Efectos del contenido funcional de la instrucción sobre el desempeño en igualación a la muestra de segundo orden

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Resumen

En el presente estudio se evaluó el efecto del contenido funcional de la instrucción sobre la adquisición, transferencia y descripción de la ejecución en una tarea de igualación a la muestra de segundo orden. Se asignaron veinte estudiantes de psicología a uno de cuatro grupos experimentales: (a) instrucción procedimental al inicio de la tarea (PInicio); (b) instrucción procedimental en cada ensayo (PEnsayo); (c) instrucción referida a instancias en cada ensayo (IEnsayo); y (d) instrucción referida a relación en cada ensayo (REnsayo). Se analizó la proporción de aciertos, la cual fue superior en los grupos IEnsayo y REnsayo en la fase de entrenamiento, para los grupos PInicio, PEnsayo y REnsayo en pruebas de transferencia extrainstancia y extramodal, y para el grupo IEnsayo en pruebas de transferencia extrarelacional; la mayor cantidad de descripciones adecuadas de ejecución se presentó en el grupo REnsayo. Estos resultados muestran que el control abstracto del estímulo se puede presentar tanto por transferencia de función a través de instrucciones como por diferenciación de casos positivos y negativos de las contingencias, lo cual se ve potenciado por la presencia concurrente de la instrucción y el arreglo estimulativo.
Palabras clave: Igualación a la muestra, control abstracto de estímulo, contenido instruccional, función instruccional, función dimensional.

Effects of the Functional Content of Instructions on Second-Order Matching-to-Sample Performance

Abstract

The effect of the functional content of instructions on the acquisition, transfer and description of performance in a second order matching-to-sample task was evaluated. Twenty undergraduate students were assigned to one of four experimental groups: (a) procedural instruction at the start of the task (PStart); (b) procedural instruction in each trial (PTrial); (c) instruction referring to instances in each trial (ITrial); and (d) instruction referring to relation in each trial (RTrial). The proportion of correct attempts was analyzed, and was found to be higher in the ITrial and RTrial groups for the training phase, and for the PStart, PTrial and RTrial groups in the extra-instance and extra-modal transfer test, as well as for the ITrial group in the extra-relational test; the larger number of accurate performance descriptions was observed in the RTrial group. These results show that abstract stimulus control can be presented either by way of transfer of functions throughout instructions, or by differentiation of positive and negative cases of the contingencies, which is enhanced by the concurrent presence of the instruction and the stimulus array.
Key words: Matching-to-sample, abstract stimulus control, instructional content, instructional function, dimensional function.

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Efeitos do conteúdo funcional da instrução sobre o desempenho em igualação à amostra de segunda ordem

Resumo

Neste estudo, avaliou-se o efeito do conteúdo funcional da instrução sobre a aquisição, transferência e descrição da execução numa tarefa de igualação à amostra de segunda ordem. Foram designados vinte estudantes de psicologia a um de quatro grupos experimentais: (a) instrução procedimental ao início da tarefa (PInício); (b) instrução procedimental em cada ensaio (PEnsaio); (c) instrução referida a instâncias em cada ensaio (IEnsaio), e (d) instrução referida à relação em cada ensaio (REnsaio). Analisou-se a proporção de acertos, a qual foi superior nos grupos IEnsaio e REnsaio na fase de treinamento, para os grupos PInício, PEnsaio e REnsaio em testes de transferência extrainstância e extramodal, e para o grupo IEnsaio em testes de transferência extrarrelacional; a maior quantidade de descrições adequadas de execução se apresentou no grupo REnsaio. Esses resultados mostram que o controle abstrato do estímulo pode ser apresentado tanto por transferência de função por meio de instruções quanto por diferenciação de casos positivos e negativos das contingências, o que se vê potencializado pela presença simultânea da instrução e do acordo estimulativo.

Palavras-chave: Conteúdo instrucional, controle abstrato de estímulo, igualação à amostra, função dimensional, função instrucional.

INTRODUCTION

The study of the functional relations between the organism's behavior and the objects and events in the environment has been founded on the segmentation of at least two discrete events, namely, those of stimulus and response (Baum, 2013). Such segmentation has allowed for the proposal of a number of stimulus events preceding response events in terms of their functional properties, such as *unconditional, conditional, eliciting, evocative, excitatory, inhibitory, discriminative, instructional, and dimensional* stimuli, among others (Ribes, 1997).

It is assumed that these stimuli functions exert control on properties of behavior in terms of either pavlovian or operant conditionality relations, from which the research area known as *stimulus control* has emerged (Dinsmoor, 1995a, 1995b). In the case of operant contingencies in nonhuman animals, three ways of antecedent control have been described: simple discrimination, conditional discrimination, and abstract stimulus control (Harrison, 1991; Mackay, 1991), while for humans control by antecedent verbal stimuli has also been formulated (Hayes, 1989).

In simple discrimination, two types of antecedent stimulus are identified: discriminative stimuli (S^D) and delta stimuli (S^Δ), which determine the occasion on which a response is either reinforced or not, respectively (Dinsmoor, 1995a). Alternatively, in conditional discrimination the S^D and S^Δ functions change depending on the occurrence of another event, called a conditional stimulus (S^C) (Mackay, 1991). It needs to be pointed out that in simple discrimination the S^D and S^Δ functions are kept constant or are absolute in regard to the reinforcement of the response, while in conditional discrimination, the S^D and S^Δ functions are characterized by their being variable or relative in relation with the conditional stimulus and the reinforcement of the response (Saunders & Williams, 1998).

This function of the conditional stimulus coincides with what Goldiamond (1966) called instructional function (S^{Di} and $S^{\Delta i}$), and the discriminative and delta functions with what he called dimensional function (S^D and S^Δ, to keep the same nomenclature). According to Goldiamond, the S^{Di} function is characterized by restricting the response alternatives to the modalities in which the stimulus events present a dimensional function, S^D; in other words, the instructional function determines the S^D or S^Δ control that a stimulus property can exert.

Additionally, if the relation between the S^{Di} and S^D functions is held constant throughout changing properties of the objects, such responding is characterized as a relational discrimination and the control exerted by such stimuli is called *abstract stimulus control* (Goldiamond, 1966; Ribes, 2000). For instance, if reinforcement in the presence of a constant property (e.g., triangular shape) occurs in conditions of variation by other properties (e.g., position, color, size, texture, etc.), it is possible to argue that the response to such constant property shows instructional control, and that the response to a particular element (e.g., a large-yellow-triangle) shows dimensional control, which is a synonym for abstraction, conceptualization, or rule-governed behavior (Goldiamond, 1966); hence, it can be said that the rule *'respond to the triangle'* has been abstracted.[1]

[1] The instructional function proposed by Goldiamond (1966) as a constant property, does not differentiate whether the events showing such functionality are referred to an absolute property,

Finally, in the case of human behavior relations of control by antecedent verbal stimuli whose function has been typified as a rule have been postulated. The control relation has been generally called rule-governed behavior (Vaughan, 1989), or particularly instructional control (Baron & Galizio, 1983), which implies correspondence between the *content* of a description which specifies or refers the dependence relations between effective behavior and events in a situation, and the behavior emitted in such situation (Martínez, Ortiz, & González, 2002; Ortiz, González, & Rosas, 2008; Ortiz, González, Rosas, & Alcaraz, 2006). In this way, a rule can describe relations implying simple, conditional, or abstract stimulus control.

Further, it is often considered that the quintessential process by which discriminative control is established is differential reinforcement. Presentation or omission of the reinforcer following the response occurring to stimulus changes in simple discrimination, or to stimulus-stimulus relations in conditional discrimination, allows for a sharper differentiation of the positive and negative contingencies involved in absolute or relative S^D or S^Δ functions, respectively (Green & Saunders, 1998; Harrison, 1991; Mackay, 1991; Saunders & Williams, 1998).

In the case of the establishing of abstract stimulus control, presentation of the reinforcer to positive cases of the stimulus-stimulus relations holding some correspondence (e.g., having the same shape), and its omission in negative cases, supports the differentiation of the S^{Di} and S^D functions as properties in constant correspondence (Carrigan & Sidman, 1992). If such differentiation has occurred, favored by the variation in contingencies resulting from differential reinforcement, and hence abstract stimulus control has been established, its identification requires that the act of responding to a constant stimulus-stimulus relation occurs to changing or novel stimulus properties. In these properties, it is identified that behavior occurs in a generic manner and not to specific relations, since they demand non-directly trained abstract behavior[2] (Carter & Werner, 1978; Ribes, Moreno & Martinez, 1998).

In contrast, it has been assumed that if the establishment of abstract stimulus control occurs by way of antecedent verbal stimuli, the range of potential responses in the contingencies is limited, in such a way that the differentiation of the S^{Di} and S^D functions as properties that are in constant correspondence; that is, insofar as the content of the verbal description specifies the effective behavior in the situation, the contact with programmed contingencies is reduced to the positive cases (Carrigan & Sidman, 1992; De la Sancha, Guzmán-Díaz & Serrano, 2015; Goldiamond, 1966; Ribes, 2000; Serrano, García & López, 2009; Stewart & McElwee, 2009).

In this context, the procedures of first-order (FOMTS) and second-order matching-to-sample (SOMTS) (Cumning & Berryman, 1965; Fujita, 1983) have been shown useful for the study of the processes of conditional discrimination and abstract control (Zentall, Galizio, & Critchfield, 2002), since the S^{Di} and S^D functions are separated in different events, specifically, sample stimuli and comparison stimuli. In the FOMTS procedure, abstract control is fostered by the variation of individual sample-comparison relations holding the same correspondence, which implies not only the change of the S^D or S^Δ functions of the comparison stimuli relative to the S^{Di} function of the sample stimulus, but also that different comparisons share the same S^D function and different sample stimuli share the same S^{Di} function, insofar as the same relation is held (Ribes, Torres, Barrera, & Ramírez, 1995). For example, two FOMTS trials can present the same correspondence (e.g., the same shape) if in the first one a red triangle is presented as a sample, a blue square (S^Δ) and a red triangle (S^D) as comparisons, while in the other one a blue square is presented as a sample, and a red triangle (S^Δ) and a blue square (S^D) are presented as comparisons.

In the SOMTS procedure, there is an additional stimulus event with an S^{Di} function which conditions the S^D or S^Δ function of the sample-comparison relations; in the above example, in the presence of an additional stimulus prescribing the relation of sameness in shape, the same S^D or S^Δ functions of the comparison stimuli are maintained, while in the presence of a different stimulus prescribing the relation of difference in shape, such relations are inverted.

In the matching-to-sample procedures, thus, the effects of different variables on abstract stimulus control can be assessed, recognizing processes affecting its development and transfer, like differential reinforcement, or the control by antecedent verbal stimuli, among others.

For instance, many studies (León, 2015; Quiroga-Baquero, Padilla, Ordoñez & Fonseca, 2016; Rodríguez-Pérez, Silva-Castillo, Bautista-Castro, & Peña-Correal, 2015; Vega & Peña, 2008) have reported the establishment of abstract stimulus control by way of different procedures: (a) instrumental with continuous feedback; (b) accompanied by the presentation of precise or imprecise instructions; and (c) different types of modeling, comparing performance in

a relation among properties, a relation of relations, or a linguistic event stating a regularity.

[2] In the human case, it has been suggested, in addition, that it is possible for an individual to formulate a description of the way of behaving according to experienced contingencies (Skinner, 1966), although this is not a necessary effect of have been exposed to the contingencies (Ribes, 2000).

acquisition, maintenance, and transfer phases. Overall, results show higher accuracy percentages in phases of acquisition and transfer in the presence of precise instructions and expert modeling, as compared with other training conditions.

Specifically, in relation to the effect of antecedent verbal stimuli on abstract stimulus control, the *content* of instructions has assumed a number of values in terms of both the accuracy/inaccuracy and the specificity/generality of the information about the antecedent and consequent stimuli, the effective and ineffective responses, the relations of conditionality among them, and even about the procedure of the experimental task, under the assumption that they promote differential levels of involvement of the experienced contingencies or of instruction on the control of behavior (Hickman, Plancarte, Moreno, Cepeda, & Arroyo, 2011; Ruiz-Castañeda & Gómez-Becerra, 2016).

A number of studies (Ortiz et al., 2006, experiment 1; Ortiz, Pacheco, Bañuelos & Plascencia, 2007; Ortiz & Cruz, 2011), for example, have reported differential effects of the accuracy of instructional content in conjunction with variations in the density of feedback on the performance in FOMTS tasks, and on the elaboration of post-contact descriptions. In these studies, instructional accuracy was varied in terms of how generic or specific, pertinent or non-pertinent, irrelevant or absent the content was regarding the response component (i.e., the choice criterion based on modality and relation) in the matching task (Ortiz et al., 2008). Thus, three levels of feedback were evaluated: Absent, continuous or accumulated. The main findings replicated in these three studies were: (a) performances with accuracy percentages close to zero in training and testing phases under conditions of generic instruction and without feedback; and (b) accuracy percentages close to 100% in training and testing phases under conditions of specific/pertinent instruction and continuous feedback.

In contrast, Serrano, García & López (2006) assessed the effects of a generic instruction referring an unspecified relation, which was nonetheless indicated by second-order stimuli (Group 1), versus instructions referring the modality (Group 2) or the relation (Group 3), on the performance in training and transfer phases in a FOMTS task. It should be noted that in the training phase of their study, second-order stimuli were replaced by the corresponding instruction for groups 2 and 3. Their results showed that in training Group 1 had accuracy percentages lower than 50%, while groups 2 and 3 had percentages higher than 80%. In the transfer tests, out of the twelve possible performances, only one in Group 2 (extradimensional) and two in Group 3 (in intramodal and extradimensional) were higher than 80%; the remaining performances, across all groups, were lower than this percentage.

Similar findings were reported by González-Becerra & Ortiz (2014) in a FOMTS task in which either pertinent specific instructions or descriptions exemplifying correct/incorrect responding, whose contents referred to instances, modalities or relations, were presented. While the results showed performances higher than 80% in the training phase for all conditions, the performances were deficient in the transfer tests; out of the 32 possible performances, only five in the modality groups, 11 in the instance groups, and 13 in the relation groups were higher than 80% correct choice.

Likewise, Serrano, Garcia and Lopez (2008) presented either generic instructions (Group 1), or instructions referring to instance (Group 2), modality (Group 3) or relation (Group 4). Within a 27-trial block the relations of identity, similarity in color, and difference occurred in a successive manner (Nine sub-blocks per relation). In the case of Group 1, the generic instruction was presented at the start of the 27-trial block, but for Groups 2, 3, and 4 each precise instruction was presented at the start of each sub-block corresponding to each relation. Results showed that during training 25% of participants from Group 1 and more than 75% of those from Groups 2, 3 and 4, obtained percentages higher than 80%. In the transfer tests (intramodal, extramodal, and extradimensional), out of the 12 possible performances, only two in Group 2, five in Group 3, and three in Group 4 were higher than 80%.

Ribes and Zaragoza (2009, Experiment 1 Block 1) found similar results for four training conditions: Group 1 received instructions about relation and modality in each trial; Group 2 received instructions about the instance that should be selected in each trial; Groups 3 and 4 received generic instructions at the start of training (with Group 4 receiving correcting training). During training all participants had 100% correct trials, while in transfer performances above 80% were more frequent when the instruction referred to relations rather than when it referred to instances; when instructions were generic, performance was equivalent to that of the first group only when feedback was corrective.

According to this review, results have not been conclusive in regard to the effects of the functional content of instructions. In the study by González-Becerra y Ortiz (2014) a FOMTS procedure was used, while in Serrano et al. (2006) second-order stimuli were not present during training, so it can be argued that poor performances were due to the lack of stimulus components developing the instructional discriminative function. This stands in contrast with the good performance during transfer in the studies by Serrano et al. (2008), and Ribes and Zaragoza (2009), which used, instead, a SOMTS procedure, and in which differential effects of instructional content were observed.

In this way, the fact that the degree of specificity that was manipulated in the instructions did not necessarily limit the transfer of abstract control, despite restricting contact to positive cases of the contingencies without making contact with negative cases, casts some doubt on the function that has been attributed to instructions on the control of abstract responding, insofar as not every instruction with some degree of precision limits abstract stimulus control, even when they limit behavioral variability.

This can be attributed to the fact that the precise content of instructions specified functional aspects of stimulus components, like instances (e.g., red triangle), modalities (e.g., shape, color), or relations (e.g., identity, difference), which are effective for the matching of the sample-comparison relations. Instructions whose content refers to the effective relations and modalities can establish a general way of behaving which is applicable to different cases without being restricted to particular properties of positive cases, while instructions whose content refers to instances can establish a concrete way of responding to the immediate situation.

Instructions whose content refers to modalities and/or relations would promote transfer of abstract control insofar as behavior is linked to a regularity in the contingency, while those referring to instances would restrict such transfer insofar as behavior would remained attached to the particular cases of the contingency. Finally, instructions whose precise content specifies the stimulus and response components but not their functional aspects (i.e., generic instructions), even though they might enable contact with positive and negative cases, might or might not promote transfer. Whatever the case, the effects of such contents can be potentiated or mitigated by other variables yet to be discerned.

Consequently, the aim of the current study was to assess the effects of three types of functional content of the instruction (instance, relation, or procedural) on the acquisition, transfer and accuracy of the description of contingencies experienced in a SOMTS task.

METHOD

Participants

Twenty first-year students in the undergraduate program in Psychology at the National University of Colombia (10 males, 10 females, ages ranging between 16 and 23 years) participated in the study. They had no previous experience in matching-to-sample tasks. Monetary retribution was provided for their participation, regardless of their performance in the task.

Instruments and Setting

The experimental task was programmed in Macromedia Authorware 7.0, and was presented in a 17" monitor screen. The experiment was conducted in a cubicle of 2 x 3 meters, which was well illuminated and provided acoustic isolation for outside noise.

Procedure

Experimental design. A univariate design with four groups of five participants each was used. Participants were randomly assigned to each group. Group 1 received an instruction with procedural-type content at the start of the experimental task (PStart), while Groups 2, 3 and 4 received instructions with content referring to the procedure (PTrial), instances (ITrial) or relations (RTrial), respectively, in each of the training trials. All groups then were faced with an acquisition phase consisting of training and learning test, and a transfer phase consisting of three tests, each followed by a request to do a written report (see Table 1).

Experimental task. A second-order matching-to-sample (SOMTS) procedure was used. In each trial two objects were presented in the upper portion of the screen, an object in the middle, and three aligned objects in the bottom of the screen. The stimulus objects employed in the task consisted of a series of geometric figures with different stimulatory modalities (see Table 2).

Table 1
Design and Experimental Conditions

	Phase 1: Acquisition		Phase 2: Transfer		
Group	Train with instruction type				
1	Procedural at the start (PStart)				
2	Procedural in each trial (PTrial)	Learning Test	Extra-instance	Extra-modal	Extra-relational
3	Instance in each trial (ITrial)				
4	Relation in each trial (RTrial)				

Table 2
Stimuli Used During the Experimental Task

Stimuli	Shapes	Colors	Sizes	Texture	Phase
Second Order	Cross and Pentagon	Brown and Pink	3 cm	None	Training, Learning, and Transfer
Sample and Comparison	Circle, Triangle, and Square	Yellow, Blue, and Red	3 cm	None	Training, Learning, and Extra-relational Transfer
	Diamond, Rectangle, and Trapezoid	Green, Orange, and Purple	3 cm	None	Extra-instance Transfer
	Circle	Blue	4.5 cm, 2.5 cm & 1.0 cm	Small grid, checkerboard and 70%	Extra- modal Transfer

For Group 1 (PStart) the instruction was presented once at the start of the experimental task, before the first training block; for Group 2 (PTrial) the instruction was always the same, and was presented in each of the training trials; for Group 3 (ITrial) instructions varied in each trial according with the presented instances; finally, for Group 4 (RTrial) instructions varied each trial according with the type of relation specified by the second-order stimuli (see Appendix). For those groups where instructions were presented trial-by-trial, the text was presented above the second order stimuli.

The training phase comprised a minimum of 36 trials or a maximum of 126 trials, divided in blocks of 18 trials consisting of nine identity problems and nine problems of similarity in shape or color. Feedback was provided in each trial when a comparison stimulus was selected, consisting of the words "correct" or "incorrect." Each of the tests consisted of 24 trials: (a) learning test with 12 trials of identity in color and shape, and 12 of similarity in color or shape; (b) extra-instance transfer test with 12 trials of identity in color and shape, and 12 of similarity in color or shape; (c) extra-modal transfer test with 12 trials of identity in texture and size, and 12 of similarity in texture or size; and (d) extra-relational transfer test with 12 trials of difference in color and shape, and 12 of similarity in color or shape. No feedback was provided in any of the test trials, nor were instructions used during training presented. At the end of each transfer test participants were required to write a report on their performance.

General procedure. Once participants were in the laboratory, they were generally informed about the task, and then were asked to seat in front of the computer screen and to carefully read the information about each of the exercises to be developed that was presented in two consecutive screenshots (see Figure 1).

Then, participants were presented with two training blocks of 18 trials each; if they met a mastery criterion of 90% or more correct responses in the second block, they progressed to the learning test, and if they met the same mastery criterion in this learning test, they were presented with the transfer tests. If the mastery criterion was not reached, whether during the training or the learning test, participants were presented with an additional block of training up to a maximum of seven blocks (126 trials). If participants did not reach the criterion in any of the seven blocks, their participation was finished without the transfer tests being presented. Information related to the progress from the training phases to the testing phases was provided, and at the end of each transfer test a written report describing the experienced contingencies were requested (see Table 3).

RESULTS

Figure 1 shows the individual performances in each of the blocks of training, learning test, and transfer, in terms of the proportion of correct responses (left ordinate axis), and the identification of relations in the post-test description of contingencies by participant (right ordinate of the axis).

Training phase results

Regarding the proportion of correct attempts obtained by each experimental group during the training phase, taking into account the performance in the required blocks to reach the mastery criterion, it is possible to determine that in the conditions corresponding to Groups PStart and

Table 3
Instructions presented in the experimental task

Time During the Task	Provided Information
Welcome	Welcome, and thanks for participating in this study. This is an investigation on learning processes that are common to most people. The task you will be completing has nothing to do with intelligence or personality testing, but with process of solving a certain type of problems. Your personal information will be used for research purposes exclusively.
Familiarization Group 1	Six figures will appear in the screen: two in the top, one in the middle, and three in the bottom. You must choose one of the bottom figures, by clicking on it. On some occasions you will be informed whether or not your selection was the correct one. Your goal is to make as many correct attempts as possible. If you have any question please ask it right now, since no additional information can be provided later on. You can start now. When you are ready, please click on the "Continue" button.
Familiarization Groups 2, 3, and 4	An array of six figures and an instruction will appear in the screen. You must choose one of the bottom figures, by clicking on it according to what the instruction will read. On some occasions you will be informed whether or not your selection was the correct one. Your goal is to make as many correct attempts as possible. If you have any question please ask it right now, since no additional information can be provided later on. You can start now. When you are ready, please click on the "Continue" button.
Training Groups 1 and 2	Six figures will appear in the screen: two in the top, one in the middle, and three in the bottom. You must choose one of the bottom figures, by clicking on it.
Training Group 3	Taking into account that the top figures are a BROWN CROSS and a PINK CROSS, and that the middle figure is a RED TRIANGLE, choose the bottom figure that is a GREEN TRIANGLE.
Training Group 4	Taking into account that the top figures are SIMILAR to each other, choose the bottom figure that is SIMILAR to the middle figure.
Tests Group 1	From this moment on, you will NOT be told whether your choice was correct or not.
Tests Groups 2, 3 and 4	From this moment on, the instruction will NOT appear any longer, and you will NOT be told whether your choice was correct or not.
Contingency Description Screen	In this moment, please describe the correct way of responding in the previous series of trials. When two _________ figures appeared in the top portion of the screen I chose the figure _________ to the middle figure, and when two _________ figures appeared in the top portion of the screen I chose the figure _________ to the middle figure.

PTrial the lowest correct attempt proportions were found ($X = .48$; *D.T.* = .19; $X = .61$; *D.T.* = .23, respectively), while in Groups ITrial and RTrial the highest proportions of correct attempts were found ($X = .96$; *D.T.* = .04; $X = .98$; *D.T.* = .03, respectively). It should be pointed out, in addition, that within-group variability was higher for conditions PStart and PTrial than that obtained for conditions ITrial and RTrial.

Concerning the number of training and learning test trials required to progress to the transfer tests, it was found out that for Group PStart the average was 89.1 (*Min* = 60; *Max* = 126); for Group PTrial it was 103 (*Min* = 60; *Max* = 150); for Group ITrial was 119 (*Min* = 60; *Max* = 186), and finally for Group RTrial it was 60 (*Min* = 60; *Max* = 60).

Furthermore, only two participants from Group PStart progressed to the transfer test phase, while the remaining three participants were exposed to seven consecutive training

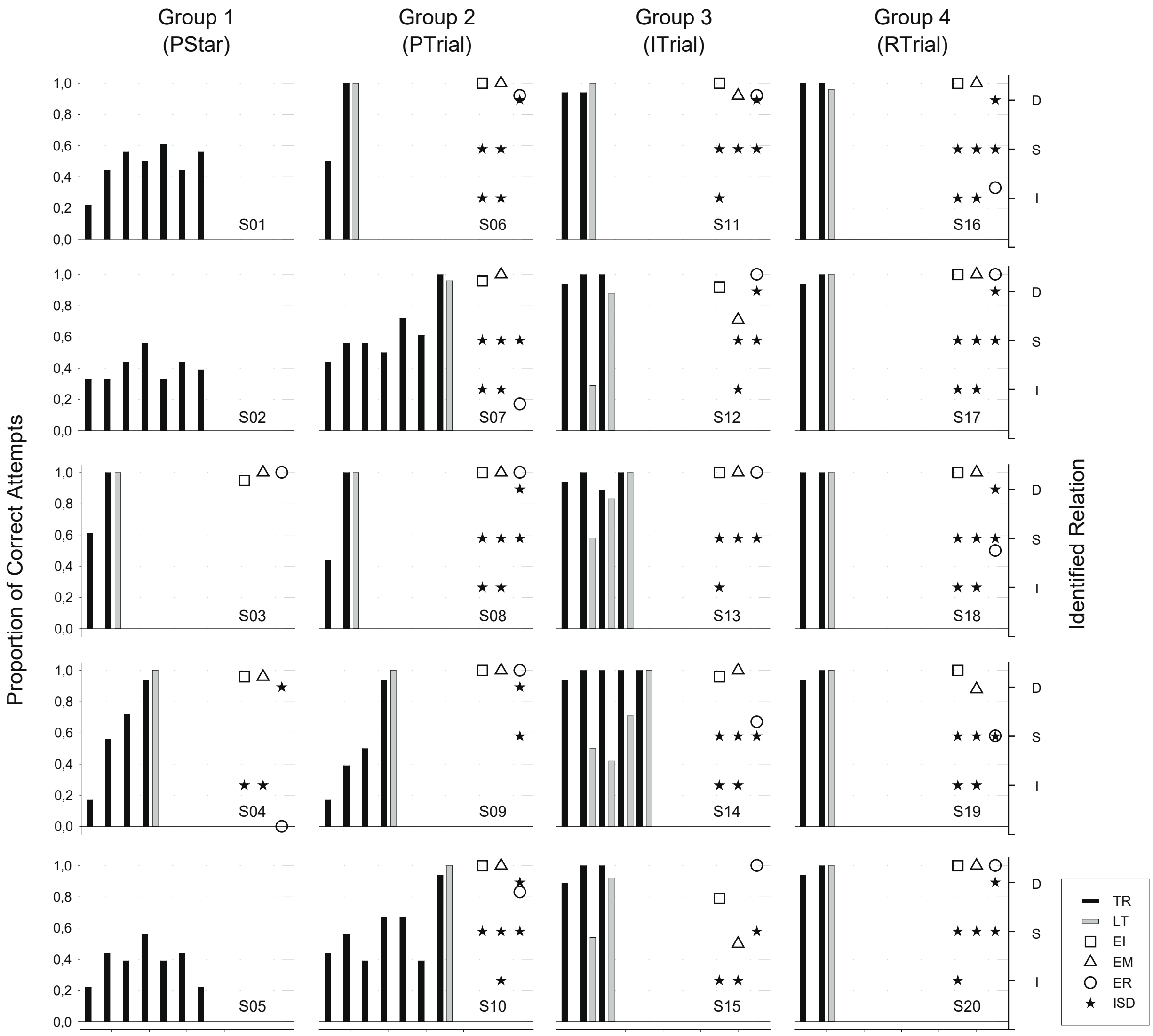

Figure 1. Proportion of correct attempts and type of identified relation in the contingency description. The left ordinate axis represents the proportion of correct attempts in training (TR), learning test (LT), and extra-instance (EI), extra-modal (EM), and extra-relational (ER) transfer tests. The number of 18-trial blocks to which each participant was exposed is presented in TR, while the number of times each participant went through the learning test is presented in LT. The right ordinate axis represents, by way of asterisks, the relations of identity (I), similarity (S), and/or difference (D) identified in the contingency descriptions occurring after each transfer test. Descriptions in each test could be: accurate = two asterisks; partially accurate = one asterisk; inaccurate = no asterisk.

blocks without ever reaching the 90% correct attempt mastery criterion. In Group PTrial, all participants met the learning criterion in the training blocks (two of the required seven blocks), and were exposed to a single learning test block, while in Group ITrial four participants required more than three blocks of training and more than two learning tests to meet the 90% correct attempt criterion. Finally, the highest performances occurred in Group RTrial, with all participants reaching the mastery criterion in merely two blocks of training and one block of learning testing.

These data support the conclusion that the presentation of procedural instructions whether at the start of the training phases or on a trial-by-trial basis, promoted lower correct attempt proportions as compared with conditions with instructions referring to instances or relations in each trial. It needs to be pointed out, however, that condition ITrial promoted performances above 90% correct attempts in the training blocks, but once exposed to learning tests (without feedback) participants didn't meet the mastery criterion, and had to be exposed to a new training block.

Transfer test results

When the correct attempt proportion averages in the extra-instance transfer test were compared across groups, homogenous performance was found in that across all groups the averages were higher than .90 (Group PStart: $X = .96$; $D.T. = .00$; PTrial: $X = .99$; $D.T. = .01$; Group ITrial: $X = .93$; $D.T. = .08$; y Group RTrial: $X = 1.0$; $D.T. = .00$), which indicates that the experimental manipulation didn't have a differential effect on performance in transfer trials with novel instances.

In the extramodal test, Group ITrial ($X = .82$, $D.T. = .21$) showed the lowest averages of correct attempt proportions, while those of Groups PStart ($X = .97$, $D.T. = .02$), PTrial ($X = 1.0$, $D.T. = .00$), and RTrial ($X = .97$, $D.T. = .05$) were close to 1.0, which indicates that the presentation of procedural instructions –as well as those referring to relations–, whether at the start or trial-by-trial, promoted the highest performances regarding the variation in stimulus modalities.

The comparison made of the mean correct attempt proportions across groups in the extra-relational test allowed to determine that the average of Group ITrial ($X = .91$, $D.T. = .14$) was higher than those of groups PStart ($X = .50$, $D.T. = .70$), PTrial ($X = .78$, $D.T. = .35$), and RTrial ($X = .68$, $D.T. = .30$). According to this, procedural or relational instructions trial by trial brought about a higher number of errors when presented with an untrained relation (difference), which was nonetheless prescribed by the second-order stimuli.

Identification of relations in post-test description

Figure 1 (right axis) presents the relations of identity, similarity, and/or difference identified in the descriptions occurring right after the transfer tests, which were classified as *accurate* if both of the relations operating in each test were identified, as *partially accurate* if only one of the relations was identified, and as *inaccurate* if none of them was identified. One of the two participants from Group 1 (PStart) who were exposed to transfer tests provided inaccurate descriptions, while the other one provided three partially accurate descriptions. In Group 2 (PTrial), ten accurate descriptions, three partially accurate, and two inaccurate descriptions were found. In Group 3 (ITrial) seven accurate descriptions, seven partially accurate, and one inaccurate description were provided. Finally, in Group 4 (RTrial) 13 accurate descriptions, two partially accurate ones, and no inaccurate descriptions were obtained.

DISCUSSION

The current experiment was developed to investigate the effect of different instructional contents on the performance in the phases of acquisition and transfer in a SOMTS task, and on the description of experienced contingencies. Results of performance in the training phase show that: (a) all participants exposed to the presentation of instructions in each trial (groups PTrial, ITrial, and RTrial) met the mastery criterion, while in the group being exposed to instructions only at the start of training (PStart) only two participants reached it; and (b) that the conditions of exposure to instructions referring to instances (group ITrial) and relations (group RTrial), promoted the most accurate performances in the training phases, in terms of a higher number of correct attempts, and a lower number of required trials required to meet the established mastery criterion. In the learning test, however, condition RTrial promoted performance close to a 1.0 correct attempt proportion, while the EIn condition required two or more tests for participants to meet the mastery criterion.

These results can be interpreted in the light of the arguments by Goldiamond (1966), and Layng, Sota and León (2011), according to which in a matching-to-sample-type stimulus array, second order stimuli might develop an instructional function insofar as they restrict or circumscribe the response to those object properties which are discriminative, according with the requirements of reinforcement schedules. These responses are thus limited to the dimensional properties shared by the sample stimulus and a comparison stimulus (color, shape, etc.), changing moment by moment, but maintaining a constant correspondence. According to Layng and colleagues (2011), it is possible that certain properties of a stimulus acquire instructional discriminative control (S^{Di}) by way of function transfer throughout a verbal statement, hence delimiting the relevant dimensional discriminative properties (S^D and S^Δ) for choice, or throughout the differentiation resulting from exposition to consequences of both positive and negative cases, which provides the differential feedback in the face of changing contingencies.

In the case of Group PStart, the fact that participants were exposed to a procedural instruction at the start of the task which specified the amount and location of the stimuli in the screen, as well as the requirement to choose one of them, did not favor the emergence of abstract stimulus control; that is, neither the establishment of S^{Di} functions in the second order stimuli, nor the discrimination of the pertinent modalities and relations (Ribes et al., 1995). In this way, the assumption that responding to relational properties is promoted by the differentiation of positive and negative cases provided by differential feedback in the face of changing contingencies (De la Sancha et al., 2015; Ribes, 2000; Serrano et al., 2009; Stewart & McElwee, 2009), is only partially supported, since while in this condition behavioral variability was promoted, the fact that three out of the five participants were unable to progress to the testing phases suggests that this is not necessarily the case, and that additional variables need to be considered.

It is plausible that being reactive to the function of the stimulus segments involved in the second order matching to sample situation (selector, sample, and comparison stimuli), might have been favored by concurrent presence of the instruction and the stimulus array, which facilitated the perceptual discrimination of the relevant dimensions and relations. Such facilitation might have consisted of a redirection of observing responses towards the stimulus segments comprising the array.

This seems to be the case for Group PTrial, which was exposed to the co-occurrence of instruction and stimulus array in each trial, and which evidenced multiple repetitions in the number of blocks necessary to meet the mastery criterion. Once such a criterion was met, however, all participants passed the learning test. These results suggest that concurrent instructions promoted the discrimination of stimulus segments, but that the establishing of S^{Di} functions was a result of the direct exposure to programmed positive and negative contingencies, hence promoting the onset of abstract stimulus control. The empirical possibility that instructions by themselves or their co-occurrence with the stimulus array might have promoted such observing responses needs to be considered, as reported by Huziwara, Souza and Tomanari's (2016) study on ocular movements in matching-to-sample tasks.

In regard to the second finding, Group ITrial was exposed to instructions referring to relevant properties of each present stimulus, and the specification of selecting one of them, that is, their dimensional S^D property. Reinforcement of this correspondence might have promoted that selecting behavior, moment by moment, was put under control of the instance specified in the instruction, limiting the establishment of instructional discriminative properties in the second order stimuli, hence the instruction would act only as altering the discriminative functions (Schlinger, 1993) on a comparison stimulus, an effect that should vary trial after trial.

This becomes evident in the fact that participants had good performances in the training blocks, but poor ones in the learning tests (no instructions and no feedback), which agrees with what was reported by Serrano et al. (2008), and Ribes and Zaragoza (2009). Nevertheless, the fact that every participant met the mastery criterion in the last learning test they faced casts doubt on whether the second order stimuli promoted abstraction by themselves, or if not, what was the factor enabling the establishment of abstract control by those stimuli, since in this condition the instructional content would only alter discriminative functions in concrete trials, and would not facilitate the differentiation of positive and negative cases. It is possible that abstract control by second order stimulus developed because of over-exposition to the learning test, in which the variability of the situation became salient in the absence of concrete instructions, but also in the absence of feedback, which suggests the need to empirically explore what factors might influence the development of the instructional function in situations in which reinforcement contingencies enabling the identification of positive and negative cases of the active relations are not present.

In contrast, the introduction of instructions referring to relations for Group RTrial might have favored the establishment of *instructional* discriminative functions (Goldiamond, 1966; Layng et al., 2011) in the second order stimuli, which can be observed both in the proportion of correct attempts (close to 1.0), as well as in the smaller amount of training and learning test trials, with all participants meeting the mastery criterion. A possible explanation for these results is that the content of the instruction specified an abstract relation, so that in addition to facilitate observing responses, it might have acted as a function-altering event for the stimulus segments (Schlinger, 1993), and for the abstract relation therein implied. This might be related to results reported by Rodríguez-Pérez et al. (2015), who identified the establishment of abstract stimulus control in a SOMTS task by presenting precise instructions referring to relations in each training trial, without any feedback. Nevertheless, although a similar instructional condition was used in the present research, we provided feedback on each trial, which suggests the need for further empirical inquiry into the function of exclusively positive feedback during training, the function of relational instructions in the absence of feedback, and into the possible interaction between these two variables.

Additionally, it was found out in the transfer phase that during the extra-instance and extra-modal tests the higher performances were promoted by the conditions involving procedural instructions and relational instructions in each trial (PTrial and RTrial), and that in the extra-relational test performances tended to be homogenous across experimental conditions. Similar findings have been reported by Ortiz et al. (2006), Rodríguez-Pérez et al. (2015), and Serrano et al. (2008), in conditions of continuous feedback, like those used in the present research.

According to the proposals by Ribes (2000), and Serrano et al. (2009), exposure to negative and positive instances of the programmed contingencies in matching-to-sample types of tasks happens to be a necessary factor for establishing abstract stimulus control, which can be affected in turn in situations of precise instructions limiting such variability. The performance of groups ITrial and RTrial doesn't support these arguments, and seems to suggest instead that this type of instructions might favor the establishment of instructional discriminative functions in the second order stimuli, hence promoting abstract relational responding. Accordingly, those conditions presenting instructions concurrently to stimulus arrays on trial-by-trial basis (PTrial, ITrial, and RTrial), promoted high performances in the learning and transfer phases, thus evidencing abstract stimulus control.

Finally, the accuracy of the contingency descriptions requested at the end of each transfer test was favored by those conditions involving procedural instructions in each trial (10 accurate descriptions), and relational instructions in each trial (13 accurate descriptions). In the first case, a correspondence was observed among proportions of correct attempts higher than .8 for all participants in the extra-instance and extra-modal tests, and for four participants in the extra-relational test, and a higher frequency of accurate descriptions in each of these tests.

The same finding was evident in Group 4 (RTrial), with the difference that in the extra-relational test the descriptions were mostly accurate, but only two participants had correct attempts proportions higher than .8, which might support the assumption that the establishment of abstract stimulus control does not correspond always with accurate verbal formulation of the contingencies array (Ribes & Rodríguez, 2001), as can be observed as well with participant S03 from Group 1 (PStart), who obtained correct attempt proportions higher than .9 in all transfer tests, but was unable to make accurate or partially accurate descriptions.

In Group 3 (ITrial), an equal amount of accurate and inaccurate descriptions was observed (7 in each case), homogeneously distributed in each transfer test. This suggests that the identification of one or two operational relations in each test was not affected by the type of variation that constituted each transfer test (instances, modalities or relations). It should be noticed that this group had multiple exposures to training and testing blocks in the training phase, unlike group RTrial, in which all participants met the mastery criterion in merely two blocks.

Taking this into account, it isn't clear whether the higher frequency of accurate descriptions in each of the transfer tests might have been fostered by the type of instructional content provided during the training phase, by the high performance in the corresponding tests, or by the interaction between these two factors and the performance in the training phases, which makes this grounds for future research.

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