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Simple discrimination training and conditional discrimination response

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Título: Entrenamiento de discriminación simple y respuesta de discriminación condicional.
Resumen: La discriminación condicional es un procedimiento cuyo uso está ampliamente extendido en el AEC (Análisis Experimental del Comportamiento), especialmente las denominadas "Igualaciones a la Muestra". Aunque se ha puesto en práctica con una amplia variedad de especies, el comportamiento de humanos con competencias verbales en este tipo de tareas puede involucrar otras variables de control diferentes a las contingencias de cuatro términos programadas. El objetivo de este trabajo fue comprobar si se podían adquirir discriminaciones condicionales aunque las contingencias de refuerzo no involucrasen a la muestra. Participaron 109 alumnos de psicología que fueron distribuidos en tres condiciones. Todos fueron expuestos a dos bloques de entrenamiento (A y B) con una muestra y tres comparaciones, no obstante, en el 75% de los ensayos del bloque B la muestra no funcionaba realmente como un estímulo condicional. Se manipularon la simultaneidad muestra-comparaciones y el requerimiento de respuesta de observación a la muestra, dando lugar a tres condiciones diferentes. Los resultados no mostraron diferencias entre la velocidad de adquisición del bloque A y del B en ninguna condición, lo que apunta a que el comportamiento de los participantes estaba más controlado por la configuración estimular que por las contingencias de reforzamiento.
Palabras clave: Igualación a la muestra; discriminación simple; conducta gobernada por reglas; humanos.

Abstract: The conditional discrimination is a procedure the use of which is widely extended in the EAB (Experimental Analysis of Behavior), especially those known as "Matching to Sample". Although it has been used with a wide variety of species, the behavior of humans with verbal skills in these kinds of tasks may involve other control variables which are different from the scheduled contingencies of four terms. The aim of this work was to verify if conditional discriminations could be acquired, although reinforcement contingencies did not involve the sample. 109 psychology students, who were divided into three conditions, participated in the study. All of them were exposed to two blocks of training (A and B), with one sample and three comparisons, however, the sample did not really function as a conditional stimulus in 75% of the trials in block B. Simultaneity between sample and comparisons, as well as the requirement of a sample observation response, were manipulated resulting in three different conditions. The results showed no differences between acquisition speed in block A and block B in any condition, which suggests that the behavior of the participants was more controlled by the stimuli configuration than by the reinforcement contingencies.
Key words: Matching to sample; simple discrimination; rule-governed behavior; humans.

Introduction

Although the experimental study of operant behavior conditional control began 75 years ago, the use of Conditional Discriminations has experienced a boom in recent decades, both in its basic and applied aspects. A Conditional Discrimination is defined as a situation in which the role of the Discriminative Stimuli (DS) depends on the presence of another event: the Conditional Stimulus (Pellón, Miguens, Orgaz, Ortega & Pérez, 2014). One of the most used formats of a Conditional Discrimination is known as "Matching to Sample", which is mainly characterized by the fact that the controlled response is orientated to the DS (called "Comparisons"), being selected one or the others as a function of the Conditional Stimulus presented (called "Sample").

However, although in these types of tasks four term contingencies are programmed, causal variables of the conditional discrimination observed in humans with verbal skills still being an issue that could be discussed.

On one hand, it has been found that humans perform Matching to Sample consistent with trainings in which conditional discriminations were not explicitly reinforced, either they were simple discriminations (Vaughan, 1988; Sidman, Wynne, McGuire & Barnes, 1989; Smeets, Barnes & Roche, 1997; Smeets, Barnes & Cullinan, 2000; Debert, Huziwara, Faggiani, Siomes de Mathis & McIlvane, 2009; Debert, Matos & McIlvane, 2007) or respondent-type trainings (Leader, Barnes & Smeets, 1996, 2000; Smeets, Leader & Barnes, 1997; Leader & Barnes-Holmes, 2001a, 2001b; Clayton & Hayes, 2004).

On the other hand, some studies have shown that subjects tend to perform consistent Matching to Sample even if no kind of explicit feedback is applied to neither of their decisions, for example in test situations (Leonhard & Hayes, 1990; Pérez & García, 2009). The emergence of this conditionality in the response without explicit differential reinforcement was analyzed in a later work (Pérez & García, 2010), finding that it depended on the possibility of continue responding ("matching") consistently trial after trial, which was interpreted as a rule-governed behavior way.

The present work is part of this research line, providing, on one hand, more empirical evidence of the lack of need for conditionality in training to observe Matching to Sample, and on the other hand, analyzing possible training characteristics that could explain this phenomenon.

Method

Participants

109 Universidad Nacional de Educación a Distancia (UNED) psychology students participated, of which 86 were women and 23 were men. The ages ranged from 18 to 56 [*M* = 29.17, *D.S.* = 10.02]. All of them voluntarily participated in the study and had no knowledge of its purpose and development.

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Of the 109 participants, 36 were exposed to the first condition, 39 to the second and 34 to the third.

Materials

The whole procedure was designed with Flash CS4, programmed with Action Script 2.0 and then compiled in a single executable application. Both the stimuli and consequences display as the responses registry were carried out through this independent application, without the mediation at any moment of the experimenter. Participants emitted their responses selecting the stimuli with the computer mouse.

The stimuli used were 60 images of grey tones abstract art paintings, containing no recognizable figures (Figure 1).

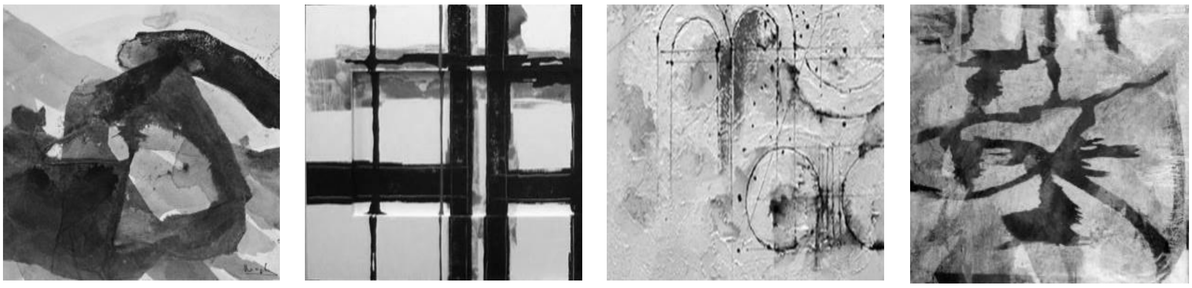

Figure 1. Examples of the stimuli that were used.

Procedure

This study was guided by a Repeated Measures Design (Ato, López & Benavente, 2013), formed by one inter-subject independent variable with three levels ("condition") and one within-subjects independent variable with two levels ("block").

After introducing personal data and confirming that the instructions had been understood, participants were randomly assigned to one of the three experimental conditions, consisting of two training blocks each:

- *Block A. Conditional discrimination.* Arbitrary matching to sample procedure, with one sample and three comparisons, in which three relations were reinforced (A1-B1, A2-B2 and A3-B3). Training was considered successfully passed when the participant performed ten consecutive correct trials in each pair. If a mistake was made, success counter for that pair returned to zero.
- *Block B. Simple discrimination with conditional discrimination trials.* Although the trials were superficially identical to the Block A trials (a stimulus at the top center of the screen and three at the bottom, from which the subjects had to choose one), reinforcement contingencies responded to a simple discrimination 75% of the time and in 25% to a conditional discrimination.

In simple discrimination trials, choices of D1, D2 and D3 stimuli were reinforced, but never appeared at the same time, therefore, the choice did not depend on the "sample" stimulus (which did not function as a conditional stimulus in these trials). For example, if C1 stimulus was presented at the top center in a trial, D1, X1 and X2 were presented at the bottom. And if C1 appeared again in another trial, X3, X4 and D1 were presented at the bottom. In this manner, discriminative stimuli were always the same in these trials, while delta stimuli changed trial after trial and were never repeated (Figure 2).

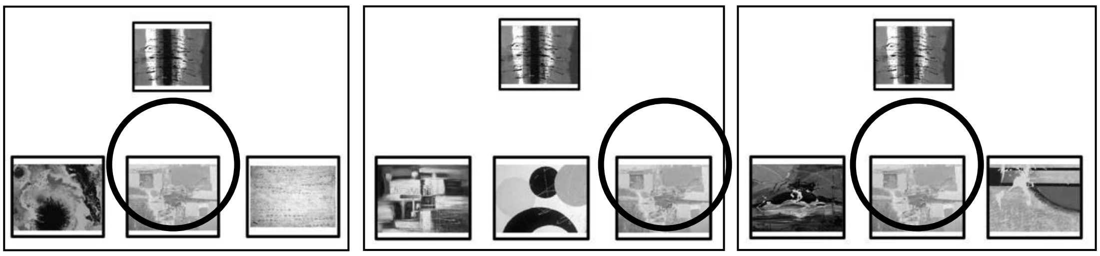

Figure 2. Three trials in which the same simple discrimination is reinforced.

In the conditional discrimination trials comparisons were always D1, D2 and D3 (the position where each comparison appeared was counterbalanced) and the choice of each one of them was reinforced as a function of the sample stimulus that was present (C1, C2 or C3) (Figure 3). Each sample appeared the same number of times. Success criteria was the same that was applied to Block A (ten consecutive correct trials), which prevented the participants to pass the block if they did not behave in a conditional way in these kinds of trials.

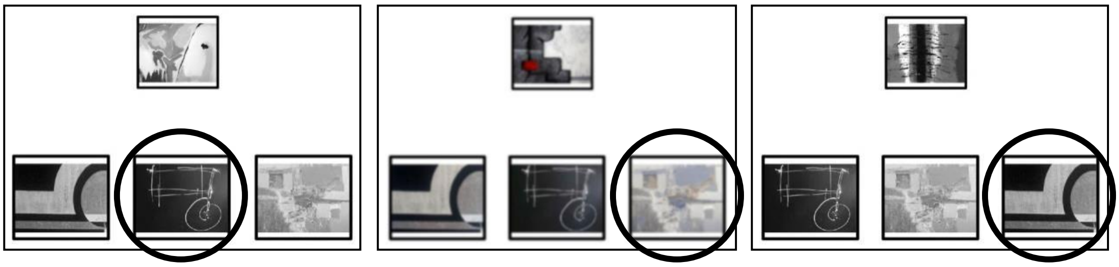

Figure 3. Three trials in which three different conditional discriminations are reinforced.

In each condition, half the participants were first exposed to Block A, and then to Block B, and the other half first to B and then to A. Experimental conditions differed in some training features (in both blocks):

- Condition 1. Simultaneous discrimination (sample and comparisons were presented at the same time) and requiring sample observation (Wyckoff, 1952).
- Condition 2. Successive discrimination (when the comparisons were presented, the sample disappeared) and requiring sample observation.
- Condition 3. Simultaneous discrimination but without requiring sample observation.

The reinforcer stimulus used was the message "¡GOOD!" on a green background while one of the multiple auditory messages of congratulation ("right", "excellent", etc.) was deployed. The aversive event used was the message "¡WRONG!" on a red background while an unpleasant sound was deployed.

The number of trials needed by each participant to reach success criteria in each training block was measured as dependent variable.

Results

The minimum number of trials required to pass any of the blocks was 30 (due to issues related to success criteria), while the maximum was 156. Considering grouped results of the three conditions, the mean of trials needed to complete Block A was 66.82 and to complete Block B, 69.6. A Paired-Samples t-Test was applied and no significant differences were found [t (109) = -0.76, p = .451, d = 0.15]. Figure 4 shows the participants distribution as a function of the number of trials that they needed.

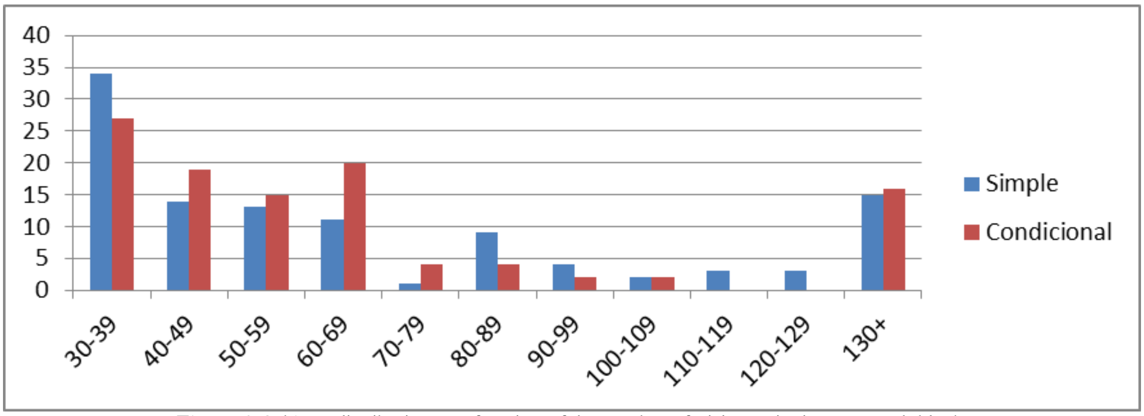

Figure 4. Subjects distribution as a function of the number of trials required to pass each block.
X - Axis: Number of trials needed, grouped by intervals. Y - Axis: Number of participants.

In Table 1 these data are shown separately according to each condition. No significant differences were found between the mean of each block:

- Condition 1: [t (36) = - 0.90, p = .374, d = 0.30].
- Condition 2: [t (39) = - 1.16, p = .252, d = 0.37].
- Condition 3: [t (34) = 0.48, p = .636, d = 0.16].

Table 1. Mean of the number of trials required to pass training blocks in each condition.

	Block A	Block B
Condition 1	55.69	63.14
Condition 2	63.67	69.15
Condition 3	82.21	78.12

The results shown in Table 1 suggest that there could have been an interaction effect (Condition*Block). However, a two factor ANOVA with repeated measures on one factor was carried out, showing that there was not a significant interaction effect [F (2,106) = 0.70, p = .499, $\eta p2$ = .013, $1\text{-}\beta$ = .166]. This analysis also shows that the factor "condition" has a significant effect on the dependent variable [F (2, 106) = 4.08, p = .020, $\eta p2$ = .072, $1\text{-}\beta$ = .714].

The analysis of the means, grouping the responses of participants in both blocks, revealed the following results (shown in Figure 5):

1) Blocks that were presented first were completed in 76.34 trials on average, while blocks that were presented in second place were completed in 60.43. After applying a Student´s t-test, significant differences were found [t (109) = 4.14, p < .001, d = 0.79].

2) Training blocks in which a sample observation response was required, needed 61.89 trials on average, and those in which this response was not required, needed 80.16. This difference was also significant [t (68) = -3.66, p < .001, d = 0.72].

3) Training blocks in which the sample remained present at the same time as the comparisons did, needed 57.69 trials on average to be passed, and when it was not like that, the mean was 66.41. This was not a significant difference [t (78) = -1.86, p = .066, d = 0.39].

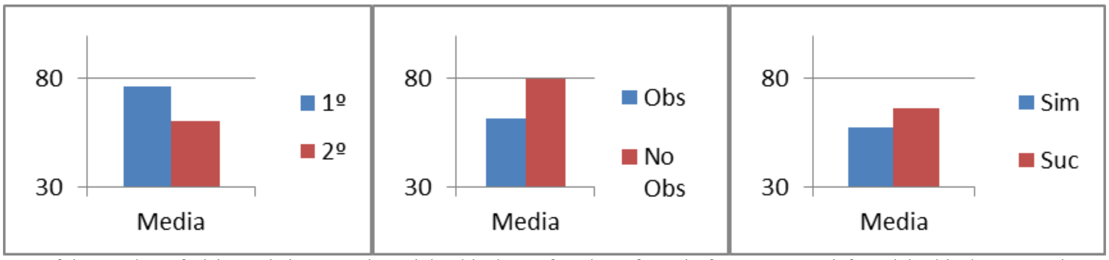

Figure 5. Mean of the number of trials needed to pass the training block as a function of certain features. From left to right: block presentation order (first or second), requiring a sample observation response (with or without it) and either simultaneous or successive discrimination training. X - Axis: Shows the two groups (red and blue bars) as a function of the signaled features. Y - Axis: Number of trials needed.

The effect as a function of the presentation order was also found when attending each block by separate:

- When block A was presented first, the mean number of necessary trials was 70.28, while when it was presented in second place, it was 62.51. This difference was significant [t (54) = 6.25, p < .001, d = 1.20].
- When block B was presented first, the mean number of necessary trials was 74.75, while when it was presented in second place, it was 50.30. This was also a significant difference [t (54) = 7.62, p < .001, d = 1.46].

However, significant differences were found depending on which block appeared in second place [t (54) = 4.67, p < .001, d = 0.89], 62.51 in block A and 50.30 in block B.

Discussion

The starting hypothesis was that if D1, D2 and D3 stimuli acquired a positive discriminative stimulus function in a simple discrimination contingency in block B (being reinforced in 75% of the trials), their comparison stimuli function would be interfered when they were involved in a conditional discrimination (in the 25% of remaining trials). The results have not shown any acquisition speed differences between block A and block B, which suggests that participants behaved always as if they had been exposed to a conditional discrimination, although reinforcement did not depend on the relation between the presented sample stimulus and the comparison stimulus chosen.

Conditional discrimination response requires that the subjects' choice also remain under conditional stimulus (sample) control, and not only under discriminative stimuli (comparisons) one. Some training conditions which favor that behavior of the subjects remain under sample stimulus control, increasing conditional discrimination acquisition speed, have been identified. Therefore, it would be expected that the absence of some of those conditions increased the probability that the subject would behave in block B exclusively attending to discriminative stimuli. However, the results do not support this assumption.

On one hand, the facilitating effect of the sample response requirement found in the literature has been replicated (for example, Riesen & Nissen, 1942; Eckerman, 1970; Lyderson & Perkins, 1974; Zentall & Hogan, 1978; Urcuioli & Honig, 1980; Paul, 1983), however, subjects continued behaving in block B as if a conditional discrimination was being trained, although this observation response was not required.

No significant differences were found between the execution in block A and in block B when the discrimination changed from simultaneous to successive or delayed. Further, the acquisition speed difference reported in the literature was not observed (Berryman, Cumming & Nevin, 1963; Cumming & Berryman, 1965; for example), maybe because the delay between sample stimulus disappearance and the comparisons appearance was very short.

These results suggest that the participants' behavior was more determined by the stimuli configuration rather than by the own reinforcement contingencies. Based on the description made in a work about learning without explicit reinforcement (Pérez & García, 2010), the "problem-situation" to which participants were exposed in this study, with one stimulus at the top and three at the bottom (one from which had to be chosen), suggested that the question "With which picture from below does the top one go?" was functionally comparable to the reinforcement contingencies. And so it was in block A, but not in block B (or at least not in most of it).

Verbal behavior emission, concurrent to the performance of Matching to Sample tasks, is a proved fact since the first works with this kind of procedure (Sidman & Cresson, 1973). Subjects with verbal skills tend to label (either publicly or privately) both present stimuli as the relationships between them, which has been called "naming" (Catania, 1988; Horne & Lowe, 1996; Greer & Ross, 2008). This behavior has shown to favor both the acquisition of conditional discriminations (see Moreno, Cepeda, Hickman, Peñalosa & Ribes, 1991; and Ribes, Cepeda, Hickman, Moreno & Peñalosa, 1992; Torres & López, 2004, for example) and the solution of problems of another nature (Catania, Matthews & Shimoff, 1981; Shimoff, 1986; Hayes, 1989; Törneke, Luciano & Valdivia, 2008).

The description of our environment, our own behavior and consequences that follow it, could be reinforced both for the positive correlation with reinforcer stimulus appearance as well as for the negative correlation with aversive stimuli. Once they are emitted with a high probability, they may precede the emission of the own operant functioning as a guide, as a control stimulus (Critchfield & Perone, 1990). This behavior, known as rules or instructions following (Baron, Kaufman & Stauber, 1969), could be at the same time reinforced by the own contingencies of the procedure (appearance or not of the programmed reinforcer stimulus) but also by the consistent application of the rule (Pérez & García, 2010), although it does not completely fit to all the nuances of the programmed reinforcing contingencies.

In the block B of our study, generating and following a rule based on a conditional relation was consistently applicable and also correlated with reinforcer stimulus appearance, but did not fit to the real control function of the discriminative stimuli. However, as has been shown in multiple studies (Lippman & Meyer, 1967; Matthews, 1977; and Shimoff, 1981, for example), once the behavior falls under an instruction control, it becomes less sensitive to change by direct contingencies.

There is a fact in our study that reinforces this thesis: the acquisition speed difference between block A and B (directly related to the conditional behavior) when they were presented in second place. In both cases, the number of necessary trials was significantly less than when they were presented first, consistent with the phenomenon known as Learning Dispositions (Harlow, 1949; Lawrence, 1963; and Seraganian, 1979), but the improvement was significantly higher in A-B sequence than in B-A. We could think that the exposure to block A favored a conditional rule creation which was applied since block B began. The design does not permit to conclude in this way, we would need a new experimental condition in which subjects were exposed to a simple discrimination and then analyze the behavior in block B. However, although it was like that, conditional behavior in block B has been demonstrated even when this block was presented first, so that we could be facing two compatible explanations: a) a rule generated in the presence of conditional contingencies and which is then followed even when the contingencies change; b) a conditional rule generated in the presence of simple contingencies due to the present stimuli configuration.

The results of this study add further empirical evidence for the consideration of the role of verbal behavior, and specific for the rule generation and following, as one of the most important aspects to explain the behavior observed in human studies (Hayes, Thompson & Hayes, 1989). And related to this, the results also add more arguments which question the role of the conditionality in training as the cause of the observed Matching to Sample, as well as the necessity of negative relationships establishment between sample and comparison.

These kinds of studies have important implications for explaining the phenomenon known as Equivalence Classes (Sidman, 1971) and its relationship with language. It is yet an unsolved issue for which there is evidence that points both to their independence (Sidman, Cresson & Willson-Morris, 1974; Sidman, Rauzin, Lazar, Cunningham, Tailby & Carrigan, 1982) and to its close relationship (Devany, Hayes & Nelson, 1986; Peláez, Gewirtz, Sánchez & Mahabir, 2000). Or at least, although having verbal skills is not a requirement in order to form equivalence classes (or to acquire a Match ing to Sample, of course), at the moment that they are available they are highly likely to be implemented, increasing acquisition speed and allowing certain relationships between stimuli to be established. That is, it is a sufficient but not necessary condition (Luciano, Gómez & Rodríguez, 2007).

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