Combinaciones de retroalimentación e igualación de la muestra generalizada bajo estímulos y relaciones de igualación familiares y no familiares

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Resumen

Seis grupos de estudiantes de preparatoria se expusieron a una tarea de igualación de la muestra de segundo orden y a pruebas de generalización con estímulos familiares y no familiares, así como con una nueva relación de igualación. Para dos grupos, las respuestas de igualación correctas e incorrectas produjeron la retroalimentación correspondiente de acuerdo con un programa continuo y uno intermitente, respectivamente. Las respuestas correctas produjeron retroalimentación y las respuestas incorrectas produjeron pantallas en blanco y viceversa para otros dos grupos, respectivamente. Dos grupos adicionales estuvieron expuestos a combinaciones similares de retroalimentación y pantallas en blanco, pero se instruyó a los participantes sobre el "significado" de las pantallas antes del entrenamiento. Se observó igualación de la muestra generalizada extra-relacional con estímulos familiares o no familiares solo después de las condiciones de entrenamiento en las que se programó retroalimentación intermitente *Correcto-Incorrecto*, así como cuando las respuestas de igualación incorrectas produjeron pantallas en blanco y las respuestas correctas produjeron la retroalimentación correspondiente. Las instrucciones sobre el significado de las pantallas en blanco produjeron ejecuciones generalizadas ligeramente superiores a las observadas después de la retroalimentación continua *Correcto-Incorrecto*, las cuales a su vez fueron similares a las ejecuciones observadas después de la condición *Correcto-Pantalla en blanco*, sin instrucción. Los resultados confirman una tendencia inicial a tratar las pantallas en blanco como retroalimentación para respuestas correctas y sugieren un proceso común de "desligamiento" entre la retroalimentación intermitente y la retroalimentación *Incorrecto-Pantalla en blanco*.
Palabras clave: control abstracto del estímulo, discriminación condicional, igualación de la muestra generalizada, humanos.

Feedback combinations and generalized matching-to-sample performance under familiar and unfamiliar stimuli and matching relations

Abstract

Six groups of high-school students were exposed to a second-order matching-to-sample task and generalization tests trials using familiar and unfamiliar stimuli as well as a new matching relation. For two groups correct and incorrect matching responses produced the correspondently feedback according to continuous and intermittent schedules, respectively. Correct responses produced feedback and incorrect responses produced blanks and vice versa for other two groups, respectively. Two additional groups were exposed to similar feedback-blanks combinations but participants were instructed about the "meaning" of blanks before training. Extra-relational generalized matching-to-sample performance with either familiar or unfamiliar stimuli was observed after training conditions in which intermittent right-wrong feedback was scheduled, as well as when incorrect matching responses produced blanks and correct responses produced the correspondently feedback.

Instructions about the meaning of blanks produced generalized performances slightly higher to those observed after continuous right-wrong feedback, which in turn were similar to performances observed after the uninstructed right-blank feedback combination condition. Results confirm an initial tendency to treat blanks as if they mean right and suggest a common "detachment" processes between intermittent feedback and the wrong-blanks feedback combination.

Keywords: abstract stimulus control, conditional discrimination, generalized matching-to-sample, humans.

Combinações de retroalimentação e igualação da amostra generalizada sob estímulos e relações de igualação familiares e não familiares

Resumo

Seis grupos de estudantes de vestibular foram expostos a uma tarefa de igualação da amostra de segunda ordem e a testes de generalização com estímulos familiares e não familiares, bem como a uma nova relação de igualação. Para dois grupos, as respostas de igualação corretas e incorretas produziram a retroalimentação correspondente de acordo com um programa contínuo e um intermitente, respectivamente, em que as respostas corretas produziram retroalimentação e as incorretas, ecrãs brancos — e vice-versa para outros dois grupos. Dois grupos adicionais estiveram expostos a combinações semelhantes de retroalimentação e ecrãs brancos, mas foi instruído aos participantes o "significado" das telas antes do treinamento. Foi observada igualação da amostra generalizada extrarrelacional com estímulos familiares e não familiares somente depois das condições de treinamento nas quais foi programada a retroalimentação intermitente *Correto-incorreto*, bem como quando as respostas de igualação incorretas produziram ecrãs brancos, e quando as respostas corretas produziram a retroalimentação correspondente. As instruções sobre o significado dos ecrãs brancos produziram execuções generalizadas levemente superiores às observadas após a retroalimentação contínua *Correto-incorreto*, as quais, por sua vez, foram similares às execuções observadas depois da condição *Correto-ecrã branco*, sem instrução. Os resultados confirmam uma tendência inicial a tratar os ecrãs brancos como retroalimentação para respostas corretas e sugerem um processo comum de "desligamento" entre a retroalimentação intermitente e a retroalimentação *Incorreto-ecrã branco*.

Palavras-chave: controle abstrato do estímulo, discriminação condicional, igualação da amostra generalizada, humanos.

Introduction

In a conditional discrimination situation, discriminative and delta functions of stimuli varies from one moment to the other conditionally upon a third, previous or concurrent stimulus segment. In terms of the typical matching-to-sample procedure with pigeons originally described by Skinner (1950), the third stimulus segment is the sample stimulus while comparison stimuli are the stimulus objects whose functions varies from trial to trial. Different matching relations could be trained on the basis of the physical properties of stimuli (e.g., identity, difference, similarity, etc.). In the case of human beings, after learning to perform according to one or more matching relations, participants may immediately match unfamiliar sample and comparison stimuli according with such criteria. If so, the performance is said to be generalized because it is not restricted to the specific trained stimuli or their physical properties.

As in natural settings, responding under matching-to-sample procedures could be influenced by feedback, that is, exteroceptive stimuli regarding the correspondence between an individual's behavior and prior or ongoing reinforcement contingencies (Mangiapanello & Hemmes, 2015). In a recent experiment, for example, Hirst, DiGennaro Reed and Reed (2013) explored the effects of feedback accuracy upon the acquisition of an arbitrary conditional discrimination by young adults. In their study, groups of participants received feedback that their matching responses were correct following incorrect choices and vice versa on 25, 50, 75 and 100% of the trials. They observed that the higher the proportion of inaccurate feedback trials, the lower the acquisition of the conditional discrimination in a second phase with accurate feedback; suggesting that feedback accuracy establishes the discriminative relation between a stimulus situation and behavior in a similar way to instructions or contingency-specifying stimuli. In this sense, Catania (2006) previously pointed out that providing information to an individual about that his response was correct is likely to say "respond the same way next time", suggesting that "it may be misleading to speak of the reinforcing properties of being correct and the punishing properties of being incorrect" (p. 298).

Using a verbal learning discrimination task, Spence (1964) reported that performance along training trials was

lower under a Right-Nothing feedback combination than under a Wrong-Nothing feedback combination, which in turn produced similar performances to those observed under the typical Right-Wrong feedback condition. In agree with the idea expressed by Catania (2006), she suggested that the dissimilar effects of Right-Nothing and Wrong-Nothing feedback combinations were due to the "informative" characteristics of nothing (i.e., blanks) rather than to a difference in positive and negative reinforcement functions of right and wrong, respectively. More specifically, Spence proposed that in the absence of instructions about its meaning, participants tend to treat blanks as if it meant right under both kind of feedback combinations. Being that way, such tendency is incompatible with the demands of the experimental task to treat blanks as incorrect under the Right-Nothing feedback combination, while under the Wrong-Nothing feedback combination the tendency promotes conditions similar to those in which correct and incorrect responses produce the correspondently feedback in each trial.

Previous experiments on generalized matching-to-sample, however, suggest that the absence of feedback in some trials has a more complex effect upon behavior. For example, Martínez and Ribes (1996) reported that participants exposed to an intermittent (i.e., every third trial) Right-Wrong feedback condition were less controlled by initial false instructions regarding the correct matching relation in both training and generalization tests than participants exposed to continuous Right-Wrong feedback. A third condition of delayed feedback (i.e., at the end of each training session) produced an intermediate performance. Martínez and Ribes suggested that the absence of feedback in some matching trials prompted a "detachment" from moment-to-moment contingencies and, accordingly, the self-construction of an abstract verbal discriminative stimulus controlled by the functional propriety shared by stimuli along trials (i.e., the matching relation).

Using matching-to-sample tasks with both Right-Nothing and Wrong-Nothing feedback combinations as well as the typical continuous Right-Wrong feedback condition, Serrano, García, and López (2009) reported that generalized matching-to-sample performance agree with the hypothesis expressed by Spence (1964) that participants tend to treat nothing as if it meant right along training trials. More recently, Serrano, Flores, Peralta and Martínez (2017) observed a higher generalized matching-to-sample performance after a Wrong-Nothing feedback combination training condition than after a Right-Nothing one, but also that the Wrong-Nothing feedback combination produced a higher generalized accuracy than continuous Right-Wrong feedback when generalization tests contained an untrained matching relation. By virtue of the performance observed under such "extra-relational" generalization tests trials, these latter authors suggested that their results were due to the initial tendency to treat nothing as if it meant right, but also to a detachment from moment-to-moment contingencies similar to that described by Martínez and Ribes (1996) regarding intermittent Right-Wrong feedback. The experiment, however, did not include a condition in which correct and incorrect responses produced feedback in an intermittently fashion.

On the one hand, the present experiment was conducted in order to compare the effects of a Wrong-Nothing feedback combination versus intermittent Right-Wrong feedback upon generalized matching-to-sample performance. If the effects of the Wrong-Nothing feedback combination are the result of an initial tendency to treat nothing as if it meant right but also the promotion of self-constructed verbal stimulus due to a detachment from moment-to-moment contingencies, participants trained under a Wrong-Nothing feedback combination should show similar generalized performances to those observed for participants exposed to intermittent Right-Wrong feedback, which in turn should be higher than performances observed for participants trained under continuous Right-Wrong feedback. On the other hand, it must be noted that in contrast with the hypothesis expressed by Spence (1964), neither available experiment on feedback combinations and generalized matching-to-sample had included participants instructed about the meaning of blanks before training. Following the suggestion expressed by Catania (2006), if right and wrong have an instructional function like "respond (or do not respond) the same way next time", participants instructed about the meaning of blanks and trained under Right-Nothing and Wrong-Nothing feedback combinations should show generalized performances similar to those observed for participants exposed to continuous Right-Wrong feedback.

Method

Participants

Participants were 30 high-school students aged 17 to 18 years, 21 female and 9 male, experimentally naïve in conditional discrimination tasks as well as in any other experimental procedure in Psychology. All participants provided written informed consent. Five participants were randomly assigned to each of six groups: Continuous Right-Wrong Feedback, Intermittent Right-Wrong Feedback, Right-Nothing Feedback, Wrong-Nothing Feedback, Instructed Right-Nothing Feedback, and Instructed Wrong-Nothing Feedback.

Apparatus and experimental settings

Participants worked individually in different small (3-m2), quiet rooms. Each of the five rooms was equipped with a table, a chair, a desktop computer (HP Compaq Model, dc5850) and a mouse. Stimuli were presented via the computer's monitor and the mouse served as the response device. Experimental events were automatically controlled and recorded using Superlab® 4.5.

Simultaneous second-order matching-to-sample trials were used for all groups of participants along the experiment. Each second-order matching-to-sample trial displayed seven colored shapes. Two colored shapes were the second-order stimuli that visually modeled the ongoing matching relation in each trail, one colored shape was the sample stimulus and the remaining four colored shapes were comparison stimuli. Second-order stimuli were displayed at the top of the computer's monitor, while sample and comparison stimuli were displayed at the center and bottom, respectively. Second-order stimuli were always different in shape and color from sample and comparison stimuli. In each matching trail one comparison stimulus was identical to the sample stimulus, one was similar in shape, another was similar in color and the fourth one was different in both color and shape. The spatial position of each kind of comparison stimulus was randomly changed from trial to trial along the experiment.

There were 36 pretest trials and 36 generalization test trials (12 color-similarity trials, 12 shape-similarity trials, and 12 difference trials), while there were 72 training trials (36 color-similarity trials and 36-shape similarity trials). Table 1 shows shapes and colors used to create second-order stimuli and first-order matching-to-sample arrangements (i.e., one sample and four comparison stimuli) used in each phase of the experiment.

Three shapes (rhombus, cross, and circle) and three colors (lightsky blue, gold, and black) allowed the construction of 18 pairs of stimuli similar in shape, 18 pairs of stimuli similar in color, and 36 pairs of stimuli different in both shape and color. Another set of three shapes (triangle, square, and pentagon) and three colors (green, yellow, and red) allowed the construction of 36 first-order matching-to-sample arrangements that were presented twice between two blocks of training trials. All pairs of colored shapes from color-similarity and shape-similarity pools of second-order stimuli were randomly correlated with first-order matching-to-sample arrangements in the first block of training trials. Correlations between second-order stimuli and matching-to-sample arrangements were inverted between training trials in the second block. Six pairs of stimuli different in both shape and color from the

Table 1.

Shapes and colors used to create second-order stimuli and matching-to-sample arrangements in each phase of the experiment.

Stimuli	Pretest and Generalization trials		Training	
	Shape	Color	Shape	Color
Second-order stimuli	rhombus	lightsky blue	rhombus	lightsky blue
	cross	gold	cross	gold
	circle	black	circle	black
	equal to	gray		
	chevron	purple		
	trapezoid	pink		
Sample and comparison stimuli	triangle	green	triangle	green
	square	yellow	square	yellow
	pentagon	red	pentagon	red
	L shape	blue		
	parallelogram	orange		
	hexagon	brown		

third pool of second-order stimuli were randomly extracted and correlated with six, randomly extracted matching-to-sample arrangements. These six matching trials were used as pretest and generalization test trials.

A third set of three shapes (equal to, chevron, and trapezoid) and three colors (gray, purple, and pink) allowed the construction of three new pools of second-order stimuli similar to those just described. A second set of 36 matching-to-sample arrangements was constructed using additional three shapes (L-shape, parallelogram, and hexagon) and three colors (blue, orange, and brown). Six pairs of colored shapes similar in color were extracted from the correspondently pool and were correlated with six matching-to-sample arrangements, randomly extracted from the just mentioned set. These six matching trials were used as pretest and generalization test trials. A similar procedure was used to construct six trials in which the ongoing matching relation was shape-similarity and six trials in which the ongoing matching relation was difference. Remaining pretest and generalization test trials were six color-similarity and six shape-similarity arrangements randomly extracted from the first and the second blocks of training trials.

Summarizing, pretest and generalization tests trials were identical tasks with 36 matching-to-sample trails; half constructed using the shapes and colors used in training (familiar stimuli) and the other half constructed with shapes and colors

not used in training (unfamiliar stimuli). For each half there were six color-similarity trials, six shape-similarity trials, and six trials in which the ongoing matching relation was difference. The training phase consisted in two blocks of 36 second-order matching-to-sample trials in which the spatial position of the four kinds of comparison stimulus (i.e., the identical one, the one similar in color, the one similar in shape, and the one different in both color and shape) was randomly changed across trials. In order to ensure variations in discriminative and delta functions of stimuli, a particular colored shape was the correct comparison stimulus under a shape-similarity trial but an incorrect one under a color-similarity trial between blocks of training trials.

Procedure

Participants from all groups were exposed to pretest trials, a training phase, and two kinds of generalization tests trials that were presented in a mixed fashion across the test phase. No performance criterion was imposed to get access to generalization tests trials in order to ensure homogenous training conditions between groups (except for feedback variables). Correct and incorrect matching responses produced a 5 s long blank screen for participants from all groups along pretest trials as well as along generalization tests trials. Instructions before pretest and generalization test trials were:

Seven geometric figures will appear on the following screens: two at the top, one at the center and four at the bottom. You must choose the figure at the bottom that you think goes with the figure at the center, according to the indication by figures at the top. To register your choice, place the mouse pointer within the figure that you chose and press the left button. Click the START button to begin.

Similar instructions preceded training trials for most groups. During training, correct and incorrect responses produced the correspondently feedback every matching trial for participants from the Group Continuous Right-Wrong Feedback and every third trial for participants from the Group Intermittent Right-Wrong Feedback. Feedback for correct and incorrect matching responses respectively consisted in the presentation of the words "right" and "wrong" during 5 s on the center of the computer's monitor. For participants from the Group Right-Nothing Feedback, correct matching responses produced the word "right" in the center of the monitor during 5 s, while incorrect matching responses produced a 5 s long blank screen. For participants from the Group Wrong-Nothing Feedback, correct matching responses produced a 5 s long blank screen, while incorrect responses produced the word "wrong" during 5 s. Participants from the Group Instructed Right-Nothing Feedback and those

from the Group Instructed Wrong-Nothing Feedback were exposed to feedback combinations similar to those used for participant from groups Wrong-Nothing Feedback and Right-Nothing Feedback, respectively; however, they were instructed about the meaning of blanks before training began:

Seven geometric figures will appear on the following screens: two at the top, one at the center and four at the bottom. You must choose the figure at the bottom that you think goes with the figure at the center, according to the indication by figures at the top. We will let you know if your choices were right or wrong. The word CORRECT [INCORRECT] will follow a right [wrong] choice, while a blank screen will follow a wrong [right] choice. To register your choice, place the mouse pointer within the figure that you chose and press the left button. Click the START button to begin.

Results

Figure 1 shows the mean percentage of correct responses on pretest (white bars) and generalization test (black bars) trails, as well as performance along the training phase in blocks of 18 trials for each participant. Dashed horizontal lines indicate 80% of correct responses. Figure 1 shows that except for one participant from the Group Wrong-Nothing Feedback (P16), performances were between zero and 50% of correct responses for most participants in pretest trials. Mean performances in generalization test trials were between 22 and 38% of correct responses for participants from the Group Continuous Right-Wrong Feedback, while for most participants from the Group Intermittent Right-Wrong Feedback performances were between 88 and 100% of correct responses. The exception was P8, whose performance in generalization tests trials was 22% of correct responses. Generalized performances were between 16 and 66% of correct responses for participants from the Group Right-Nothing Feedback, while for most participants from the Group Wrong-Nothing Feedback performances were between 88 and 100% of correct responses. In this case, the exception was P8, whose performance in generalization tests trials was 66% of correct responses. Terminal performances were between zero and 50% of correct responses for most participants from the remaining two groups. The exception was P23, whose performance in generalization tests trials was 63% of correct responses. Regarding the training phase, Figure 1 shows that performances were around or below 50% of correct responses for most blocks of trials and participants. In general, except for some participants from different groups (e.g., P13, P23, and 29), only participants from groups Intermittent Right-Wrong
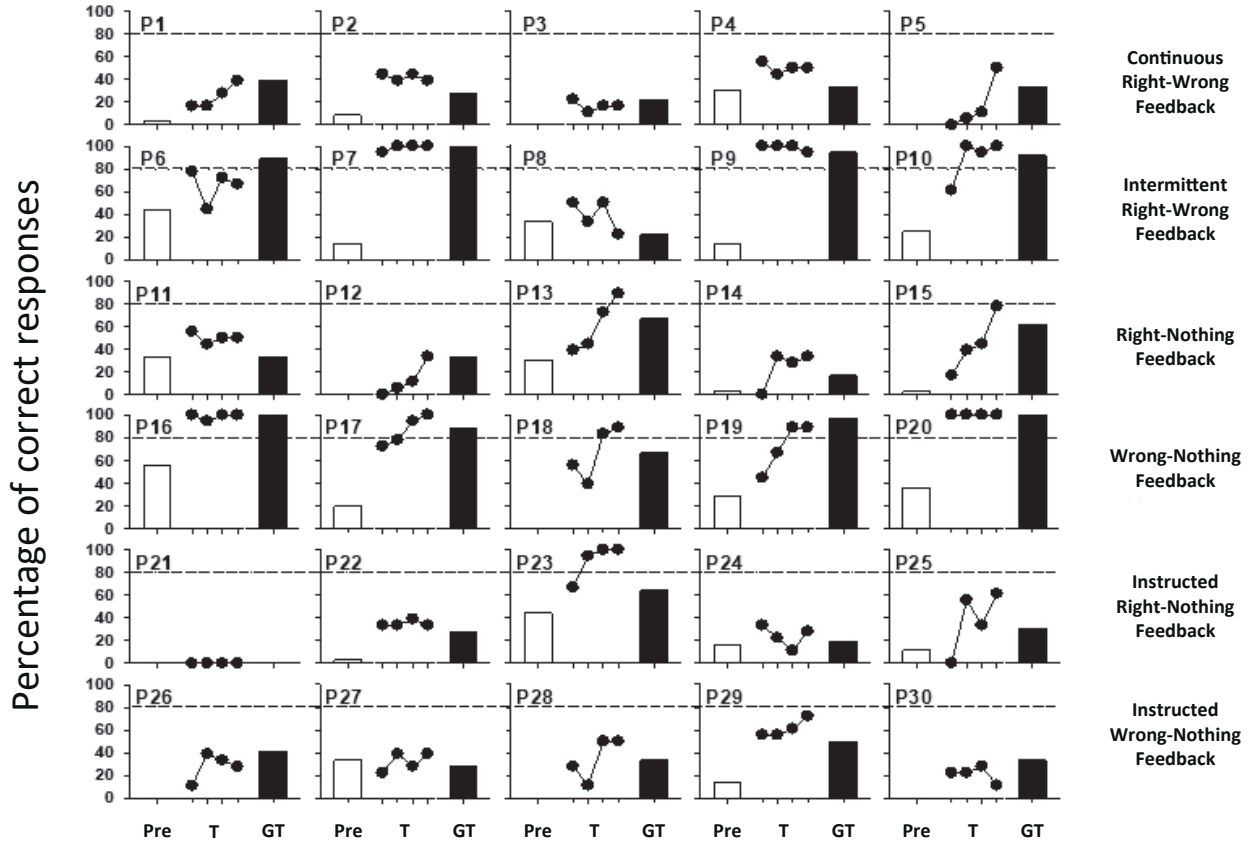
Figure 1. Percentage of correct responses in the pretest (white bars), training [blocks of 18 trials (dots)] and in generalization test (black bars) trails for each participant. Note: Pre = pretest, T = training, GT = generalization test trials, and dashed lines = 80%.
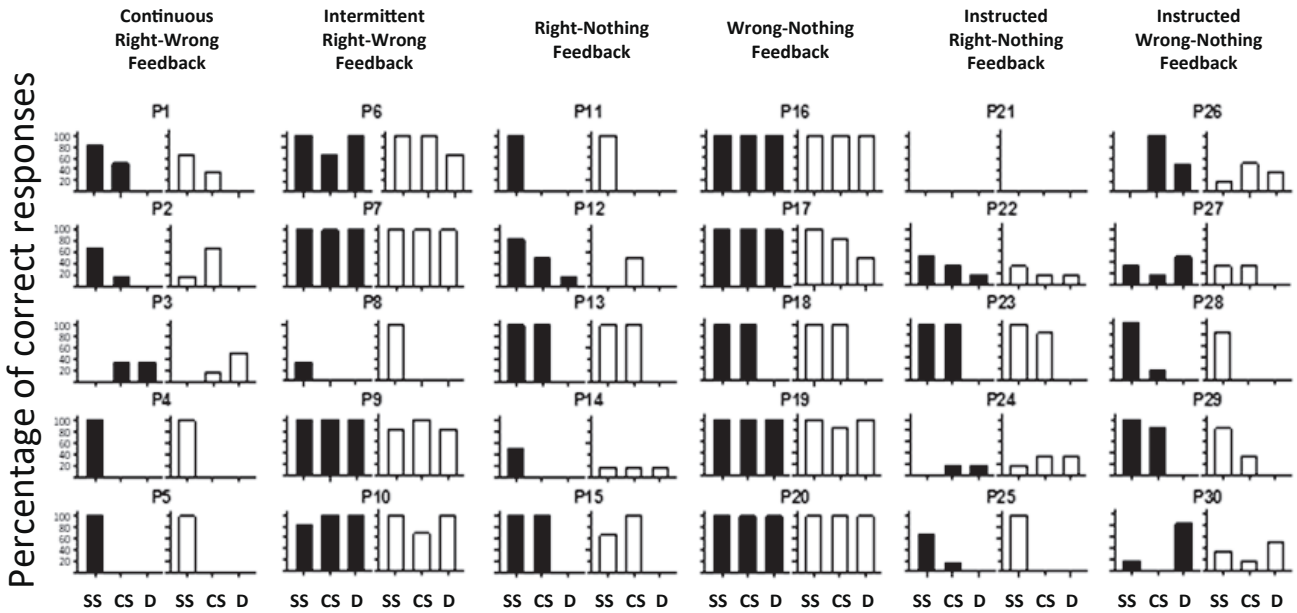

Figure 2. Percentage of correct responses per matching relation on generalization test trials with familiar (black bars) and unfamiliar (white bars) stimuli for each participant. Note: SS = shape-similarity, CS = color similarity, and D = difference.

Feedback (except P8) and Wrong-Nothing Feedback showed performances above 50% of correct responses in two or more blocks of training trials.

Figure 2 shows individual percentages of correct responses per matching relation on generalization test trials with familiar (black bars) and unfamiliar (white bars) stimuli. Visual inspection of Figure 2 suggests that: a) high percentages of correct responses under generalization test trials in which the ongoing matching relation was difference were possible only for participants from groups Intermittent Right-Wrong Feedback and Wrong-Nothing Feedback (except for P30 with familiar stimuli); b) performances were relatively independent of the familiar or unfamiliar character of displayed stimuli; and c) shape-similarity seemed slightly less difficult matching relation than color-similarity.

Discussion

Intermittent feedback for both correct and incorrect matching responses (i.e., Group Intermittent Right-Wrong Feedback) during second-order matching-to-sample training produced a higher accuracy of responding in generalization tests trials than continuous feedback (i.e., Group Continuous Right-Wrong Feedback). Feedback and blanks for incorrect and correct matching responses (i.e., Group Wrong-Nothing Feedback), respectively, produced a higher "intra-relational" generalized matching-to-sample performance (i.e., under shape- and color-similarity trials) than the reverse feedback-blanks combination (i.e., Group Right-Nothing Feedback) and, moreover, an extra-relational generalized performance similar to that observed under the intermittent right-wrong feedback condition. As it was expected, instructions about the meaning of blanks (i.e., both instructed groups) produced performances similar to those observed under the condition in which both correct and incorrect matching responses produced the correspondently feedback; however, accuracy of responding under all these three conditions was as low as the accuracy observed under the condition in which correct and incorrect matching responses produced the correspondently feedback and blanks, respectively.

In particular, later results suggest that although effectively "it may be misleading to speak of the reinforcing properties of being correct and the punishing properties of being incorrect" (Catania, 2006, p. 298), providing information regarding the accurate (or inaccurate) character of an individual´s behavior is not necessarily equivalent to an instruction like respond (or do not respond) the same way next time. In fact, and partially in contrasts with the hypothesis expressed by Spence (1964) regarding the meaning of blanks, results of the present experiment suggest that instructions about the potential function of events may obstruct its actualization; in this case, probably due to a similar "confusion" that according to such author seems to take place under the right-nothing feedback combination, or due to the kind of contingencies implied in the experimental task as well as its particular characteristics. New experiments should assess both possibilities.

The fact that intermittent feedback produced a higher generalized matching-to-sample performance in tests trials than continuous feedback is consistent with the idea that the later enhances control by particular properties of sample and comparison stimuli, while the absence of feedback in some matching trials prompts a detachment from moment-to-moment contingencies (Martínez & Ribes, 1996). According to the taxonomic proposal offered by Ribes and López (1985), being language available, such a detachment takes place as a linguistic interaction between participant's own performance and the ongoing contingencies (e.g., The concept is similarity!) and, due to their functional properties within a conventional medium of contact, additionally allows the introduction of other, pertinent verbal discriminative stimulus for an untrained problem-solving situation in that particular domain (e.g., The new relation is difference!). Given that participants from the Group Wrong-Nothing Feedback showed generalized matching-to-sample performances similar to those observed for participants from the Group Intermittent Right-Wrong Feedback under generalization test trials in which the ongoing matching relation was difference, results of the present experiment suggest that a functional detachment process similar to that just described for intermittent right-wrong feedback have took place when incorrect and correct responses produced feedback and blanks, respectively (Serrano et al. 2017). Based on performances observed for participants from groups Wrong-Nothing Feedback and Right-Nothing Feedback, results of the present experiment also agree with the hypothesis expressed by Spence (1964) about an initial tendency by participants to treat blanks as if they mean right under both kinds of feedback-blank combinations and, correspondently, the incompatibility of the right-nothing feedback combination regarding the task's demands.

The fact that in the present experiment participants exposed to continuous feedback showed severely low performances probably was due to the kind of trained matching relations. Serrano et al. (2009) reported similar performances between participants exposed to continuous feedback and participants exposed to feedback and blanks for incorrect and correct responses, respectively. In their experiments, however, trained matching relations included identity and difference, which seemed to be less difficult to learn than the color- similarity matching relation (see

also Ribes & Torres, 2001). The difference between experiments regarding the number of displayed comparison stimuli per matching trial (three versus four) probably also affected the acquisition of the conditional discrimination by participants from the Group Continuous Right-Wrong Feedback in the present report. New experiments should address both possibilities.

Any case, it is noteworthy that accuracy of responding on generalization tests trials for participants exposed to continuous feedback was as low as accuracy of the performance observed for participants instructed about the meaning of blanks and exposed to feedback-blanks combinations. These results are important, on the one hand, because they suggest that the initial instructions about the meaning of blanks effectively turned right-nothing and wrong-nothing feedback combinations similar to the continuous right-wrong feedback condition along training trials and, on the other hand, because -unexpectedly- neither continuous feedback condition produced a relatively high percentage of correct responses in the training phase. Notice, however, that incipient extra-relational generalized performance was observed for two participants from the Group Instructed Right-Nothing Feedback and three participants from the Group Instructed Wrong-Nothing Feedback, while incipient extra-relational generalized responding was not observed for four of the five participants from the Group Continuous Right-Wrong Feedback.

Following the experiment conducted by Hirst et al. (2013) on the proportion of trials with accurate feedback, new experiments on continuous *versus* intermittent feedback and generalized matching to sample may assess the effects of feedback probability along training trials; especially under matching-to-sample tasks with no instructional second-order stimuli (e.g., González-Berra & Ortiz, 2014), as well as following designs in which naïve subjects observe the performance of expert participants (e.g., Rodríguez Pérez, Silva Castillo, Baustista Castro & Peña Correal, 2015) and interact with them in an linguistically fashion, as an experimental model of scholar teaching.

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