Progressive Matrices is, when it is available, sent to me for the copyright owners, and that you will allow publication of any relevant passages in the Manual to the Raven Progressive Matrices, subject to full acknowledgement being given.

4) that all rights in the Raven Progressive Matrices, other than those specifically granted in this letter are reserved by the copyright owners.

Separate author consent is not required.

I shall look forward to having confirmation of your acceptance of these terms, and to hearing that you have remitted the fee mentioned above.

Yours sincerely,

John McLaughlin

Appendix D

Organization of the "Modified Raven Test"

Table No. 20.

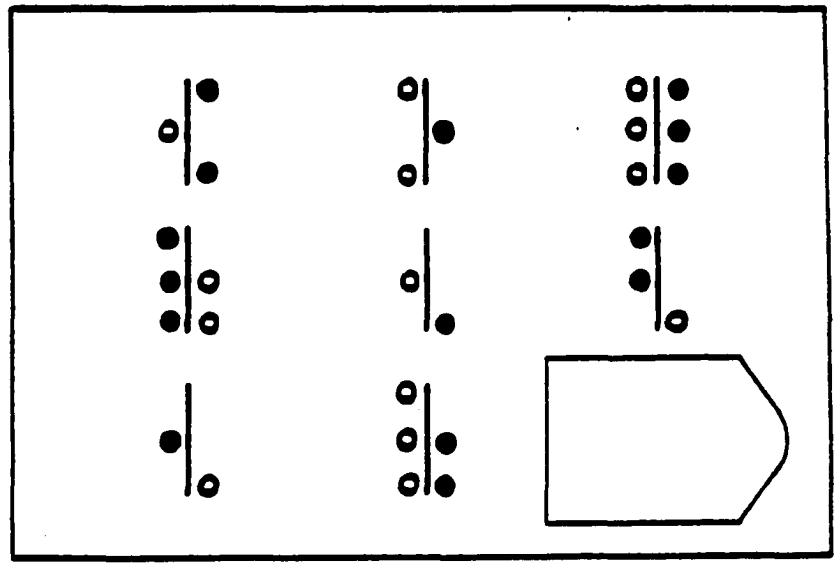
Organisation of the Modified Raven Test.

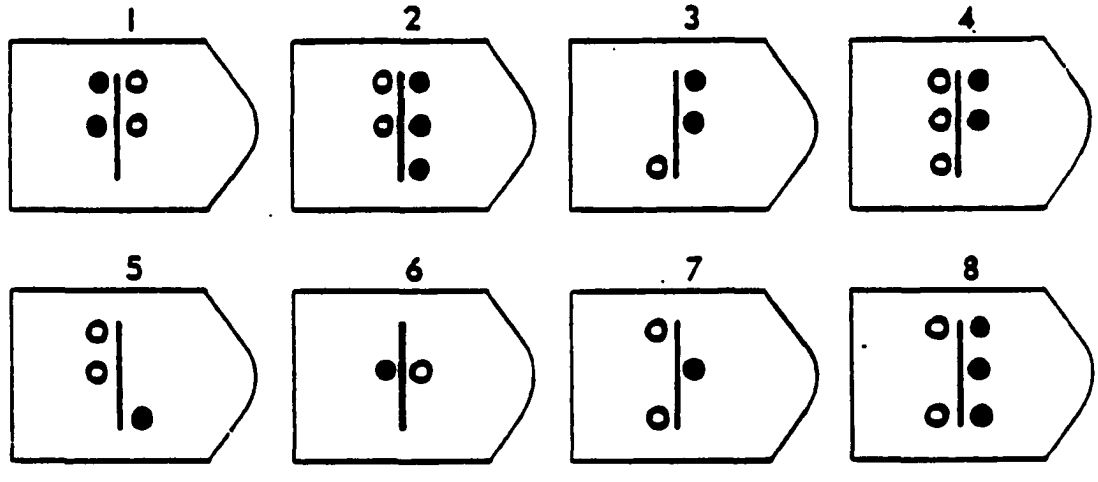
Item	A	B	C	D	E
1	A 2	A 4	A 6	A 8	A 10
2	B 8	B 6	B 4	B 2	A 12
3	B 10	B 12	C 2	C 4	C 6
4	D 4	D 2	C 12	C 10	C 8
5	D 6	D 8	D 10	D 12	E 2
6	E 12	E 10	E 8	E 6	E 4
7	1	2	3	4	5
8	10	9	8	7	6
9	11	12	13	14	15
10	20	19	18	17	16
11	21	22	23	24	25
12	30	29	28	27	26
13	31	32	33	34	35

Appendix E

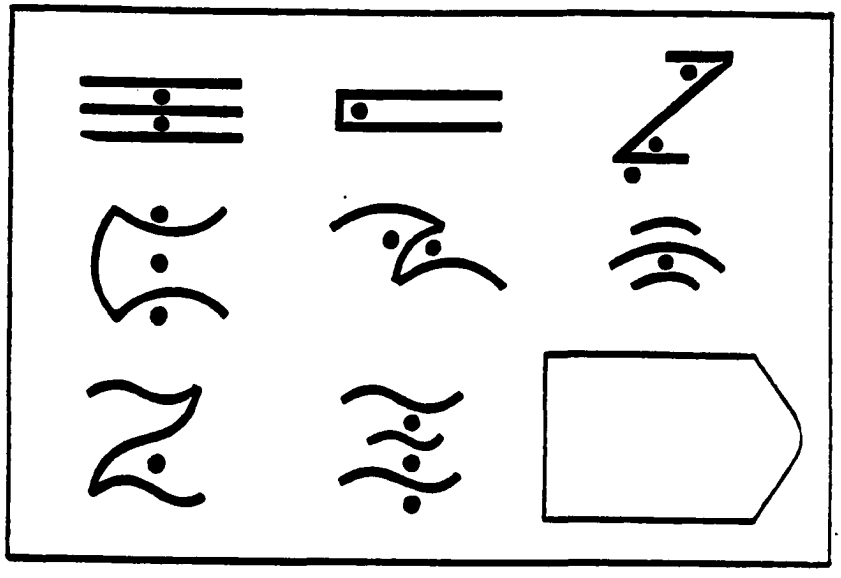
Sample of Raven Test Problems

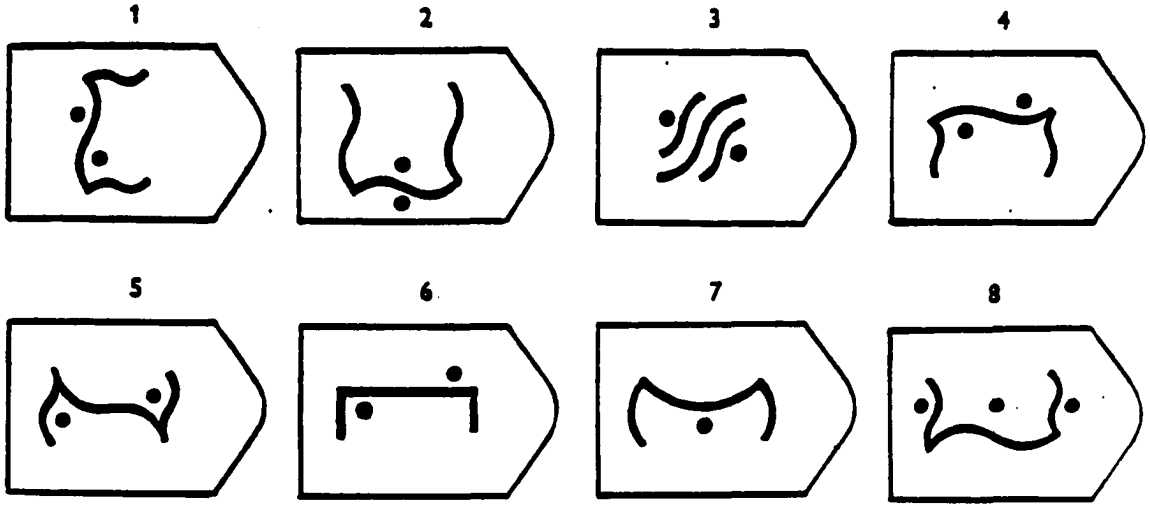
C13





D13





Appendix F

General Test Instructions

GENERAL INSTRUCTIONS

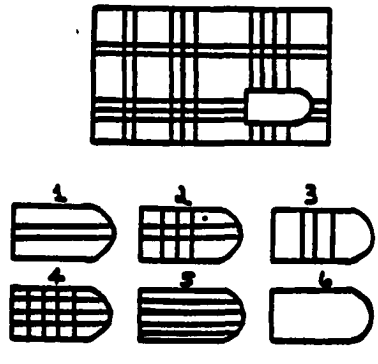
For this test you will be given an Answer Sheet, on which to write all your answers, and a Test Booklet. No marks are to be made in the Test Booklets.

Look at your Answer Sheet. Please, fill in the particulars at the top of the page. Remember, all your answers will be made on the answer sheet. Don't mark the Booklet in any way.

Put your answer sheet besides your book.

This is a test of observation and clear thinking in which you have to solve complex problems. At the top part of each problem, there is a pattern with a piece cut out of it. Look at the pattern, think what the missing piece must be like to complete the pattern correctly, both along and down, and then find the right alternative out of the six/eight pieces shown below. Only one of theses alternatives is perfectly correct. Once you have found the solution to a problem enter it against the number of the problem on your answer sheet. Once you have moved to a new problem, you are not allowed to go back to previous problems and change your answers.

By way of illustration, consider the following example. After reviewing the top pattern, you are to select the one piece from the six options that complete the pattern. If this were a problem in the test, you would record the number of you answer on the Answer Sheet.



If you selected piece # 4, you were right. The correct

answer is number 4. That is the only piece that follows the general pattern (along and down) of the matrix. It has four vertical lines and three horizontal lines.

This is not a timed test. Take your time to carefully analyze each problem. It should take approximately one hour to answer all the problems.

Please do your best to identify the correct answers. If you are not sure of the correct answer, you may guess the answer. There is no penalty for guessing. If you make a mistake and want to change your answer, raise a hand and one of the proctors will give you and eraser.

If you have any questions don't hesitate to ask. Questions will not be allowed once the test has begun.

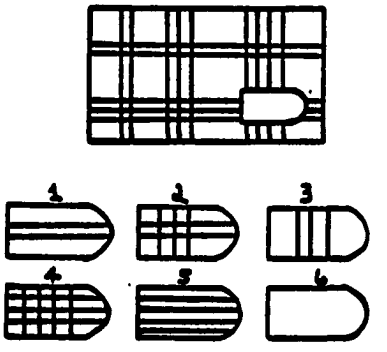
Appendix G

Information to Facilitate Test Performance

Information to facilitate test performance.

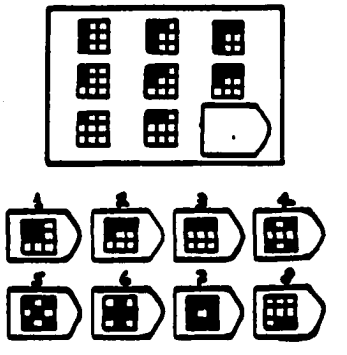
1. Be sure to analyze the whole pattern before you decide which of the alternatives is the best solution to the problem. In doing so, study the horizontal, vertical, and diagonal relationships among the designs of the matrix. In some cases the logic applies to only one of the previous orientations. In others, you might have to study more than one orientation to find the solution.

2. In some cases think of the matrix as piece of ceramic. To determine the next figure in the pattern, imagine how the overall pattern would be continued through the missing piece.



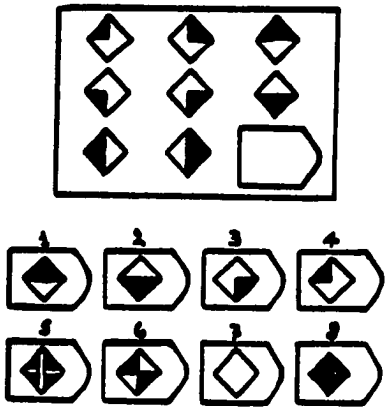
Correct answer: 4 It has four vertical lines and three horizontal lines.

3. In some cases a quantitative increment or decrement in an attribute such as size, position, or number occurs across rows or down columns.



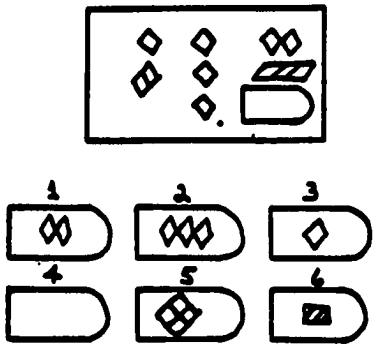
Correct answer: 3 The number of black squares in the top of each row increases by one from column to column. The number of black squares along the left remains constant within a row, but changes between rows from three to two to one.

4. There will be cases where details from a figure from one column or row are added to or subtracted from the second figure to produce the third.



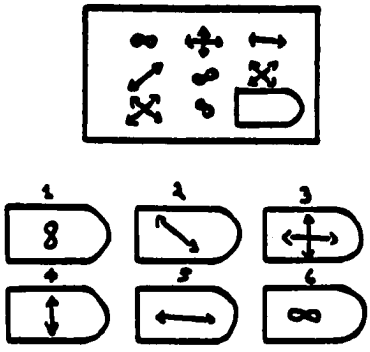
Correct answer: 8 The dark part of the figure in column one is added to the dark part of the figure in column two to obtain the figure in the third column.

5. In some cases it can be helpful to consider that the details of the designs are either positive or negative numbers, so that you can perform basic algebraic operations such as addition or substraction.



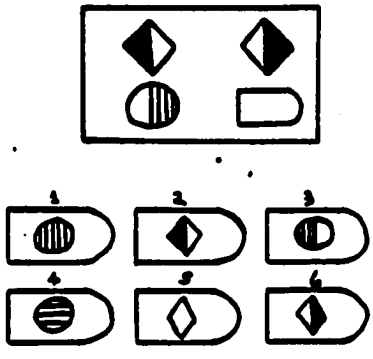
Correct answer: 3 This an example of addition of the number of diamonds in column one and two to yield the number of diamonds in column three.

6. There are cases in which a detail such as size, position, orientation or number is the same throughout a row, but changes down a column.



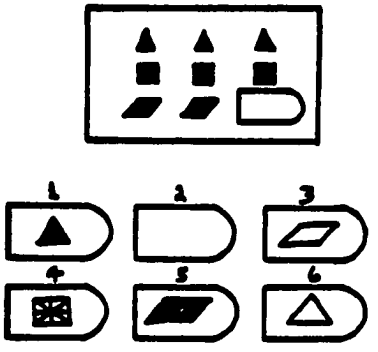
Correct answer: 2 The critical element is the orientation of the designs with the third row having a diagonal orientation with the high end of the figure on the left (see figure 8 in third row).

7. In some cases a mirror placed either vertically or horizontally in the middle of the matrix yields the correct answer which is a mirror image of the figure in the opposing column or row.



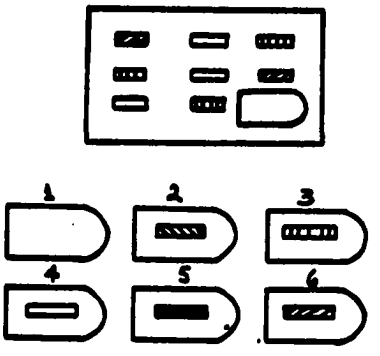
Correct answer: 3 The figure of the second column is a mirror image of the first column.

8. There are cases in which the same value (such as size, position, design, orientation or number) occurs throughout a row, but changes down a column.



Correct answer: 5 The geometrical design is constant throughout the row, but changes down the columns.

9. Finally, in some cases three values or characteristics of the design (such as figure type, size, orientation, number or position) are distributed through a row.



Correct answer: 6 There are three internal designs in the rectangles. Each of these three internal designs is represented in each row. In some cases this rule applies only to rows, in other cases, only to columns and sometimes to both rows and columns.

NOTE:

As you will see, in some cases you can utilize more than one of these strategies. In other, however, one of them will be enough to find the right solution.

Appendix H

Questionnaires

Questionnaire for Control group.

Please give a brief answer to the following questions.

1) Please go back to the problem A 13, which one is the correct answer? What was your rationale for choosing that response?

2) Please go back to the problem B 13, which one is the correct answer? What was your rationale for choosing that response?

3) Please go back to the problem C 13, which one is the correct answer? What was your rationale for choosing that response?

4) Please go back to the problem D 13, which one is the correct answer? What was your rationale for choosing that response?

5) Please go back to the problem E 13, which one is the correct answer? What was your rationale for choosing that response?

6) Would you have preferred getting feedback about the correctness of your responses during the different sessions? Explain, please.

7) Would you have preferred getting special information about strategies that could have facilitated your test performance during the tests? Explain, please.

8) Do you think that repetition of the test helped you to improve your performance in the test? Explain, please.

Questionnaire for the CSB group.

Please give a brief answer to the following questions.

1) Please go back to the problem A 13, which one is the correct answer? What was your rationale for choosing that response?

2) Please go back to the problem B 13, which one is the correct answer? What was your rationale for choosing that response?

3) Please go back to the problem C 13, which one is the correct answer? What was your rationale for choosing that response?

4) Please go back to the problem D 13, which one is the correct answer? What was your rationale for choosing that response?

5) Please go back to the problem E 13, which one is the correct answer? What was your rationale for choosing that response?

6) How often did you look for the feedback about the correctness of your response?

X---------X-----------X-------------X--------------X

never rarely sometimes usually always

7) How often did you try to understand why your rationale was wrong when you did not choose the right answer?

X---------X-----------X-----------X-------------X

never rarely sometimes usually always

8) How helpful was the feedback you received during the test?

X----------X----------X-------------X-------------X

not helpful very helpful

9) Would you have preferred not getting feedback about the correctness of your responses during the sessions? Explain, please.

10) Would you have preferred getting special information about strategies that could have facilitated your test performance during the tests? Explain, please.

Questionnaire for the CSB+RGB group.

Please give a brief answer to the following questions.

1) Please go back to the problem A 13, which one is the correct answer? What was your rationale for choosing that response?

2) Please go back to the problem B 13, which one is the correct answer? What was your rationale for choosing that response?

3) Please go back to the problem C 13, which one is the correct answer? What was your rationale for choosing that response?

4) Please go back to the problem D 13, which one is the correct answer? What was your rationale for choosing that response?

5) Please go back to the problem E 13, which one is the correct answer? What was your rationale for choosing that response?

6) How often did you look for the feedback about the correctness of your response?

X---------X----------X----------X----------X

never rarely sometimes usually always

7) How often did you try to understand why your rationale was wrong when you did not choose the right answer?

X---------X-----------X-----------X-------------X

never rarely sometimes usually always

8) How helpful was the feedback you received during the test?

X----------X----------X-------------X-------------X

not helpful very helpful

9) Would you have preferred not getting feedback about the correctness of your responses during the sessions? Explain, please.

10) Were you able to understand the information about strategies to facilitate your performance in the test?

Yes------ No------

11) How often did you use those strategies?

X---------X-----------X-----------X-------------X

never rarely sometimes usually always

12) How helpful were the strategies?

X---------X-----------X-----------X-------------X

not helpful very helpful

13) Would you have preferred not getting special information about strategies that could have facilitated your test performance during the tests? Explain, please.

Questionnaire for the RGB group.

Please give a brief answer to the following questions.

1) Please go back to the problem A 13, which one is the correct answer? What was your rationale for choosing that response?

2) Please go back to the problem B 13, which one is the correct answer? What was your rationale for choosing that response?

3) Please go back to the problem C 13, which one is the correct answer? What was your rationale for choosing that response?

4) Please go back to the problem D 13, which one is the correct answer? What was your rationale for choosing that response?

5) Please go back to the problem E 13, which one is the correct answer? What was your rationale for choosing that response?

6) Were you able to understand the information about strategies to facilitate your performance in the test?

Yes------ No------

7) How often did you use those strategies?

X---------X----------X----------X----------X

never rarely sometimes usually always

8) How helpful were the strategies?

X---------X----------X----------X----------X

not helpful very helpful

9) Would you have preferred not getting special information about strategies that could have facilitated your test performance during the tests? Explain, please.

10) Would you have preferred getting feedback about the correctness of your responses throughout the tests? Explain, please.

Appendix I

Answer Sheets

ANSWER SHEET No. 1

Name: _____ Social Sec. Num.(last 6 digits): _____

Sex: _____ Academic level: _____

Age: _____ Date: _____

*A	*B	*C	*D	*E
*1	*1	*1	*1	*1
*2	*2	*2	*2	*2
*3	*3	*3	*3	*3
*4	*4	*4	*4	*4
*5	*5	*5	*5	*5
*6	*6	*6	*6	*6

TOTAL SCORE: _____

ANSWER SHEET No. 2

Last six digits of social security number: _____

Sex: _____ Academic level: _____

Age: _____ Date: _____

A	B	C	D
1	1	1	1
2	2	2	2
3	3	3	3
4	4	4	4
5	5	5	5
6	6	6	6
7	7	7	7
8	8	8	8
9	9	9	9
10	10	10	10
11	11	11	11
12	12	12	12
13	13	13	13

TOTAL SCORE: _____

ANSWER SHEET No. 3

Last six digits of social security number: _____

Sex: _____ Academic level: _____

Age: _____ Date: _____

A			B			C			D			E		
1			1			1			1			1		
2			2			2			2			2		
3			3			3			3			3		
4			4			4			4			4		
5			5			5			5			5		
6			6			6			6			6		
7			7			7			7			7		
8			8			8			8			8		
9			9			9			9			9		
10			10			10			10			10		
11			11			11			11			11		
12			12			12			12			12		
13			13			13			13			13		

TOTAL SCORE: _____

ANSWER SHEET No. 4

Last six digits of social security number: _____

Sex: _____ Academic level: _____

Age: _____ Date: _____

*A		*B		*C		*D		*E	
*1		*1		*1		*1		*1	
*2		*2		*2		*2		*2	
*3		*3		*3		*3		*3	
*4		*4		*4		*4		*4	
*5		*5		*5		*5		*5	
*6		*6		*6		*6		*6	

TOTAL SCORE: _____

A		B		C		D		E	
1		1		1		1		1	
2		2		2		2		2	
3		3		3		3		3	
4		4		4		4		4	
5		5		5		5		5	
6		6		6		6		6	
7		7		7		7		7	
8		8		8		8		8	
9		9		9		9		9	
10		10		10		10		10	
11		11		11		11		11	
12		12		12		12		12	
13		13		13		13		13	

Appendix J

Individual Data Per Group and Sessions

Contingency-Shaped Behavior Group.
Individual Data Per Sessions

Subject Number	Sessions				
	Pretest (30 items)	Train. 1 (52 items)	Train. 2 (52 items)	General. (13 items)	Posttest (52 items)
1	28	38	37	8	45
2	29	46	43	9	44
3	26	44	45	10	44
4	30	47	48	10	49
5	29	38	43	9	46
6	28	38	41	9	39
7	27	29	38	8	46
8	29	37	39	9	37
9	27	45	50	12	47
10	30	48	48	10	48
11	28	40	45	11	39

Rule-Governed Behavior Group
Individual Data Per Sessions

Subject Number	Sessions				
	Pretest (30 items)	Train. 1 (52 items)	Train. 2 (52 items)	General. (13 items)	Posttest (52 items)
1	28	36	45	11	48
2	29	26	31	10	30
3	30	48	46	11	46
4	27	43	45	11	44
5	27	38	40	11	41
6	26	34	31	10	32
7	29	44	44	12	45
8	29	42	42	11	44
9	28	43	45	11	43
10	28	45	42	11	45

Control Group. Individual Data Per Sessions

Subject Number	Sessions				
	Pretest (30 items)	Train. 1 (52 items)	Train. 2 (52 items)	General. (13 items)	Posttest (52 items)
1	29	40	45	11	46
2	29	42	39	12	41
3	29	37	42	11	41
4	28	38	40	10	40
5	27	37	35	12	35
6	30	48	48	12	48
7	28	41	43	10	43
8	29	33	34	10	41
9	26	36	42	10	42
10	25	35	33	7	35
11	27	42	39	10	44
12	27	30	29	9	32

Contingency-Shaped and Rule-Governed Behavior Group.
Individual Data Per Sessions

Subject Number	Sessions				
	Pretest (30 items)	Train. 1 (52 items)	Train. 2 (52 items)	General. (13 items)	Posttest (52 items)
1	28	46	41	10	44
2	27	40	43	11	45
3	29	33	39	11	44
4	28	33	45	9	45
5	26	31	43	10	46
6	29	40	44	10	46
7	29	44	44	12	43
8	21	32	32	7	34
9	30	42	39	11	44
10	28	45	43	11	48
11	27	36	39	9	41

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