The effect of prior selection of verbal descriptions of stimulus relations upon the performance in conditional discrimination in human adults [1]

*(Efecto de la selección previa de descripciones verbales
de relaciones de estímulo en el desempeño en discriminación
condicional de sujetos humanos)*

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ABSTRACT

A study was conducted to evaluate the effects of choosing verbal descriptions prior to the matching response in a second-order matching-to-sample situation. Twelve subjects were distributed in two groups under different conditions. The experimental group was exposed to textual descriptions of stimulus arrangements prior to the matching response, while the control group was exposed to the stimulus display without those descriptions. A pretest and three transfer tests measuring intramodal, extramodal and extrarelational variations were presented in separate sessions. Subjects in the experimental group performed with a higher percentage of correct responding in both the training and test sessions. Nevertheless, an analysis of the textual descriptions selected and the type of errors made in the matching situation suggests that experimental subjects did not develop rules in responding to the discrimination tasks. Some theoretical considerations are outlined regarding the usefulness of distinguishing between verbal and non-verbal behaviors.
Keywords: matching-to-sample, conditional discrimination, intramodal, extramodal and extrarelational transference, textual descriptions, human behavior.

RESUMEN

Se realizó un estudio para evaluar los efectos de elegir descripciones verbales antes de la respuesta de igualación en una situación de igualación de la muestra de segundo orden. Se distribuyeron doce sujetos en dos grupos bajo diferentes condiciones. El grupo experimental fue expuesto a descripciones textuales de los arreglos de estímulo previamente a la respuesta de igualación, mientras que el grupo control fue expuesto al arreglo de estímulos sin dichas descripciones. Se presentaron en diferentes sesiones una preprueba y tres pruebas de transferencia que medían variaciones intramodales, extramodales y extrarrelacionales. Los sujetos en el grupo experimental mostraron un número más elevado de respuestas correctas tanto en las sesiones de entrenamiento como en las de prueba. No obstante, un análisis de las descripciones textuales seleccionadas y el tipo de errores realizado en la situación de igualación sugiere que los sujetos experimentales no desarrollaron reglas para responder a las tareas de discriminación. Se delinean algunas consideraciones teóricas respecto de la utilidad de distinguir entre conductas verbales y no verbales.

Palabras clave: Igualación de la muestra, discriminación condicional, transferencia intramodal, extramodal, y extrarrelacional, descripciones textuales, conducta humana.

The literature on conditional discrimination and so-called rule-governed behavior has focused upon the potential relevance of self-instructions following verbal descriptions of the behavior performed and the contingencies under which individuals perform (Catania, 1986; Cerutti, 1989; Hayes, 1989). The descriptions that have been analyzed range from written reports at the end of the experimental sessions to descriptions of why a particular stimulus relation "goes together".

Although theoretical arguments point to the influence of verbal factors prior to or during the performance involved in problem-solving, most studies have collected data about verbal description *after* the performance (Critchfield & Perone, 1990; Leander, Lippman & Meyer, 1966; Ribes & Martínez, 1990). Also, guessing procedures under conditions that do not demand precise responses have been used (Catania, Matthews & Shimoff, 1982). In this case, the nature of verbal descriptions and the response features to which they are related (rate requirements) are not specific enough to expect any precise functional correspondence with the subjects' behavior.

It is needless to say that, as many years ago was argued in regard to verbal conditioning experiments (Ericksen, 1960; Rosenfeld & Baer, 1969), reports obtained through questioning at the end of the conditioning procedure do not provide reliable information about the subjects' "awareness" of the procedure during the experimental sessions. The same is relevant to any kind of description obtained *after* the performance in a problem-solving situation, as matching-to-sample happens to be. Shimoff (1986) has examined the difficulties involved in the analysis of post-session verbal reports as accurate indicators of the verbal processes evoked by the experimental procedures, when it is assumed that within-session verbal behavior has causal properties over the non-verbal behavior being observed or measured.

Even when rules are mostly presented as instructions to be followed, Cerutti (1989) has distinguished rules from instructions in terms of generality. Instructions are situationally-constrained and are specific to particular behaviors and

stimulus conditions. By one hand, rules have to be identified through behavior that is sensitive to functional invariants across moment-to-moment variations within and between situations. Accordingly, rule-governed behavior should be identified with behavior controlled by *relations* among stimuli or, at least, by class-related properties of stimulus relations. On the other hand, instructions should be identified with particular behaviors under the control of specific discriminative stimuli.

When a conditional discrimination task is used, it is difficult to evaluate which of both types of control operates during the performance observed in as typical training for matching-to-sample. In order to distinguish instruction-controlled behavior from rule-governed behavior it is needed to test new matching relations using the same stimuli (extrarelational transfer) or to test new stimuli under the same relations (intramodal and extramodal transfer), since the matching performance may be correct under either type of behavior controlling process.

In order to circumvent the lack of liability of post-session verbal reports in relation to the occurrence of verbal behavior during problem-solving in matching-to-sample, and its role as instructions or rules, it is needed to include explicit verbal responses as part of the task. Since it is assumed that verbal behavior by the subject influences his/her nonverbal behavior regarding the matching-to-sample task, verbal behavior should take place *before* the matching response, and should be related to particular stimulus instances (descriptions working as discriminative stimuli in the form of implicit self-instructions) or to stimulus classes or stimulus relations (descriptions working as rules).

A study was designed using a matching-to-sample task in which textual descriptions were added as response options previous to the matching response. These textual descriptions had to do with three kinds of possible "togetherness" of the stimuli to be matched: relational, class inclussion or single-instance association. This arrangement should allow for the measurement of differential descriptions of the stimulus contingencies being presented *prior* to the matching response and their correlations with discriminative performance.

This study was addressed to answer the following questions: Does the ocurrence of verbal responses describing stimulus contingencies prior to the matching response result in a better performance when compared with traditional "nonverbal" matching-to-sample procedures? Is there a differential effect of the type of verbal description selected on the acquisition of the conditionally discriminated performance? Is there a correlation between the type of verbal description taking place during training and the performance in the various transfer tests?

METHOD

Subjects. Fifteen volunteer students of Introductory Psychology without experience or knowledge on conditional discrimination were selected. Their ages ranged between 18 and 22 years (with an average of 19.4 years). Fourteen were females and one was male. Subjects were randomly assigned to two groups, and

were asked not to communicate with each other about their participation in the study. Only twelve subjects remained during the whole experiment.

Apparatus and Setting. The experiment was run with four Commodore-128 microcomputing systems. The subjects worked in separate rooms, isolated from noise or other distractions. Stimulus displays were programmed and presented on the monitors' screens, and subjects had to move a joystick in the position corresponding to the elected stimulus. Subjects chose among textual options by pressing the numbers 1, 2, 3 or 4 on the keyboard. All the selections were automatically recorded by the microcomputer system.

Design. Subjects were assigned to one of two groups, an experimental group in wich texts had to be chosen prior to matching, and a control group exposed to a standard matching-to-sample procedure. The experimental group, although initially with ten subjects, finally included seven subjects. The control group included five subjects. The study involved eight sessions: a pretest session, four sessions corresponding to the experimental (training) phase, and three test sessions measuring intramodal, extramodal and extrarelational transfer respectively. Figure 1 describes the design.

Experimental task. The experimental task consisted of a second-order conditional discrimination employing a matching-to-sample procedure (Fujita, 1983). Figura 2 depicts the basic stimulus arrangements displayed on the screen. The task consisted of a matching-to-sample procedure in which stimuli were constant in size but varied in shape and color (except for trials testing extramodal transfer).

The stimulus arrangement included six stimuli presented on the monitor screen. On the top section of the screen two stimuli (second-order stimuli) were presented showing the matching relation to be performed: identity or similarity-matching during training, intramodal and extramodal test sessions, and difference-matching during the pretest and the extrarelational test sessions. On the central and bottom sections respectively of the screen appeared a stimulus to be matched (sample stimulus) and three stimuli to choose among for the matching relation (comparison stimuli). The second-order stimuli consisted always of shapes and colors different than those presented as sample and comparison stimuli. Identity-matching in choosing the same color or shape, and difference-matching in choosing different color and shape.

The particular arrangements changed from trial to trial and every session consisted of thirty six trials. Each trial lasted 15 seconds. If the subject responded before this time elapsed a new trial was presented. The intertrial interval was 3 seconds. Eighteen trials corresponded to identity-matching and eighteen trials to similarity-matching. These trials were randomly ordered during each session. Subjects had to move the joystick forward, to the left or to the right in order to choose one of the comparison stimuli matching the sample stimulus, according to the criteria specified by the second-order stimuli relation. In each presentation of the comparison stimuli, one was identical, another similar, and the other different to the sample stimulus. All stimuli were presented the same number of times during the study, and their position was evenly distributed among the comparison stimuli (left, center or rigth positions).

		P R E T E S T		I N T R A M O D A L T E S T	E X T R A M O D A L T E S T	E X T R A R E L A T I O N A L T E S T
EXPERIMENTAL GROUP	N = 10		TREATMENT WITH OPTIONS			
CONTROL GROUP	N = 5		TREATMENT WITHOUT OPTIONS			
SESSIONS		1	4	1	1	1

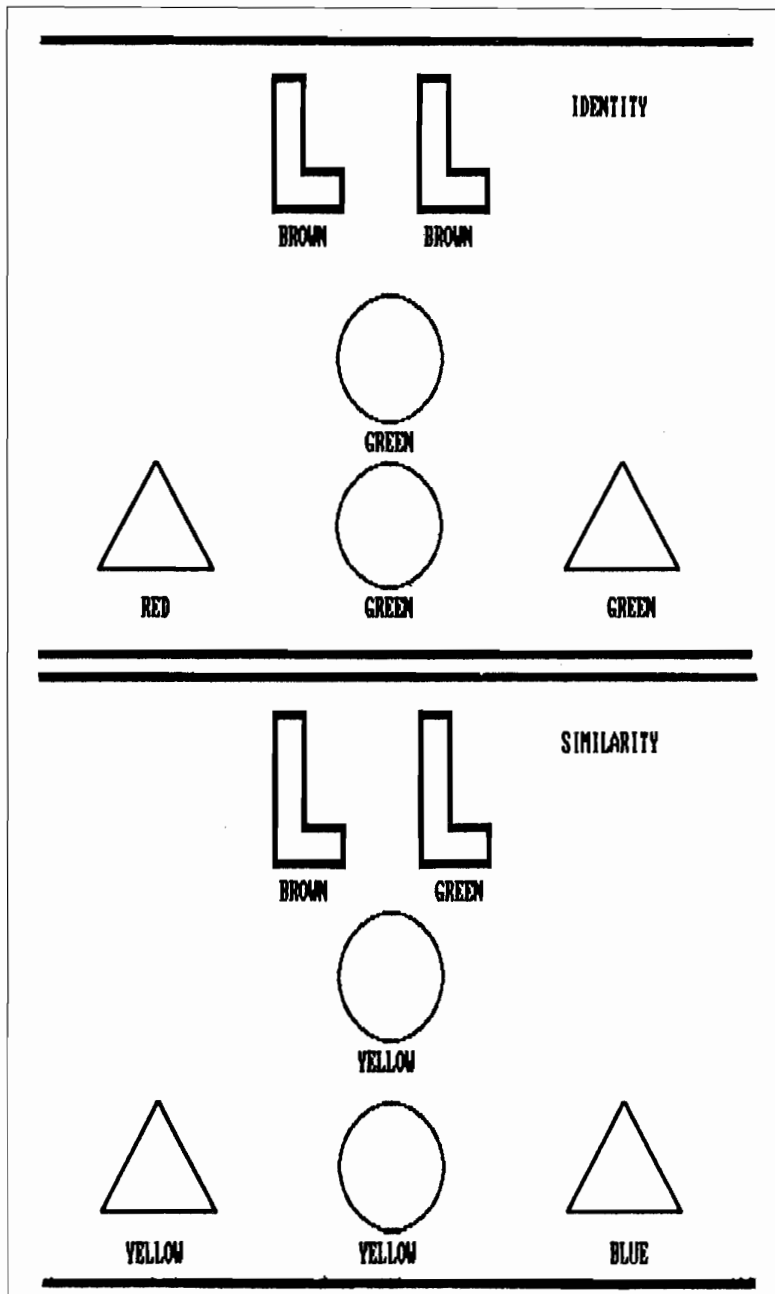Figure 1. Conditions to wich were exposed the experimental and control groups.

Figure 2. Typical arrangements used in training and test conditions for the control goup.

During the training phase for the experimental group a set of textual options was added to the experimental task. The screen was divided into two horizontal sections. In the upper section the second-order matching-to-sample stimulus arrangements described above were presented (see Figure 3). In the lower section, four verbal stimuli, numbered from 1 to 4, were presented as textual options. These textual options could refer to the various relations being trained or tested (identity, similarity or difference), to the class modalities in which stimuli were varied (color and shape), or the particular stimulus instances to which subjects were being exposed (red circle, brown square, etc.). Figure 4 shows the textual options

Among these four textual options presented in each trial to the Experimental Group during the training phase, two were correct and two incorrect. These options were randomly distributed among trials, so that every one appeared the same number of times. There were no time restrictions to choose among the textual options during this phase. Thus, trials varied in length for the Experimental Group.

In order to match the sample and comparison stimuli subjects were first required to choose a textual option. The textual option was chosen by pressing the key with the corresponding number. Once a text was chosen, response time began running for the matching stimuli using the joystick with a response interval limited to 15 seconds.

During the training sessions subjects were informed if their matching response was or not correct immediately after every trial by means of a message on the screen. On the other hand, no information about the matching response was provided during the pretest and test sessions.

The stimulus arrangements varied during the pretest and test session with respect to those used during the training phases. In the pretest, twelve identity-matching trials, twelve-similarity trials and twelve difference-matching trials were randomly presented. These arrangements were the same as those presented in the extrarelational test, and were different from those used during the training phase. In the intramodal test session new stimuli were presented varying in shape and color under identity-and similarity-matching relations. In the extramodal test session the stimuli used during training were presented but now varied according to size and shape under the same two matching relations: identity and similarity. In the extrarelational test session, the same stimuli presented during the intramodal test were used but under a difference-matching relation. Figure 5 describes the stimulus arrangements used during the test sessions.

Procedure

Joystick training. Before beginning the pretest session, subjects were trained in how to use the joystick. The following instructions were displayed in the screen:

"On the screen will appear six figures, two at the top, one at the center, and three at the bottom. You must choose one at the bottom that you think is related with the one at the center. The kind of relation between them will be indicated by the two figures at the top. Choose one of the figures at the bottom moving the joystick to the left, to the rigth or forward".

With the instructions, a sample arrangement of stimuli was presented and subjects were asked to follow the instructions with three successive stimulus displays. When subjects achieved three consecutive correct movements, the pretest session began.

Pretest. Instructions presented on the screen in the pretest session were as follows:

"1) Observe carefully the six figures that appear on the screen. You must choose one among the three at the bottom that you think is related with the one at the center. The kind of relation between them is indicated by the two figures at the top.

2) You must point to one of the three bottom figures, the one that is correct, by using the joystick. When you move the joystick to the left, to the right or forward, an arrow will appear below the selected figure.

Would you like to read again these instructions?"

Training phase. Instructions in this phase were different for subjects in the control and experimental groups.

The instructions presented in the first session to the experimental group were as follows:

"In this game, the screen will be divided in two parts: at thew top will appear six figures, and at the bottom four texts. To look at an example, please press any key".

An arrangement was presented during eight seconds. Instructions continued:

"The task consistes in the following: .

1) Observe carefully the six figures that appear on the screen. You must choose one among the three at the bottom that you think is related with the one at the center. The kind of relation between them is indicated by the two figures at the top;

2) In the section below four textual options will appear. You must choose the one that best describes the figure you think is the correct one. Look at an example... (an example was presented);

3) Once you have selected the text that best describes the figure you are to choose, now, using the joystick you must point to one of the three bottom figures, that one you have considered to be correct. When you move the joystick to the left, to the right or forward, an arrow will appear below the selected figure;

4) After you have chosen a figure, a sound and a text will be presented informing if your selection with the joystick was or not correct. This information has nothing to do with the text you chose.

	IDENTITY	SIMILARITY	DIFFERENCE
INSTANCE	THE YELLOW CIRCLE	THE BLUE SQUARE	THE BLUE CIRCLE
CLASS	THE ONE THAT SHARES COLOR	THE ONE THAT ONLY SHARES COLOR / THE ONE THAT ONLY SHARES SHAPE	THE ONE THAT DOESN'T SHARE SHAPE / THE ONE THAT DOESN'T SHARE COLOR
RELATION	THE SAME ONE	THE SIMILAR ONE	THE DIFFERENT ONE

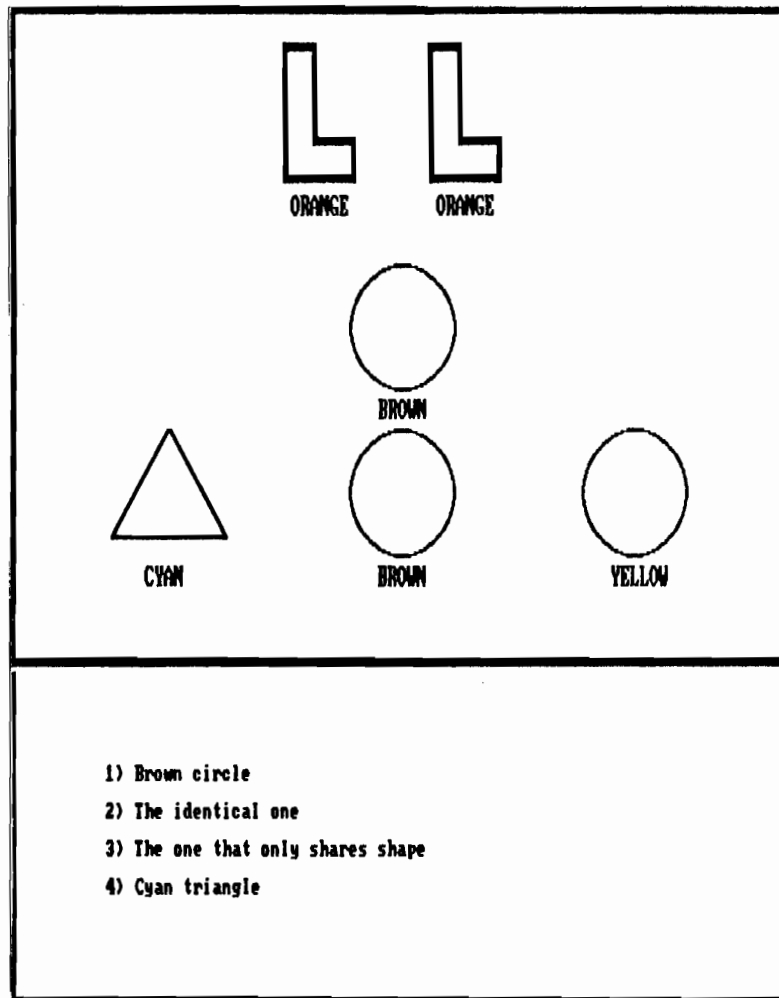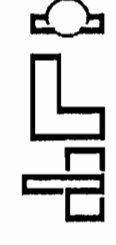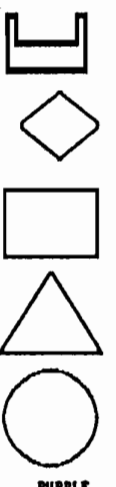Figura 3. Typical arrangements used in training for the experimental group.
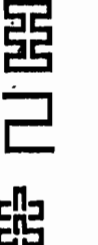
Figure 4. Examples of each kind of textual option.

PRETEST POST-TEST	TRAINING	INTRAMODAL TEST	EXTRAMODAL TEST	EXTRARELATIONAL TEST
SECOND ORDER STIMULI BLACK DARK GRAY	ORANGE MEDIUM GRAY	LIGHT BLUE WHITE	SIZE SMALL AND LARGE	BLACK DARK GRAY
COMPARATIVE STIMULI BLUE GREEN YELLOW RED	PURPLE CYAN BROWN LIGHT GRAY	DARK BROWN LIGHT GREEN LIGHT RED DARK BLUE	SIZE SMALL AND LARGE	BLUE GREEN YELLOW RED

In summary: 1) Look at the figures; 2) Identify the correct one; 3) Choose a text; 4) Choose the correct figure with the joystick.

Would you like to read these instructions again?"

These instructions were presented in successive screen presentations. After the instructions were read, two sample rehearsal trials, one of identity-matching and one of similarity-matching, were presented previous to the experimental sessions.

The instructions presented in the first session to the control group were the same that those during the pretest sessions, but with the following addition:

"After you have chosen a figure, a sound and a text will be presented informing if your election with the joystick was or not correct.

Would you like to read these instructions again?"

After the instructions were read, two sample rehearsal trials, one of identity-matching and one of similarity-matching, were presented, previous to the experimental sessions.

Intramodal, extramodal and extrarelational tests. Instructions in the sessions were the same as those provided during the pretest.

RESULTS

Figures 6, 7 and 8 depict the percentage and range of correct responses for subjects in both the experimental and control groups.

These figures show that pretest performance was similar in both groups. Nevertheless, differences appeared when the training procedures were introduced. Subjects in the experimental group showed a faster and higher acquisition performance than those in the control group. Individual performances were more scattered in relation to each other in the control group. The experimental group subjects also showed better performance in the test sessions, specially during the extrarelational test. In general, the experimental group showed a typical acquisition curve, with maintenance of correct performance, reduced between-subjects variability, and high transfer scores. The control group, however, maintained significant between-subjects variability and irregular performance in both training and test sessions.

Figures 9 and 10 depict the mean percentage of correct and incorrect responses in the experimental and control groups respectively, according to the type of matching response performed by the subjects during the training sessions. Correct responses were similar in both groups. In identity trials correct responses could only be identity responses of one kind: those matching color and shape. But in similarity trials, the relations between the second order stimuli (SOS) and the first order stimuli (FOS) could vary. Various relations could be established between them: a) SOS indicating similarity in shape, and matching in FOS according to shape (S-S); b) SOS indicating similarity in color, and matching in FOS
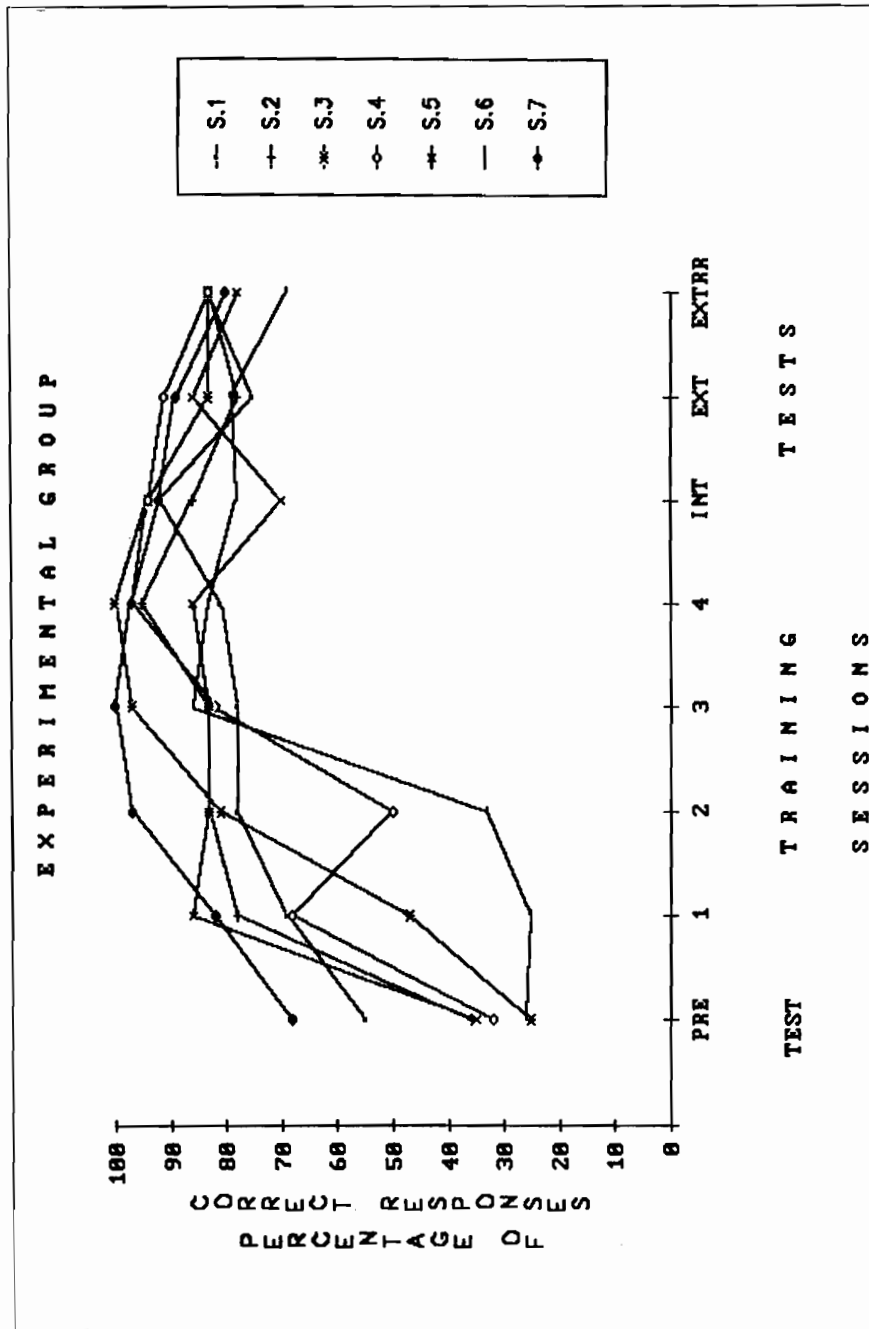
Figure 6. Percentage of correct responding for each subject in the experimental group across the test and training sessions.
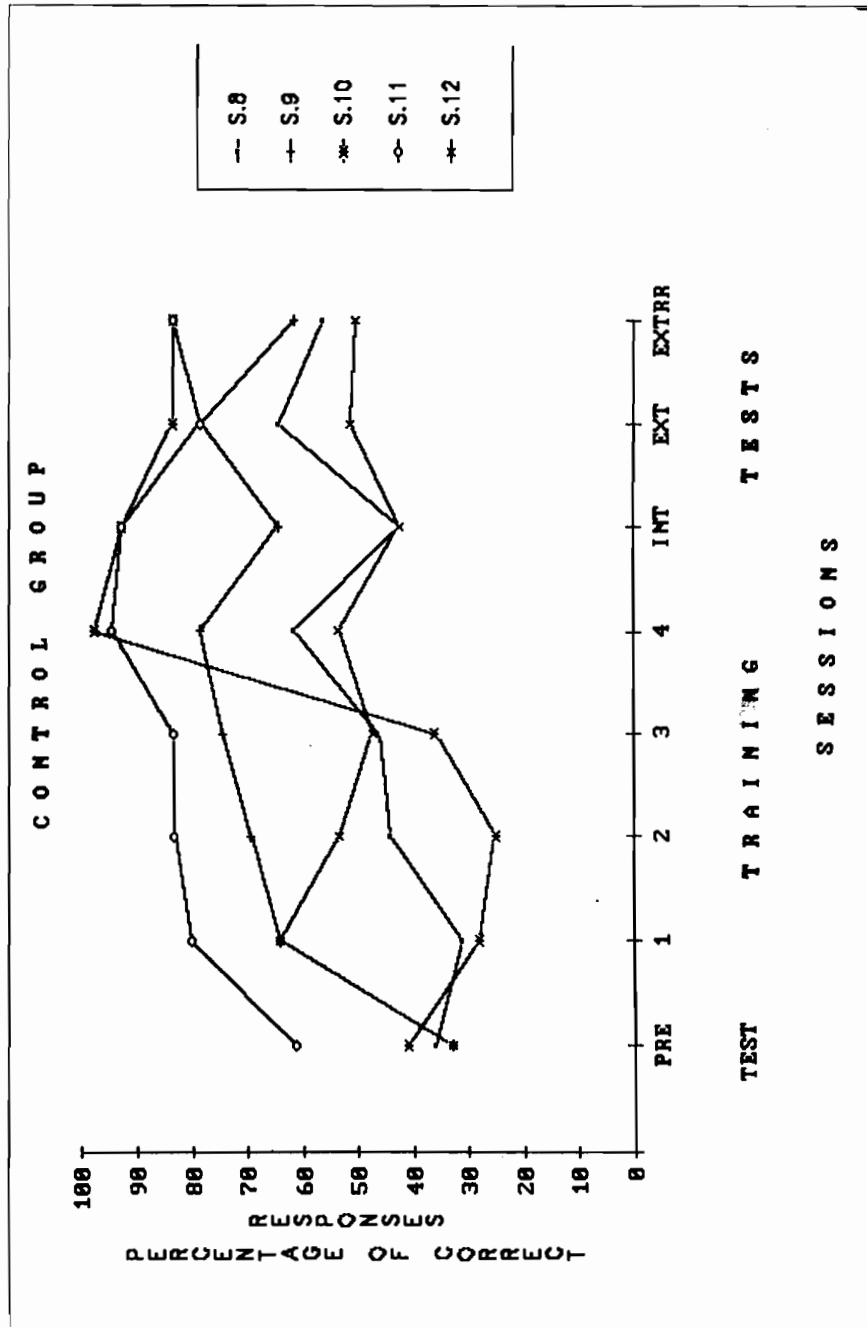
Figure 7. Percentage of correct responding for each subjects in the control group across the test and training sessions.
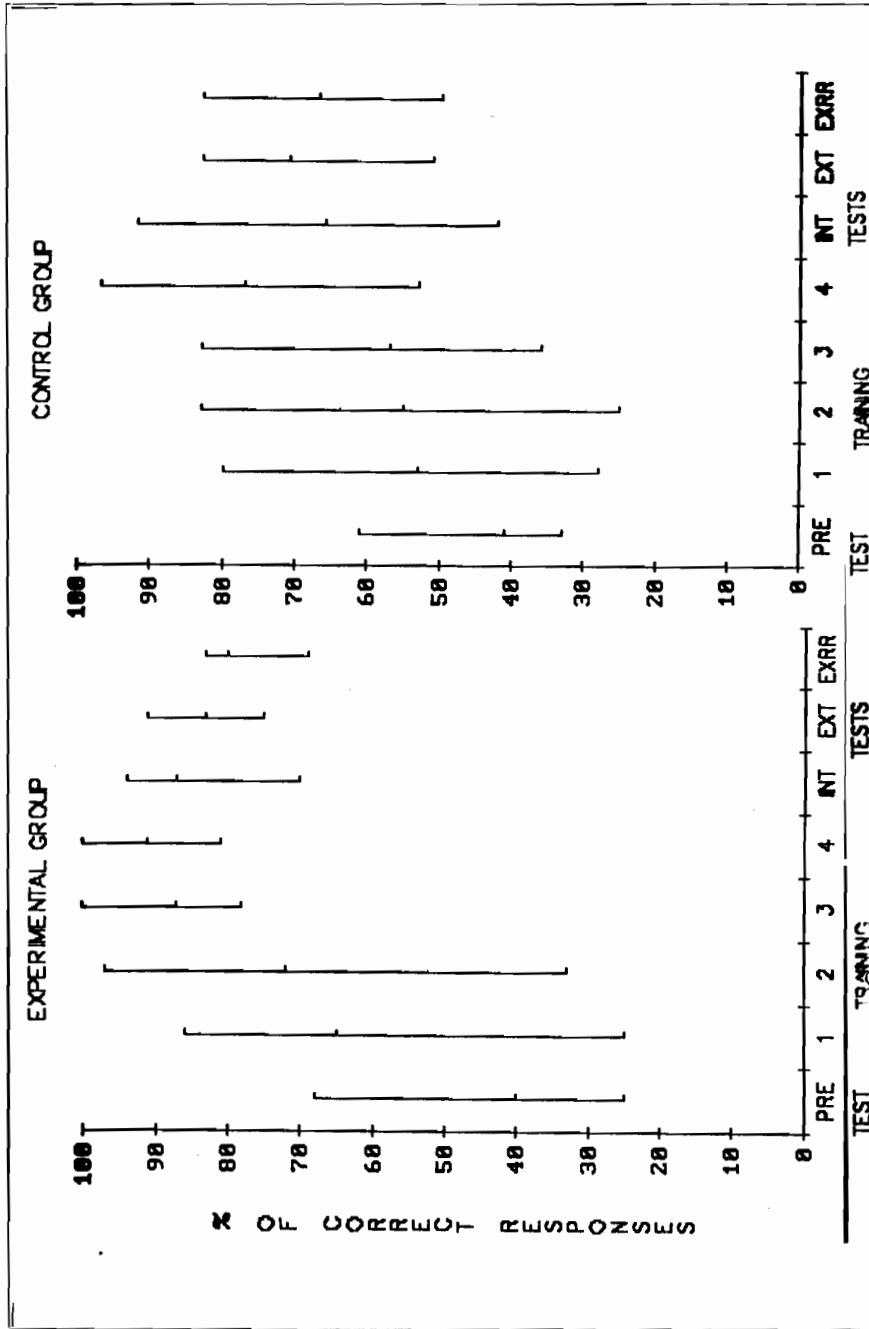
Figure 8. Mean correct perfomance and ranges for both experimental and control groups across training and test sessions.
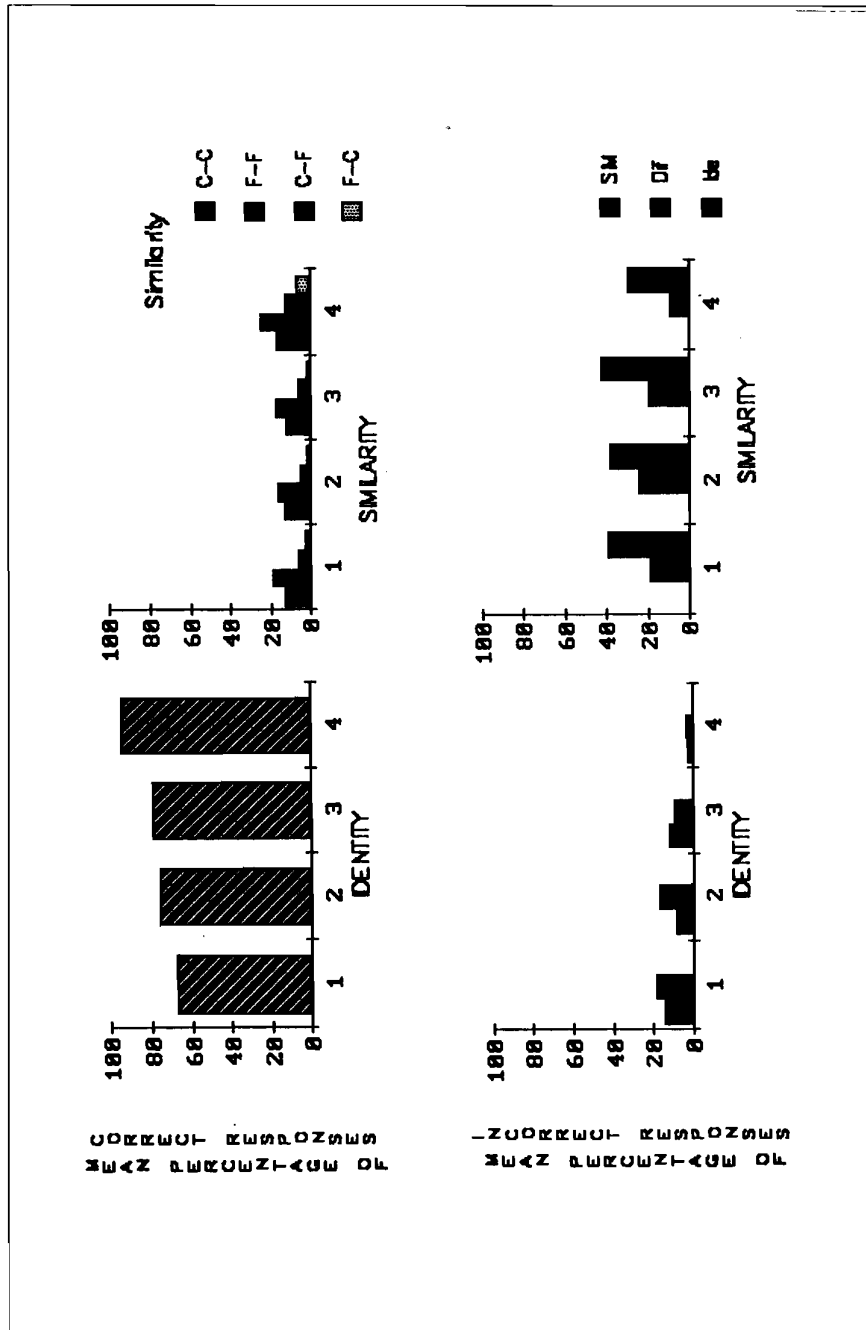
Figure 9. Mean percentages of types correct and incorrect responses during training sessions in the experimental group.
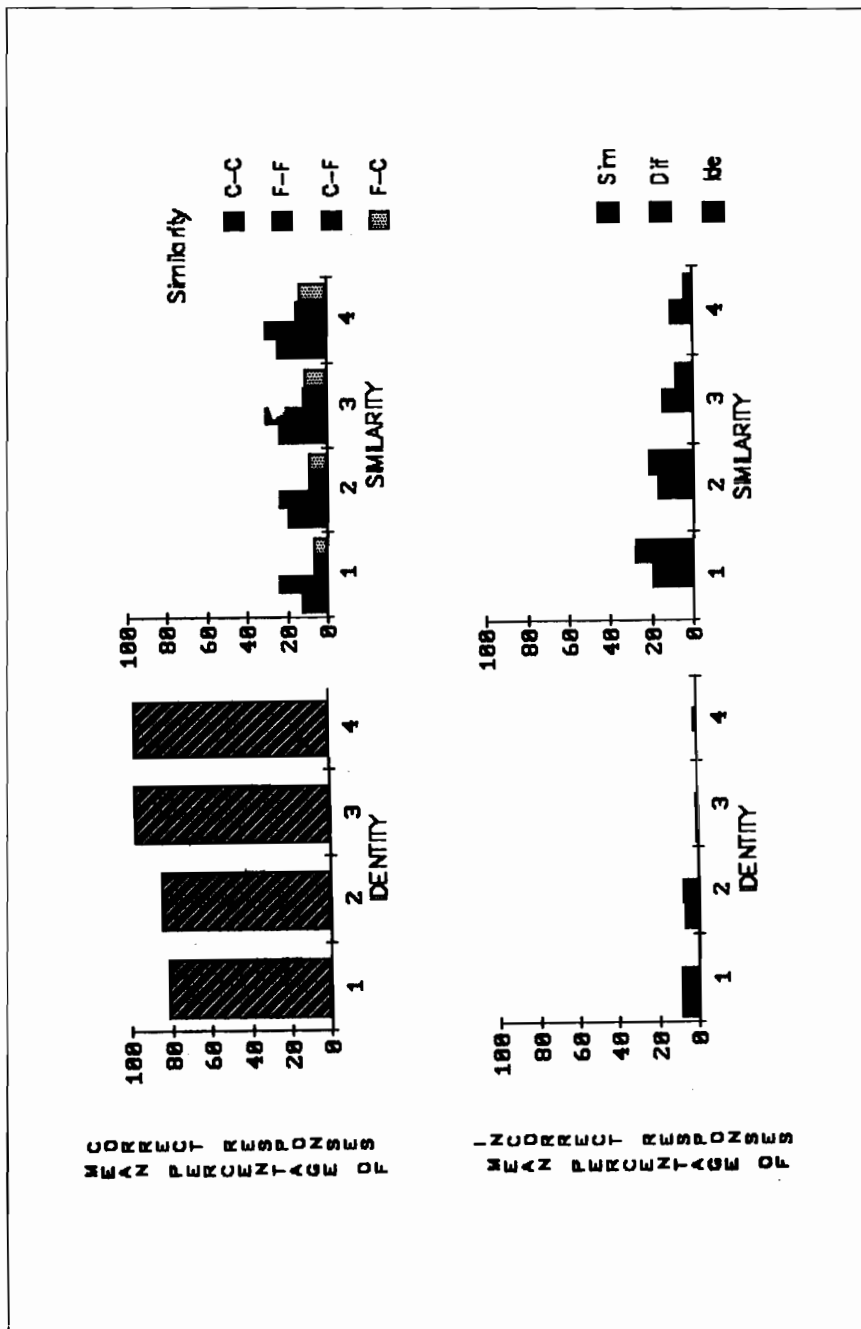
Figure 10. Mean percentages of types of correct and incorrect responses during training sessions in the control groups.

according to color (C-C); c) SOS indicating similarity in shape and matching in FOS according to color (S-C); and, d) SOS) indicating similarity in color, and matching in FOS according to shape (C-S). In both groups correct responding in similarity trials mostly followed C-C and S-S relations. Nevertheless, some differences between both groups may be observed in the kind of errors. In identity trials both groups achieved similar percentages of errors when matching according to similarity or difference-relations. But in similarity trials, the control group showed more identity type errors than the experimental group.

Table 1 describes the mean percentage of correct performance and different type of text selected (*instance, class* or *relation*) for every subject in the experimental group. There are no apparent correlations between the trends of correct responding and the election of texts. In observing individual scores, subjects were quite different, and only subject 4 showed symmetrical trends correlating *instance*-textual choices with correct performance.

Table 2 shows the percent of correspondence in correct and incorrect responses between selected texts and matching responses. Correspondence was very high, being more frequent *relation*-textual elections in identity trials, and *instance* and *class*-textual elections in similarity trials. Non-correspondence was negligible and occurred mostly in the first two training sessions.

Figures 11, 12, 13 and 14 show the percentage of the kind of correct and incorrect responses in both groups during the four test sessions.

Figures 11 and 12 describe the percentage of correct and incorrect responding in the intramodal and extramodal test sessions. The experimental group showed similar performances in both tests, with a high percentage of correct responses for identity trials and for those similarity trials in which the matching elections corresponded to the modality sampled by the second-order stimuli (color-color, shape-shape, and size-size, shape-shape). Errors were found in relation to different kinds of incorrect matchings (identity instead of similarity, difference instead of similarity and similarity instead of identity). In the control group the distributions of errors mostly concentrated in errors of identity or difference instead of similarity matching, while correct responses, although inferior to those in the experimental group, were proportionally distributed in similar way. Figures 13 and 14 depict the mean percentage of correct and incorrect responses in the pretest and extrarelational test sessions. Both groups showed an increase in correct responses in the extrarelational test session compared to the pretest. This increase was specially significant for correct responses in similarity and difference-matching trials. Most errors in the experimental group consisted in identity responses in difference-matching trials, and difference responses in similarity-matching trials. Additionally, the control group showed a high percentage of identity errors in similarity-matching trials.

SUBJECT	INSTANCE PER SESSION				CLASS PER SESSION				RELATION PER SESSION				CORRECT MATCHING RESPONSES PER SESSION			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
1	45	52	53	52	26	19	22	19	29	29	25	29	69	78	78	81
2	50	47	39	45	19	2	22	19	31	31	39	36	78	83	86	95
3	36	39	47	50	17	29	19	17	47	33	34	33	47	81	97	100
4	42	42	47	65	11	19	3	0	47	39	50	36	68	50	82	97
5	39	50	42	42	31	19	28	22	30	31	30	36	86	83	83	86
6	25	38	39	48	47	24	19	16	28	38	42	36	25	33	86	83
7	20	20	33	31	40	19	14	8	40	61	53	61	82	97	100	97

Table 1. Mean percentage of correct matching responses and type of textual options elected during training sessions.

	SESSION	CATEG	CC	CN	CC	CN
I D E N T I T Y	1	I C R	26.8 4.6 41.3	3.8 7.1 5.6	1.8 0.6 0.0	4.6 2.6 0.9
	2	I C R	32.0 2.4 43.00	4.9 4.9 3.3	0.9 0.9 0.9	3.0 0.0 4.0
	3	I C R	41.0 0.0 52.0	2.0 0.0 0.7	1.6 0.0 0.7	2.0 0.0 0.0
	4	I C R	39.0 0.0 61.0	0.0 0.0 0.0	0.0 0.0 0.0	0.0 0.0 0.0
S I M I L A R I T Y	1	I C R	18.00 20.00 5.00	9.00 10.00 9.00	1.00 2.00 1.00	9.00 6.00 8.00
	2	I C R	29.00 21.00 11.00	9.00 11.00 7.00	0.0 0.9 1.6	1.8 0.9 6.8
	3	I C R	31.00 24.00 0.0	0.0 0.0 0.0	0.8 0.8 2.6	3.4 0.0 2.5
	4	I C R	37.8 23.4 16.7	6.1 1.4 6.1	0.0 1.4 1.6	2.1 0.0 2.4

CATEG: Instance (I), Class (C) and Relation
(R) categories.
CC: Correct correspondence
CN: Incorrect correspondence
CC: Correct Non-correspondence
CE: Incorrect Non-correspondence

Table 2. Mean percentage per session correspondence between textual descriptions and correct and incorrect matching responses during training sessions.
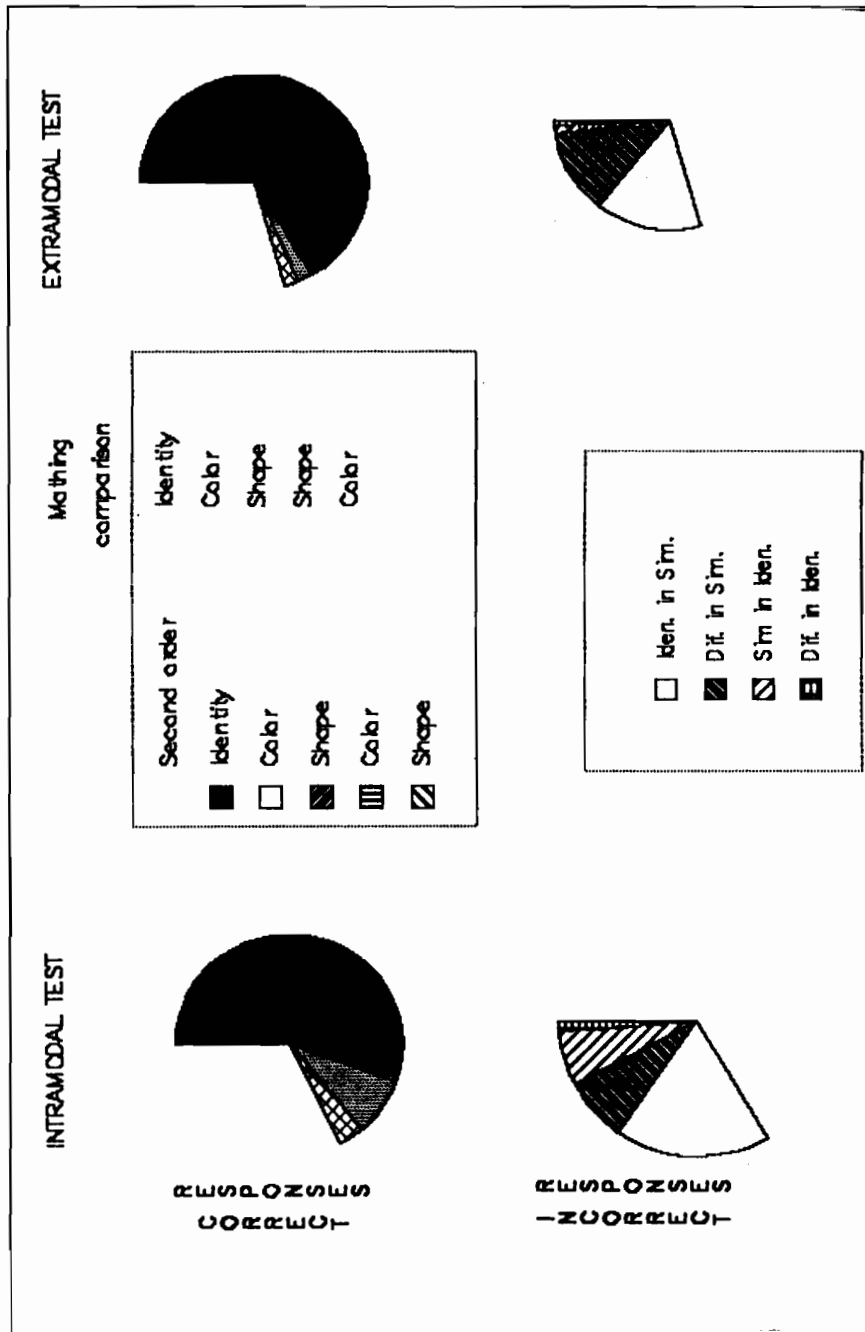
Figure 11. Mean percentage of types of correct and incorrect responses during intramodal and extramodal tests for the experimental group.
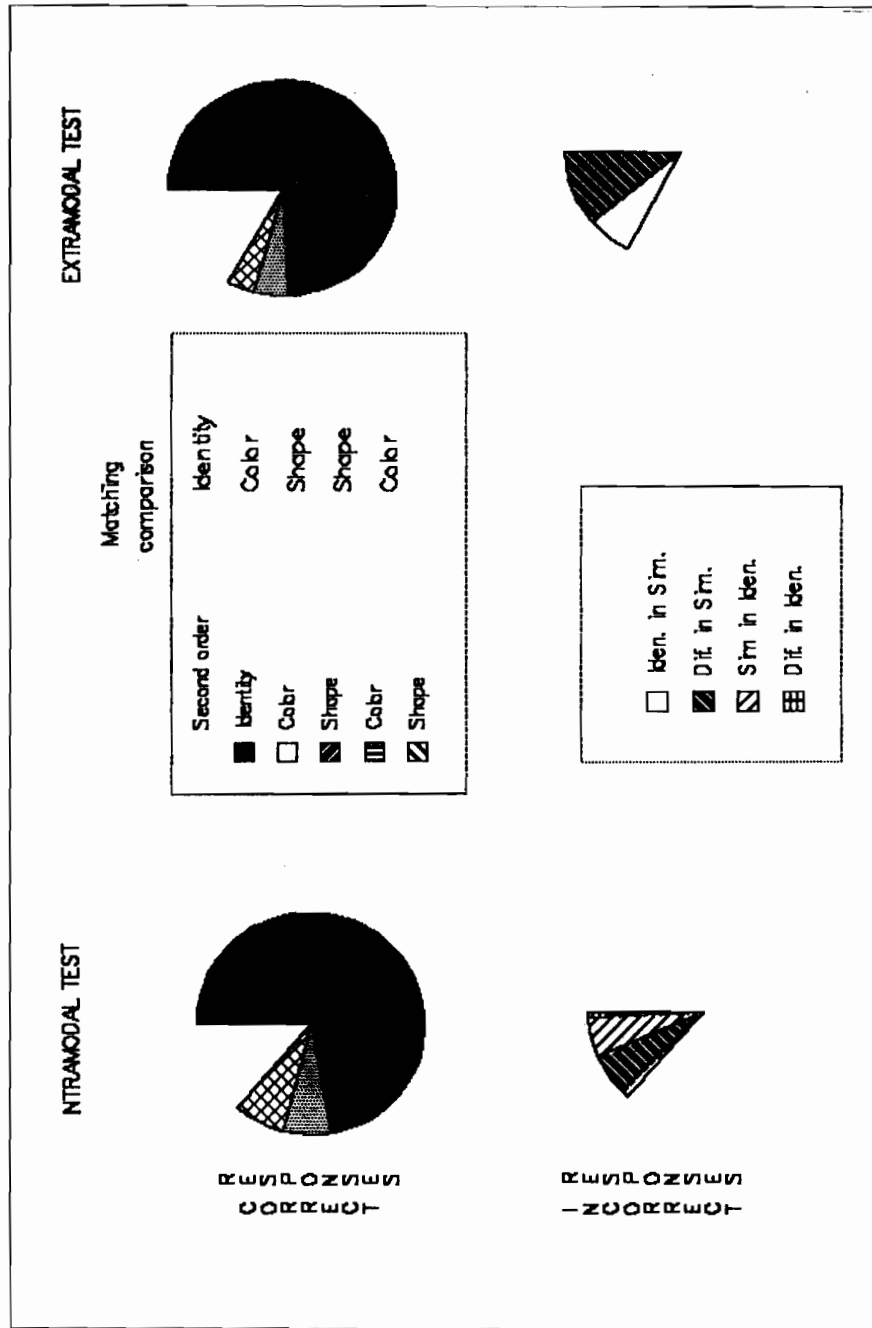
Figure 12. Mean percentage of types of correct and incorrect responses during intramodal and extramodal tests for the control group.
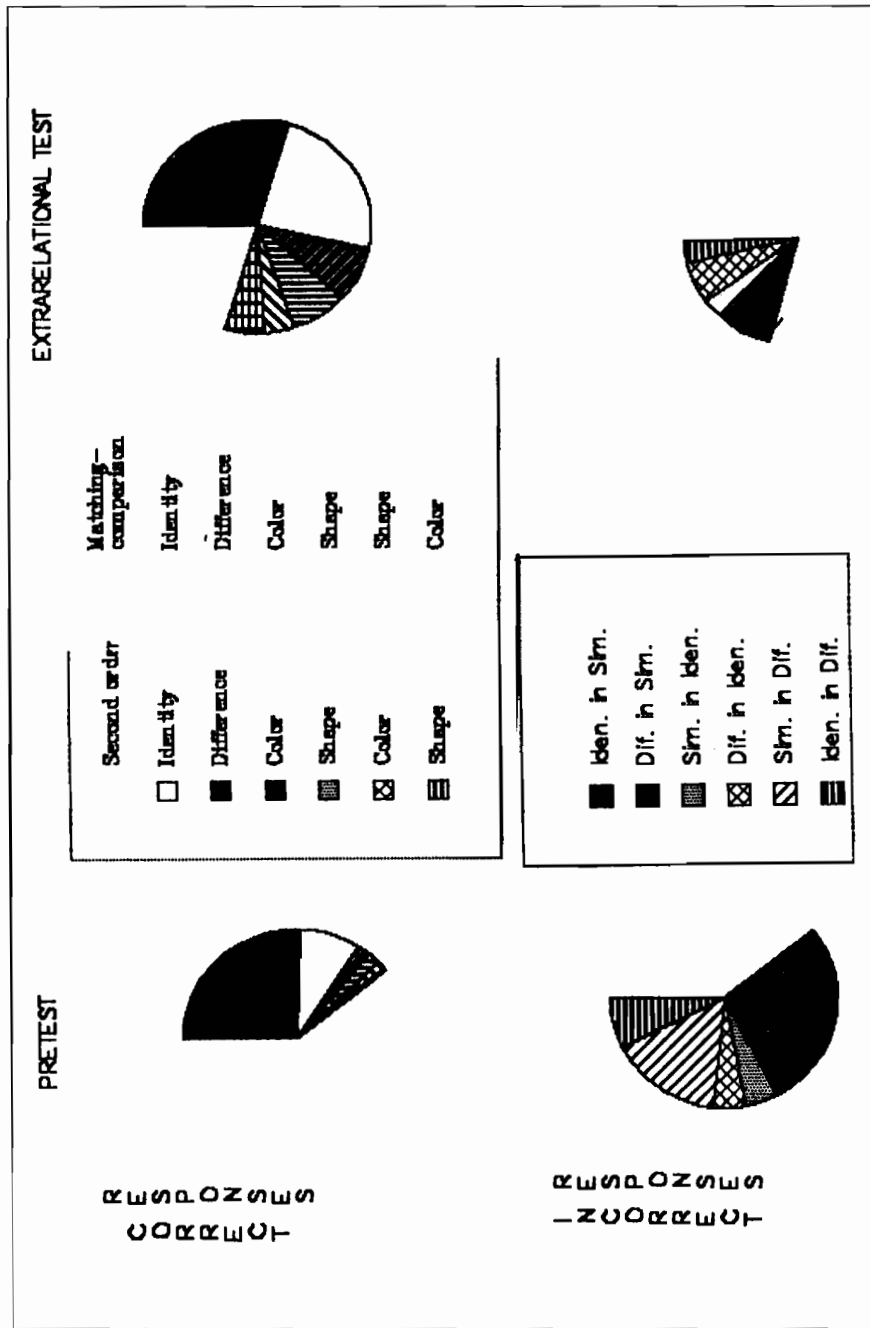
Figure 13. Mean percentage of types of correct and incorrect responses during the pretest and extrarelational test for the experimental group.
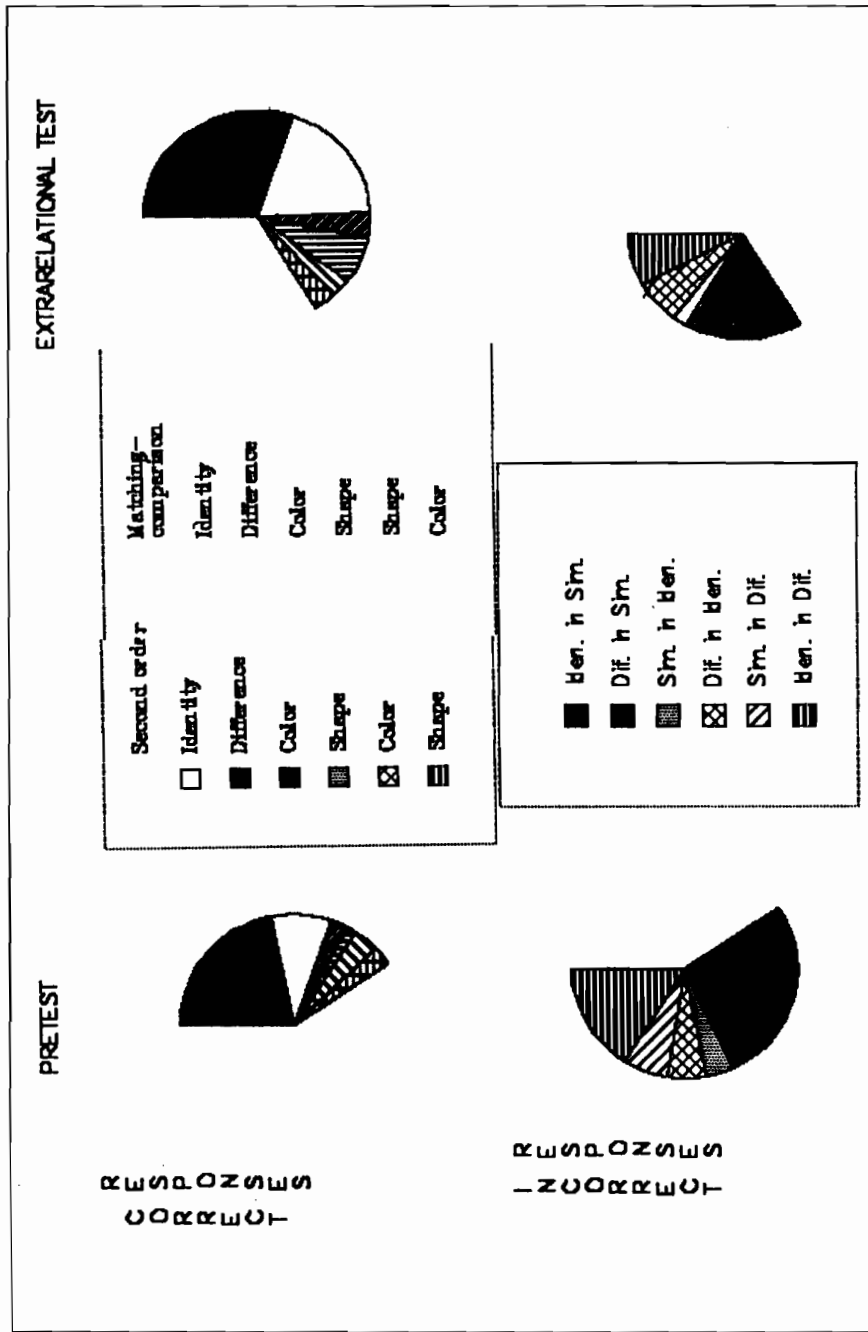
Figure 14. Mean percentage of types of correct and incorrect responses during the pretest and extrarelational test for the control group.

DISCUSSION

The results of this study show that the experimental group, which was exposed to textual options before selecting a matching comparison stimulus, had a better performance in both the training and the transfer sessions than the control group. This difference in performance also reflected an increased variability in responding among subjects in the control group. The texts selected by subjects in the experimental group seemed to be functionally related to actual performance during the training sessions because of their correspondence with the matching responses using the joystick. This correspondence gradually increased during the training sessions and may be atributed to the effect of choosing the texts before responding to the matching situation. Nevertheless, this correspondence did not seem to be straight-forward, as a hard-hypothesis about the relation between verbal "knowledge" (or rule-governed behavior) and instrumental behavior might suggest. Two features of data are important in this respect.

First, there was no systematic increase of a single kind of textual option in relation to the accuracy progressively reached in matching performance. The kind of texts selected by the experimental subjects showed a relatively even distribution along the training sessions. No single kind of textual option (*relation*, *class*, or *instance*) seemed to have a systematic and unequivocal effect on the subsequent matching response since experimental subjects chose equally any of the three kind of texts.

Second, although experimental subjects showed a better performance than control subjects in the transfer tests, aside from the quantitative differences between them, the *kind* of correct and incorrect matchings did not vary between both groups. Errors largely consisted in incorrect responding during similarity and difference-matching trials. Since rule-governed behavior, as different from instruction-controlled behavior, requires that subjects be able to describe general contingencies, performance in transfer tests should show: a) a systematic trend in terms of the relational or class criterion governing matching behavior, and b) a change in the kind of errors regarding pretest conditions. None of these were characteristics of performance of either control and experimental subjects during tests performance. Quantitative differences in transfer tests may be attributed to the differential performance reached during the training sessions by the experimental and control groups.

According to these observations, textual options seem to have increased the discriminability of present stimulus arrangements. The correspondence between textual options and matching responses support the fact that texts were actually read. Nevertheless, this increased differential behavior did not seem to involve *systematic* descriptions of the stimulus contingencies to be matched. If this was the case, it might be feasible that although experimental subjects recognized the kind of matching corresponding to the textual option being selected, they did not recognize a systematic kind of matching rule (as indicated by the three types of

texts). Therefore, it seems that the presentation of optional texts and the selection of a particular kind of text describing stimulus relations was not sufficient to induce verbally regulated instrumental performance in the form of rules.

This is additionally confirmed by the performance during the transfer tests, where no qualitative differences were observed between the experimental and control groups. None of them showed any systematic matching criterion during the tests, as should be expected if they had previously developed any rule-type behavior during training. Along the same line, both groups were very similar in the errors being made during transfer tests.

In his analyses of intelligence and thinking, Ryle (1949, 1979) has established the distinction between performing successfully (knowing how) and knowing why, that is, to be able to describe the performance and circumstances under which the performance is successful. Descriptions as 'knowing why' appear *after* successful performances (knowing how), and only when these performances and descriptions are varied enough, a general description in the form of a rule may be formulated.

If Ryle's analysis is correct, verbal behavior dealing with the performance in a problem-solving situation becomes functional as self-descriptions and/or self-instructions if it takes place *after* successful performance. These descriptions may evolve into rules if there is sufficient variety of performances and descriptions to ensure generality. This would explain why in this experiment, verbal descriptions did not seem to develop into any consistent way of verbally-regulated performance during the matching-to-sample task.

Additional studies are needed in this direction, in which explicit verbal descriptions before, during and after matching responses are evaluated during acquisition and transfer of a conditional discrimination. The role of verbal descriptions in instruction-controlled and rule-governed behaviors may depend upon their timing relative to the course of discriminative performance.

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