Efectos de la interferencia lingüística en la adquisición y transferencia de discriminaciones condicionales con tareas de igualación de la muestra de primer y segundo orden

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Resumen

En el estudio de la discriminación condicional (DC) en humanos se ha descrito que el contacto lingüístico con las propiedades y criterios de la tarea tiene una gran importancia para la adquisición y la transferencia de la misma, especialmente para las pruebas de tipo extrarrelacional y extradimensional. Sin embargo, estudios empíricos y conceptuales recientes cuestionan dicho supuesto. En estudios previos se han agregado componentes lingüísticos, pero no se ha explorado sistemáticamente el efecto de su restricción a través de tareas que compitan con la actividad verbal con respecto a tareas, como la interferencia lingüística. En el presente estudio se realizaron dos experimentos —uno con tareas de igualación de primer orden (TIMPO) y otro con tareas de segundo orden (TIMSO)— con el objetivo de evaluar el efecto de la interferencia lingüística sobre la adquisición de una DC y en el ajuste funcional en pruebas de transferencia (extrainstancia, extramodal, extrarrelacional y extradimensional). En los dos experimentos se utilizó un diseño N = 1, en el que participaron 24 estudiantes universitarios en total —doce en cada estudio—, y se contrastaron los efectos de dos condiciones experimentales: una con con interferencia y otra sin interferencia —con seis participantes para cada condición—. Los hallazgos sugieren que la interferencia en el contacto lingüístico no afecta la adquisición de la DC ni en TIMPO ni en TIMSO, pero sí afecta el ajuste en pruebas de transferencia, pues en estas se observaron efectos diferenciales por tipo, tanto en TIMPO como en TIMSO.
Palabras clave: Discriminación condicional, transferencia, desligamiento funcional, igualación de la muestra, tarea de interferencia lingüística.

Effects of linguistic interference on the acquisition and transfer of conditional discriminations with first- and second-order matching-to-sample tasks

Abstract

Studies on conditional discrimination (CD) in humans have pointed out that linguistic contact with the properties and criteria of the task is critical both for acquisition and transfer, especially in extra-relational and extra-dimensional tests. Recent empirical and conceptual analyses have challenged this assumption. Studies in the field have generally included linguistic components, but the effect of linguistic restriction through tasks that compete with verbal activity regarding tasks, such as linguistic interference, has not yet been systematically explored. Two experiments were conducted: the first one used first-order matching-to-sample tasks (FOMST) and the second used second-order matching-to-sample tasks (SOMST), aiming to evaluate the effect of a linguistic interference task on the acquisition of conditional discrimination and functional adjustment in transfer tests (extra-instance, extra-modal, extra-relational, and extra-dimensional). Both experiments used an n = 1 design. A total of 24 college students participated, 12 in each study, and the effects of two experimental conditions were tested (Interference and No Interference, with six participants in each condition per study). The findings suggest that interference in linguistic contact does not affect the acquisition of CD in FOMST or in SOMST, but it does affect the adjustment in transfer tests. In these, differential effects, by type, were observed in FOMST and SOMST.
Key words: Conditional discrimination, transfer, functional detachment, matching to sample, linguistic interference task.

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Efeitos da interferência linguística na aquisição e na transferência de discriminações condicionais com tarefas de igualação da amostra de primeira e segunda ordem

Resumo

No estudo da discriminação condicional (DC) em humanos, tem-se descrito que o contato linguístico com as propriedades e os critérios da tarefa tem uma grande importância para a aquisição e a transferência dela, especialmente para os testes de tipo extrarrelacional e extradimensional. Contudo, estudos empíricos e conceituais recentes questionam essa suposição. Em estudos prévios, têm se acrescido componentes linguísticos, mas não se tem explorado sistematicamente o efeito de sua restrição por meio de tarefas que compitam com a atividade verbal a respeito de tarefas como a interferência linguística. Neste estudo, realizaram-se duas experiências —uma com tarefas de igualação de primeira ordem (Timpo) e outra com tarefas de segunda ordem (Timso)— com o objetivo de avaliar o efeito da interferência linguística sobre a aquisição de uma DC e sobre o ajuste funcional em testes de transferência (extrainstância, extramodal, extrarrelacional e extradimensional). Nas duas experiências, utilizou-se um desenho N = 1, do qual participaram 24 estudantes universitários no total —12 em cada estudo—, e contrastaram-se os efeitos de duas condições experimentais: uma com interferência e outra sem interferência —com seis participantes para cada condição—. Os achados sugerem que a interferência no contato linguístico não afeta a aquisição da DC nem em Timpo nem em Timso, mas sim afeta o ajuste em testes de transferência, pois nestes se observam efeitos diferenciais por tipo tanto em Timpo quanto em Timso.
Palavras-chave: discriminação condicional, transferência, desligamento funcional, igualação da amostra, tarefa de interferência linguística.

INTRODUCTION

Based on Ribes and López's proposal (1985), the foundational works of human behavioral research were oriented to investigate the conditions in which complex behavior emerges, which is understood as a behavior that becomes detached or autonomous, via linguistic mediation, from the physicochemical properties of the object and from the situationality of the interaction. The matching-to-sample task, used in the study of conditional discrimination, proved to be useful as methodological exemplary basis for the study of human behavior, given that in this task the current function of a stimulus is not conformed by absolute physical properties, but by current relations with other stimuli test by test (Pérez Fernández, 2015).

In this research field, functional detachment is established with regard to particular training situations based on the participant's performance in test situations, which are called transfer tests. It is assumed that these tests, as variations of the training, allow to identify how closely related the individual's response remains to the qualities of the training (León, 2015); among such qualities are instances, modalities, relations, and dimensions. Four of the generally used tests are: a) extra-instance test, also called intra-modal, which uses instances that are different from training instances, while keeping constant the modalities, relations, and dimensions; b) extra-modal test, in which the modalities relevant for the matching task are different, while keeping constant the relations and dimensions; c) extra-relational test, where the relevant relations are varied, while keeping the dimensions constant; and d) extra-dimensional test, in which the dimension or domain to which the stimuli belong is changed.

It is assumed that high percentages of correct answers only in extra-instance and extra-modal tests indicate a strictly perceptual functional contact with the task and, therefore, they point to a situational behavior that is detached from instances and modalities, but which is linked to the relation criteria and to the training domain (Ribes & Serrano, 2006; Ribes et al., 2005). On the other hand, high percentages of correct answers in extra-relational tests are used as evidence of linguistically regulated behavior, under the assumption that responding effectively to variations of the relation criterion, detached from the specific trained criterion, can only take place when the individual's behavior is linguistically mediated (Ribes, 1990; Ribes & Serrano, 2006). Finally, high response rates in extra-dimensional tests have also been considered as evidence of linguistically regulated behavior, given that in order to achieve this, the contingency relation that structures the interaction must be abstracted and formulated linguistically, regardless of instances, modalities, relation criteria, and even specific domains. In this context, interaction is detached from any particular or situational episode and is updated to new instances, modalities, relations, and domains; for this reason, it is called trans-situational behavior.

In addition to performance in extra-relational and extra-dimensional transfer tests, the development of rule-like linguistic segments has been considered evidence of the interaction's linguistic mediation (Ribes, Domínguez, Tena, & Martínez, 1992; Ribes & Martínez, 1990; Ribes, Moreno & Martínez, 1995a). Rules are conceptualized as linguistic segments that fulfill the following characteristics: a) they are general descriptions of the contingency relations that structure interactions (apart from any specific episode); b) they are generated from varied and effective instrumental execution; and (c) the individual's behavior is adapted to the contingency relations described by the linguistic segment (Ribes, 2000).

Although it was initially assumed that varied and effective instrumental execution was a prerequisite for the emergence of rule-like segments, it was observed that they were not sufficient for the generation of such segments (Trigo, Martínez & Moreno, 1995). In this context, the effect of different factors was explored to identify the conditions involved in the generation of rule-like descriptions, in addition to effective, instrumental behavior.

Some of these factors can be grouped according to the mode of contact implied or promoted in the task: a) observational contacts (Moreno, Ribes & Martínez, 1994; Ribes, Barrera & Cabrera, 1998; Ribes & Castillo, 1998; Ribes, Moreno & Martínez, 1995b; Ribes, Torres & Barrera, 1995); and b) contacts with explicit linguistic morphology (Cepeda, Hickman, Moreno & Ribes, 1991; Ribes et al., 1992; Ribes et al., 1995a; Ribes & Serrano, 2006). In relation to the latter, it was pointed out that *linguistic contact* with the properties and criteria of the task was critical in the acquisition of conditional discrimination in training as well as in its transfer, especially in extra-relational and extra-dimensional-type tasks. However, recent works —both conceptual reviews and empirical studies— have opposite conclusions, suggesting that: a) there is no positive relationship between effective practice in test situations and linguistically regulated behavior; and b) the generation of rule-like descriptions is not necessarily associated with high performance in tests, including extra-relational tests (León, 2015; Peña, Ordóñez, Fonseca & Fonseca, 2012).

Most of the studies, aimed at identifying the functional role of linguistic interaction with the task (which hereinafter will be referred to as linguistic contact), were limited to evaluating the effect of adding linguistic components (Cepeda et al., 1991; Ribes et al., 1992; Ribes et al., 1995a; Ribes & Serrano, 2006). According to a consistent finding, the acquisition and transfer of a conditional discrimination is usually favored when components describing performance during training are added. However, the effect of interfering with linguistic contact has not yet been systematically explored. In fact, it is assumed that linguistic contact occurs mainly when: a) conventional responses are explicitly requested from participants (Cepeda et al., 1991; Ribes et al., 1992; Ribes et al., 1995a; Ribes & Serrano, 2006); or (b) matching relations are based on the conventional properties of events, assuming that, when it is not the case, contact is strictly perceptual, that is, physicochemical or non-linguistic (Guzmán-Díaz & Serrano, 2013).

An example of this is presented in the study by Guzmán-Díaz and Serrano (2013), who used a second-order matching-to-sample task with numbers as stimuli. The study had three conditions: a) linguistic, b) physicochemical, and c) redundant. In the first condition, matching relations were based on arithmetic operations (equality, addition, and subtraction). In the second one, relations were based on the typography and color of the stimuli (identity, color similarity, and difference). In the third condition, matching relations were redundantly based on arithmetic operations and on the numbers' typography and color. Subsequently, all participants were exposed to test trials similar to those implemented in training for each group, as well as to tests using geometric figures and matching relations by identity, color similarity, and form similarity. The acquisition of conditional discrimination was slightly faster in the first condition, although there were no robust differences between the tests of the first and second conditions. In discussing their findings, the authors acknowledge that these do not match the initial assumption of the experiment regarding the linguistic or physicochemical character of each of the arrangements. In our opinion, with the typically employed methodological arrangements, it is difficult to identify adjustment quality as a function of the presence/absence of linguistic contact, since this is generally not limited. Consequently, it is difficult to affirm whether it is a strictly perceptual or linguistic contact with the task.

The above is relevant given that there have been identified three possible types of functional contact with the matching-to-sample task (Ribes, 1990; Ribes et al., 2005): a) perceptual/situational; b) verbal-modal/extra-situational; and c) verbal-criterion/trans-situational. Each of them is identifiable based on the transfer test types, whose behavioral requirement for solution is differential and increasingly complex. Under this assumption, the *verbal-modal* functional adjustment, which implies an *extra-situational detachment* and which is identifiable in *extra-relational tests*, should be negatively affected if linguistic contact was interfered. Similarly, the *verbal-criterion* functional adjustment, which implies a *trans-situational detachment*, is identifiable in *extra-dimensional tests*. However, as previously noted, there is empirical evidence suggesting that successful adjustment in extra-relational tests is not associated with

relevant performance descriptions, which makes it possible to question whether, in fact, a verbal-modal contact with extra-situational detachment is required to effectively perform in such tests, or whether a perceptual contact with situational detachment is sufficient. By extension, it is reasonable to ask the same question regarding extra-dimensional tests. One way to contribute to the clarification of this controversy is to identify the adjustment quality that is affected in tests by the interference of linguistic contact during training.

In a study by Delgado, Medina and Soto (2011), using a first-order matching-to-sample task, the conditions for the presentation of linguistic interference tasks were systematically varied, in order to limit the participants' verbal production regarding the task. Exposure to interference conditions occurred during the training phase, which consisted of: (a) repeating "aloud" a word list during the training phase; (b) a reverse count three by three from 1000 to 0; and (c) repeating aloud the narration of an audiobook "*The Little Prince*." The results show that different types of exposure to tasks that limit the production of linguistic segments did not prevent the acquisition of conditional discrimination, nor the formation of matching relations. This findings suggest that even in situations that interfere with linguistic contact, the acquisition and transfer of conditional discrimination is present in first-order matching-to-sample tasks.

In first-order matching tasks, the only way in which participants can identify the matching criterion is through feedback. Consequently, feedback has a fundamental discriminative function. In contrast, in second-order matching-to-sample tasks, second-order stimuli exemplify the matching criterion. Ribes and Torres (2001) point out that for this to happen, participants must verbally acknowledge this criterion, even if the recognition is not explicit, which would imply a qualitative difference between interactions in first- and second-order tasks, being more relevant in this latter the linguistic contact with the task. If this is the case, interference with linguistic contact would have a differential effect on first- and second-order matching tasks.

Based on the above, two experiments were conducted to answer the following questions: (a) does the interference of linguistic contact affect the acquisition and transfer of conditional discriminations?; (b) does the interference of linguistic contact differentially affect the individual's type of adjustment in transfer tests?; (c) do transfer tests that have typically been considered evidence of linguistically mediated behavior (extra-relational and extra-dimensional) critically require such mediation?; and (d) does the interference of linguistic contact differentially affect behavioral adjustment in first- and second-order matching-to-sample tasks?

The objective of the present study was to evaluate the effect of a linguistic interference task on the acquisition of conditional discrimination and on adjustment in transfer tests in first- and second-order matching tasks. Two experiments were designed, one with first-order tasks (Experiment I) and the other with second-order tasks (Experiment II).

METHOD EXPERIMENT I

Participants

Twelve university students from the Universidad Nacional Autónoma de México (Mexico), aged between 18 and 23 years old, with no experience in matching-to-sample tasks, participated voluntarily.

Equipment and experimental situation

The study was conducted in a computer lab for the condition without linguistic interference task (using the cursor as a response device), and in an individual cubicle for the condition with linguistic interference task. The experimental task, as well as the record were automatically presented using the Superlab 4.0 program.

Design

The conditions were presented according to an intra-subject experimental design (n = 1). The first-order matching-to-sample task (FOMST) had two conditions: (a) with linguistic interference task (LIT condition) and (b) without linguistic interference task (no-LIT condition). Participants were randomly assigned to these conditions (a group of six participants per condition).. Experimental conditions are presented in Table 1.

Procedure

Participants went through the following phases: a) initial test, b) 1st training, c) 1st test, d) 2nd training, e) 2nd test, f) 3rd training, and g) 3rd test (see Table 1). The study was conducted in a single session in order to increase its internal validity (i.e. to prevent participants from communicating with each other and exchanging information about the test that might affect their performance).

The first-order matching-to-sample task (FOMST) was used as base task, differentiated according to the condition (with or without LIT). In the LIT condition, participants had to attend to the sound of a metronome simultaneously with the matching task and say aloud the letters of the alphabet in ascending order with each metronome sound.

In each FOMST trial, a sample stimulus (SS) was shown in the top center part of the screen and four comparative stimuli (CSs) at the bottom of the screen, arranged

Table 1
Experimental conditions of Experiment 1

Condition	Initial Test (12)	1st Train. (12)	Test 1 (24)	2nd Train. (12)	Test 2 (24)	3rd Train. (12)	Test 3 (12)
With LIT n = 6	Possible relations: identity, color, form, and difference	Train. Metr. Form similarity	Intra-mod: color and form	Color similarity	Intra-mod: color and form	Difference	Extra-dim: letters (vocals) and typography
Without LIT n = 6			Extra-mod: form and size		Extra-mod: color and size		

Train: Training; Metr: Metronome; Intra-mod: Intra-modal; Extra-mod: Extra-modal; Extra-dim: Extra-dimensional.

horizontally. The stimuli—except for those of the 3rd test—were figures. Arrangements were designed in such a way that each test trial showed CSs that were related to the sample stimulus in the following ways: one identical, one similar in shape, one similar in color, and one different from the sample (see Figure 1).

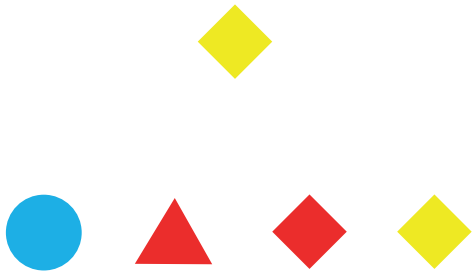

Figure 1. Standard arrangement for FOMST.
Source: Authors' own elaboration.

The phases of Experiment I are described below.

EXPERIMENT I

Initial test. Consisted of 12 trials that evaluated relations of identity, color similarity, form similarity, and difference; they were presented randomly, without any feedback. The objective of this phase was to identify the participants' response tendency toward any of the relation criteria. No performance feedback was provided. The instructions presented in both groups were:

> On the following screens you will be shown five figures: one in the center and four on the bottom. Choose one of the figures below that matches the one in the center. To register your answer, place the mouse pointer over the figure that you chose and click on the left button. If you have doubts regarding the instructions of the game, please ask the researcher. If not, click on "continue" to start.

First training. Consisted of 12 trials of form similarity. In the case of the FOMST group with LIT, in addition to solving the matching task, participants had to attend to the linguistic interference task. Prior to the matching task, in order to familiarize the participants with LIT, they were exposed to a metronome training, in which they only had to say aloud the letters of the alphabet with each "beep," without being exposed to the matching task. Stimulus arrangements were the same for both groups and they were shown randomly. In this phase, participants were immediately notified whether their response was correct or incorrect, on a subsequent slide on the screen with a duration of one second. The word "correct" was shown in the center of the screen in green letters on a white background. The word "wrong" was presented in the center in red letters on a white background. The next trial started immediately after the feedback.

The instructions presented to the FOMST group without LIT in all trainings were the following:

> On the following screens you will be shown five figures: one in the center and four on the bottom. Choose one of the figures below that matches the one in the center. To register your answer, place the mouse pointer over the figure that you chose and click on the left button. At this time you will be told whether your answer was correct or incorrect. If you have any doubts regarding the instructions of the game, please ask the researcher. If not, click on "continue" to start.

Similarly, the instructions that were presented in all trainings to the FOMST group with LIT were the following:

> On the following screens you will be shown five figures: one in the center and four on the bottom.

> Choose one of the figures below that matches the one in the center. To register your answer, place the mouse pointer over the figure that you chose and click on the left button. At this time you will be told whether your answer was correct or incorrect. In addition, you will have to say the letters of the alphabet in ascending order with every sound of the metronome. If you have any doubts regarding the instructions of the game, please ask the researcher. If not, click on "continue" to start.

Test 1. Consisted of 24 trials of form similarity, 12 of which corresponded to the intra-modal test, where the relevant dimensions of stimuli were color and shape (see Figure 2); the test corresponded to the extra-modal test, where the relevant dimensions were shape and size (see Figure 3). Stimulus arrangements were the same for both groups and were shown randomly. Participants were not notified whether their response was correct or incorrect. The instructions in all of these tests were:

> On the following screens you will be shown five figures: one in the center and four on the bottom. Choose one of the figures at the bottom that matches the one in the center. To register your answer, place the mouse pointer over the figure that you chose and click on the left button. At this time, you will not be told whether your answer is correct or incorrect. If you have doubts regarding the instructions of the game, please ask the researcher. If not, click on "continue" to start.

Figure 2. Trial example of the intra-modal test in Test 1. Source: Authors' own elaboration.

Second training. Consisted of 12 trials of color similarity (different from the first training). In the case of the FOMST group with LIT, the matching task was simultaneous with the linguistic-interference task. Stimulus arrangements were the same in both groups and were shown randomly. Participants were notified whether their answers were correct or incorrect.

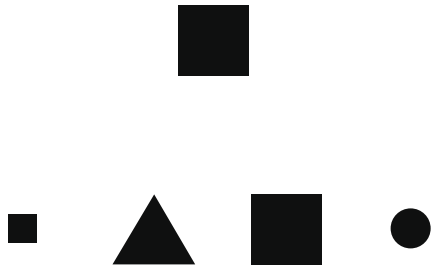

Figure 3. Trial example of the extra-modal test in Test 1. Source: Authors' own elaboration.

Test 2. Consisted of 24 trials, 12 of which corresponded to the intra-modal test, in which the relevant dimensions of stimuli were color and shape (see Figure 4). The remaining 12 trials corresponded to the extra-modal test, where the relevant dimensions were color and size (see Figure 5). Stimulus arrangements were the same in both groups and were shown randomly. No information on performance was provided.

Figure 4. Trial example of the intra-model test in Test 2. Source: Authors' own elaboration.

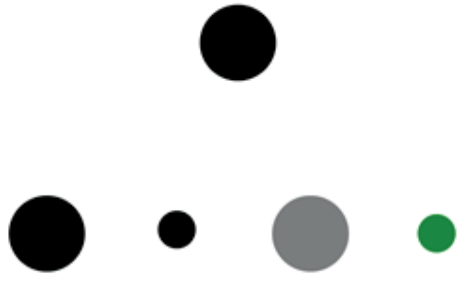

Figure 5. Trial example of the extra-model test in Test 2. Source: Authors' own elaboration.

Third training. Consisted of 12 trials of difference (different from the first and second trainings). In the FOMST group with LIT, simultaneously to the matching task, participants had to attend to the linguistic interference task. Stimulus arrangements were the same in both groups and were shown randomly. Participants were informed whether their response was correct or incorrect.

Test 3. The extra-dimensional test consisted of 12 trials of difference. In this phase, stimuli were not figures, but letters, and their relevant dimensions were shape and

typography (see Figure 6). Stimulus arrangements were the same for both groups and were shown randomly. No performance information was provided.

Figure 6. Trial example of Test 3.
Source: Authors' own elaboration.

RESULTS EXPERIMENT I

The summary of the results is presented in Table 2, showing individual success rates as percentages, grouped according to the experimental condition and study phase. The analysis focuses on the comparison of individual performances during different phases, on inter-individual difference within each group—both longitudinally and transversally—, and on the comparison of individual performances between groups, longitudinally and transversally. Two comparison criteria were established for individual performances: (a) performance above 50%; and (b) performance over 80% of right answers.

The analysis of the initial trend test showed a predominant tendency to respond to the identity criterion in participants of both conditions, who presented four different responses, three to the form criterion (P1 and P10) and one to the color criterion (P12). In the first training, no differences were identified between conditions. There was a greater number of participants with performance above 50% in the no-LIT condition (P2, P3, P5, and P6); nevertheless, the number of participants with performance above 80% was higher in the LIT condition (P7, P9, and P10).

In Test 1 (intra-modal and extra-modal), no differential effect of the experimental conditions was observed on performance. The results of participants showed a consistency between the two tests; the intra-modal test had a maximum difference of three correct answers with respect to the extra-modal test (P7). The consistency between high performers in the training phase and high performers in the test phase is notorious for the LIT condition (P7, P9, and P10).

In the second training, there was a decrease in the participants' performance and only three participants had performance above 50% (P2, P3, and P6). The decrease in performance is very pronounced in the LIT condition, since none of the participants exceeded 50%.

In Test 2 (intra-modal), performance was equally low in both conditions, except for P6 and P12. In the extra-modal

Table 2.
Summary of results in Experiment I.

Parpt.	Trend Test	1st Training	Test 1		2nd Training	2º Prueba		3rd Training	3º Pueba
	(12)	(12)	IM (12)	EM (12)	(12)	IM	EM	(12)	ED (12)
				Without TIL					
P1	10 (I) 2 (F)	25	100**	92**	33	17	33	83**	67*
P2	12 (I)	75*	0	0	67*	0	8.3	58*	0
P3	12 (I)	83**	58*	75*	75*	17	83**	58*	8.3
P4	12 (I)	50	0	0	25	0	0	58*	0
P5	12 (I)	83**	0	0	50	8.3	8.3	58*	0
P6	12 (I)	67*	100**	100**	67*	100**	100**	92**	50
				With TIL					
P7	12 (I)	83**	83**	58*	33	33	50	33	0
P8	12 (I)	0	0	0	0	0	0	0	0
P9	12 (I)	83**	83**	83**	0	0	25	0	0
P10	11 (I) 1 (F)	83**	67*	58*	33	0	8.3	8.3	8.3
P11	12 (I)	8.3	50	67*	0	0	0	0	0
P12	11 (I) 1 (C)	17	0	8.3	25	100**	92**	50	100**

Parpt: Participant; Train: Training, IM: Intra-modal; EM: Extra-modal; ED: Extra-dimensional. * Performance above 50%; ** Performance above 80%; (I) Identity; (F) Form similarity; (C) Color similarity.

test, two participants stood out with results exceeding 80% - near to 88% -in the no-LIT condition (P3 and P6), and one in the LIT condition (P12). In this test, the score difference between intra- and extra-modal tests is broader than in the first training, with a maximum difference of 8 (P3).

In the third training, a differential effect between conditions was observed. Participants in the no-LIT condition had scores above 50%, and two above 80% (P1 and P6), whereas in the LIT condition, none of the participants exceeded 50%, with the most common score being 0% (P8, P9, and P11). In Test 3 (extra-dimensional), performance was low in all participants, except for P12. Although this participant did not obtain scores above 50% in the training sessions, he did have a performance above 80% in Tests 2 and 3.

DISCUSSION EXPERIMENT I

Experiment I aimed to evaluate the effect of a linguistic interference task (LIT) on the acquisition and transfer of conditional discrimination in first-order matching-to-sample tasks (FOMST) in university students. The results are discussed based on the comparison between conditions with and without LIT, and in relation to the following points: a) acquisition and transfer of conditional discrimination (CD) under the same matching criteria—first training; b) acquisition and transfer of novel relations or matching criteria; and c) quality of adjustment and detachment in transfer tests.

Acquisition and transfer under the same matching criteria

The findings show that LIT did not negatively affect the acquisition and transfer of a first-order conditional discrimination in intra-modal and extra-modal tests. Specifically, the training in which three participants in the LIT condition had performances above 80% of right answers in the criterion of form similarity, and its comparison with the initial test in which there was a marked tendency to respond to the identity relation, suggest that the possibility of unlimited linguistic contact in training (nomination or verbalization of stimulus events and their relations) is not a necessary condition for the acquisition of conditional discrimination, at least not of this kind. These findings are in concordance with those of Delgado et al. (2011), who, using the first-order matching-to-sample methodology, systematically varied the presentation conditions of the linguistic interference tasks, without this change preventing the formation of matching relations.

As for the transfer tests, it has been pointed out that in intra-modal and extra-modal tests, effective performance can occur based on a strictly perceptual contact in training, and without any linguistic contact (Ribes, 2005; Serrano & Ribes, 2006). The high performances of three of the participants who were exposed to LIT constitute empirical evidence in this regard. In the same line, the studies by Delgado, Medina and Rozo (2013) and by Delgado, Medina and Jiménez (2014) explored the strong dependence on perceptual interactions in matching-to-sample tasks (respondent type). In these studies, high performances were related to eminently attentive aspects (Delgado et al., 2013) or to perceptual aspects (Delgado et al., 2014), regardless of the verbal description of the relations; nevertheless, the quality of verbal descriptions in the condition without linguistic interference, and even in the condition with interference, still needs to be evaluated.

In contrast, changes in the matching criterion adversely affected performance in participants for both conditions, both in the second training and Test 2. However, such an effect is pronounced in participants of the LIT condition. Given the contingency structure of FOMST, it is not feasible to program a typical extra-relational transfer test, i.e. a criterion change without response feedback. In this context, the adjustment to the second and third trainings can be considered parallel to the extra-relational test.

It has been pointed out that effective performance in an extra-relational test requires a linguistic contact with relevant modalities (Ribes et al, 2005; Serrano & Ribes, 2006). This was limited in the LIT condition, and a negative effect was expected on the behavioral adjustment to changes in the matching criterion. The observed decrease in the performance of the participants in the LIT condition (except for P12), when exposed to the change of criterion in the second training and Test 2, was consistent with what was expected. In addition, what is observed in the second change of criterion (3rd training) strengthens the evidence in the same sense. The high percentage of correct responses of P12 in Tests 2 and 3 may be due to the fact that the correct answers were presented consecutively at the end of the corresponding trainings (second and third trainings), suggesting that, although late, this participant was able to identify the current matching criteria.

In Test 3, which involved an extra-dimensional transfer, most participants had poor performance (condition with and without LIT). It has been argued that effective performance in extra-dimensional transfer requires the participant to make linguistic contact with the general criterion of the task (Peña et al., 2012: Ribes et al., 2005; Serrano & Ribes, 2006). The findings suggest that none of the two conditions promoted this, since only one participant in each condition (P1 in the no-LIT condition and P12 in the LIT condition) obtained a high percentage of correct answers. Since both

participants were exposed to different conditions and their performance was heterogeneous during the training and the subsequent tests, it is difficult to identify the variables controlling their performance in the Extradimensional Test.

Based on the above, it is plausible to argue that the limitation of linguistic contact (condition with LIT) does not affect the acquisition of a first-order conditional discrimination nor the behavioral adjustment to novel intra-modal and extra-modal situations. Consequently, the limitation of linguistic contact in FOMST does not seem to affect visual perceptual adjustment and allows detachment from the particular instances and modalities in which the acquisition of the conditional discrimination took place. Nevertheless, when the relation or matching criterion is changed, the limitation of the linguistic contact (condition with LIT) does affect behavioral adjustment. This provides evidence in favor of the assumption that linguistic contact with the arrangement during training is a condition for detachment from the particular criterion in which the conditional discrimination was initially acquired, as well as for adjustment to new relation criteria in later episodes.

In an analysis of behavioral flexibility, it can be argued that while limiting linguistic contact (condition with LIT) allows flexibility with respect to the particular instances and modalities of the situations for the acquisition of discrimination, it circumscribes this to the particular criterion in which this was acquired. In contrast, while unlimited linguistic contact (condition without LIT) allows detachment from the initial matching criterion and adjustment to new criteria, it promotes greater behavioral flexibility, allowing the reorganization of matching classes, as also reported in Hernández, Medina, and Erazo (2008). Finally, if it is considered that the extra-dimensional test requires greater detachment from the initial learning condition (Guzmán-Díaz & Serrano, 2013; Peña et al., 2012), this was not achieved, even when linguistic contact was not limited. According to the suggestions of Pérez-Almonacid (2012), the abstraction of relations as linguistic entities did not take place, so such entities did not mediate the participants' performance in situations with novel domains and relations.

EXPERIMENT II

METHOD

Participants

Twelve university students from the Universidad Nacional Autónoma de México (Mexico), aged between 18 and 23 years old, with no experience in matching-to-sample tasks, participated voluntarily. Participants were experimentally naive and different from those of Experiment I.

Equipment and experimental situation

The experiment was conducted under in the same conditions used in Experiment I.

Design

Intra-subject analysis design (n = 1) with second-order matching-to-sample task (SOMST).

Procedure

In Experiment II, participants went through the following phases: (a) Initial test, (b) Training, (c) Transfer tests: intra-modal, extra-modal, and extra-relational (see Table 3). The study was carried out in a single session in order to increase internal validity. It maintained the same criterion of 12 trials per test type, and participants were exposed to the same total (36) of training trials in both experiments. No extra-dimensional test was included.

The second-order matching-to-sample task (SOMST) was used as base task, and the conditions were varied according to the group with or without LIT. During the linguistic interference task, participants had to attend to the sound of a metronome, while saying aloud the letters of the alphabet in sequential order from A to Z with each sound of the metronome.

In each SOMST trial, two selector stimuli (SES) were shown in the upper central part of the screen, one sample

Table 3.
Description of the phases of Experiment II

Group	Initial test (36)	Training (36)		Test (36)
With TIL (n = 6)	S. form, color, and difference.	Training Metronome.	S. form, S. color, and difference	Intra-mod: Difference, S. form and color. Extra-mod: Difference, S. form and size. Extra-relational: Inclusion.
Without TIL (n = 6)				

S. Similarity; Intra-mod: Intra-modal; Extra-mod: Extra-modal.

stimulus (SS) in the central part, and four comparative stimuli (CSs) on the lower part of the screen, arranged horizontally; the stimuli were figures. The arrangements were designed in such a way that an identical comparative stimulus was presented in each trial, one similar in form, one similar in color, and one different from the sample (see Figure 7).

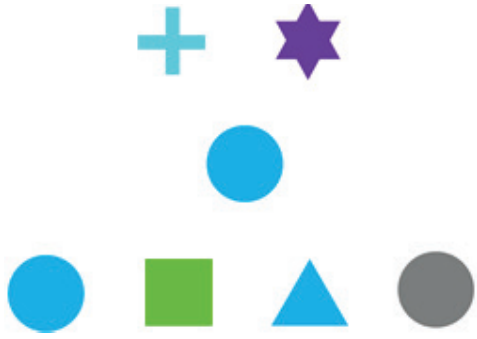

Figure 7. Standard arrangement of the SOMST.
Source: Authors' own elaboration.

The phases of Experiment II are described below.

Initial test. Consisted of 36 trials with relations of color similarity, shape similarity, and difference, randomly presented. Participants were not provided any feedback. The instructions presented to the groups were the following:

> On the following screens you will be shown seven figures: two on the top, one in the center, and four on the bottom. Choose one of the four figures at the bottom that matches the one in the center, as indicated by the two figures above. To register your answer, place the mouse pointer over the figure that you chose and click on the left button. If you have any doubts regarding the instructions of the game, please ask the researcher. If not, click on "continue" to start.

Training. Consisted of 36 trials; 12 of them were based on form similarity, 12 on color similarity, and 12 on difference. Simultaneously to the matching task, participants in the LIT condition had to attend to the linguistic interference task. Prior to the matching-to-sample task and aiming to familiarize this group with LIT, participants were exposed to a metronome training, identical to Experiment I. Stimulus arrangements were identical in both groups and were shown randomly. Participants were informed whether their response was correct or incorrect. The instructions presented in this phase to the SOMST group without LIT were the following:

> On the following screens you will be shown seven figures: two on the top, one in the center, and four on the bottom. Choose one of the four figures on the bottom that matches the one in the center, as indicated by the two figures on the top. To register your answer, place the mouse pointer over the figure that you chose and click on the left button. At this time you will be told whether your answer was correct or incorrect. If you have any doubts regarding the instructions of the game, please ask the researcher. If not, click on "continue" to start.

The instructions presented to the SOMST group with LIT were the following:

> On the following screens you will be shown seven figures: two on the top, one in the center, and four on the bottom. Choose one of the four figures on the bottom that matches the one in the center, as indicated by the two figures on the top. To register your answer, place the mouse pointer over the figure that you chose and click on the left button. At this time you will be told whether your answer was correct or incorrect. In addition, you will have to say the letters of the alphabet in an ascending order with every sound of the metronome. If you have any doubts regarding the instructions of the game, please ask the researcher. If not, click on "continue" to start.

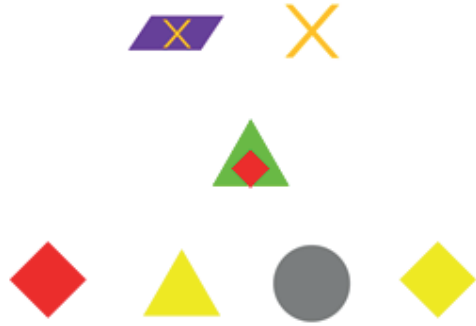

Figure 8. Trial sample of the extra-relational test.
Source: Authors' own elaboration.

Transfer tests. They consisted of 36 trials distributed as follows: (a) intra-modal test, where relation criteria were form similarity, color similarity, and difference; (b) extra-modal test, where relation criteria were similarity in form, color, and size; and (c) extra-relational test, where the relation criterion was inclusion (see Figure 8). Stimulus arrangements were identical between the groups and were presented randomly. Participants were not informed whether their answers were correct or incorrect. The instructions presented in both groups were the following:

> On the following screens you will be shown seven figures: two on the top, one in the center, and four on the bottom. Choose one of the four figures on the bottom that matches the one in the center, as indicated by the two figures on the top. To register your answer, place the mouse pointer over the figure that you chose and click on the left button. At this time you will not be told whether your answer was correct

or incorrect. If you have any doubts regarding the instructions of the game, please ask the researcher. If not, click on "continue" to start.

RESULTS EXPERIMENT II

The summary of the results of Experiment II are presented in Table 4, showing individual success rates as percentages, grouped according to the experimental condition and study phase. As in Experiment I, two contrast criteria were set for individual performances: (a) performance above 50%, and (b) performance above 80% of right answers.

In the initial training, no differences were observed between the groups. In both conditions, two participants exceeded 50% (P3, P5 / P9, P11) and, with the exception of P11, 80%. In the test phase (intra-modal), a differential effect of the LIT condition is reported. Participants in the no-LIT condition had performances above 50% and five (out of six) above 80%. At the same time, in the LIT condition, two participants exceeded 50% and one (of six) 80% of correct answers.

Consistent with the intra-modal test, in the extra-modal test differences were recorded between conditions. All participants in the no-LIT condition exceeded 80% of correct answers, while some participants with LIT obtained results higher than 80% (three participants), as well as results below 50% (three participants), including a performance of 0% (P10). In the extra-relational test, four participants in the no-LIT condition exceeded 80% of correct answers, with two cases with performance of 100% (P3 and P5). In the LIT condition, one participant achieved a performance above 80% (P9), and there were two participants (P8 and P11) with performance higher than 50%.

When comparing performance between phases (training and tests), participants of the no-LIT condition improved their performance in the test phase regarding training. In contrast, participants in the LIT condition did not improve their performance in the testing phase, except for one participant (P7) in the extra-modal test. For both conditions, participants with performances above 80% in the initial training had performances higher than 50% and 80% in the testing phase.

DISCUSSION EXPERIMENT II

The objective of Experiment II was to evaluate the effect of a linguistic interference task (LIT) on the acquisition and transfer of a conditional discrimination in second-order matching-to-sample tasks (SOMST) in university students. The results are discussed based on the contrast between LIT and no-LIT conditions, in relation to the following topics: a) acquisition and transfer of conditional discrimination; and b) quality of adjustment and behavioral detachment in transfer tests.

The findings show that the LIT condition did not affect the acquisition of discrimination with respect to the no-LIT

Table 4
Summary of results in Experiment II

	S	Initial Test (36)	Training (36)	Test IM (12)	Test EM(12)	Test ER(12)
Without TIL	1	2	25	91**	91**	83**
	2	0	47	83**	100**	50
	3	0	100**	91**	100**	100**
	4	8	19	66*	100**	66*
	5	0	80**	83**	100**	100**
	6	0	22	91**	100**	83**
With TIL	7	0	27	33	83**	0
	8	36	44	25	33	58*
	9	0	83**	91**	91**	100**
	10	22	30	33	0	50
	11	19	77*	66*	100**	75*
	12	30	33	50	33	33

Number (): Number of trials; Train: Training; IM: Intra-modal; EM: Extra-modal; and ER: Extra-relational.
* Performance above 50%; ** Performance above 80%.

condition. Consequently, it can be stated that limiting linguistic contact does not necessarily prevent the acquisition of conditional discrimination in this type of tasks. This conclusion coincides with other studies that have shown that unlimited linguistic contact is not necessary for the acquisition of derived, emergent, or congruent responses with an initial training (Delgado et al., 2011; León, 2015; Peña et al., 2012). Based on the results, it can be affirmed that in the LIT condition the performance during training was positively related to performance in all three types of tests in most participants, while in the no-LIT condition low performance in training was not related to low performance in the tests.

As already mentioned, according to some authors (Peña et al., 2012; Ribes, 2005; Serrano & Ribes, 2006), the different types of transfer tests used in this study involve different types of contact with the task or different qualities of behavioral adjustment. Specifically, it has been argued that the intra-modal and extra-modal tests can be answered based on a strictly perceptual contact with the task. According to this, there should be no relevant differences in these tests between participants with and without LIT, since what was limited was the linguistic contact, not the perceptual one; however, differences were observed and participants without LIT performed better. Based on the above, we can assert that the linguistic contact without interference was not a necessary condition for intra-modal and extra-modal transfer, given that two participants with LIT had high performances, but it was a facilitator of this transfer. As Delgado and Hayes (2013) and Pérez-Almonacid (2012) point out, although it is not yet clear what is the role of verbalizations or verbal mediations is in learning transfer tasks, interfering with them in training does not prove to be a condition that impedes transfer per se, as some theorists have previously affirmed (Barnes-Holmes, Rodríguez & Whelan, 2005).

Regarding the extra-relational transfer test, it has been stated that it requires a linguistic contact with the relevant modalities and criteria of the training episodes, arguing that such contact enables detachment not only from the particular instances and modalities of the acquisition (which is only possible with perceptual contact), but also from the relation criterion (Peña et al., 2012; Ribes & Serrano, 2006). In this sense, if the LIT condition limited the linguistic contact, it would be expected that participants exposed to this condition did not have high performance in this test. However, three participants in this condition obtained more than 50% of correct answers in the extra-relational test and one of them more than 80%. There are two things to highlight regarding these data. On the one hand, although contradictory to the previously mentioned assumptions, data are consistent with empirical evidence (León, 2015) and with review studies (Peña et al, 2012) that have suggested that linguistic contact is not a necessary condition for high performance in extra-relational tests in SOMST. On the other hand, it must be considered that since in the arrangement of inclusion the first selector stimulus includes the second one, participants may not have necessarily responded to the relation between stimuli, but simply to the absolute properties of the "included" stimulus, by choosing a stimulus that matched such properties. If this were the case, the response would be linked to the apparent properties of the stimuli and would not require linguistic mediation (which would explain the high performance of LIT participants). Subsequent experiments should use arrangements that allow to distinguish more clearly a genuinely relational response from a response linked to the apparent properties of the stimuli in extra-relational tests.

Finally, observation of inter-phase performances suggests that unlimited linguistic contact (no-LIT condition) favored flexibility with respect to training, even in participants with low performance in the early phases.

GENERAL DISCUSSION

In the research on conditional discrimination (CD) in humans, the effect of adding linguistic components has been extensively studied, either in terms of the instructions presented to participants (Arismendi & Fiorentini, 2014), descriptions of the aspects taken into account to solve a task (Cepeda et al., 1991; Ribes et al., 1992), or interference with the objective of limiting linguistic interaction with tasks (Delgado et al., 2011; León, Félix, García & Medina, in press).

Most of these investigations have pointed out that linguistic contact with task properties and criteria is a critical factor in both the acquisition and transfer of CD (Barnes-Holmes et al., 2005; Peña et al., 2012; Pérez-Fernández, 20115), especially for the extra-relational and extra-dimensional types (Guzmán-Díaz & Serrano, 2013; Ribes et al., 2005). Nevertheless, recent empirical and conceptual analyses have questioned this assumption (León, 2015; Peña et al., 2012; for a review see Delgado & Hayes, 2013). It is striking that, so far, the bulk of studies in this area, interested in identifying the functional role of linguistic contact, have been limited to adding this type of components and have not systematically explored the effect of their restriction. In this context, the experiments presented here compare the effect of limiting linguistic contact in first- and second-order matching tasks that imply behavioral adjustments of different complexity (León, 2015; Peña et al., 2012;

Ribes & Serrano, 2006), in order to identify the quality of adjustment affected by the limitation of linguistic contact (LIT condition) in the two types of matching tasks that are typical in the field of study.

The limitation of linguistic contact (LIT condition) did not affect acquisition regarding the type of the matching-to-sample task; that is, differential effects have not been observed in FOMST nor in SOMST between LIT versus no-LIT conditions. However, in the transfer tests, different effects of these conditions were observed in each type of matching task.

While in FOMST the limitation of linguistic contact (LIT condition) had no effect on the participants' performance in the intra-modal and extra-modal tests, it did affect performance in SOMST. This difference is relevant because, considering that intra-modal and extra-modal tests require a visual perceptual contact, it would be expected that there would be no differences due to the limitation of linguistic contact (LIT condition) in FOMST nor in SOMST. The findings suggest that in FOMST linguistic interference does not play a relevant role in intra-modal and extra-modal transfer, while in SOMST the possibility of linguistic contact is not necessary (since there were two participants of the LIT condition who had good performance in these tests), but it is a facilitator of the transfer. In this sense, it is plausible to affirm that in SOMST linguistic contact facilitates perceptual-type behavioral adjustment without necessarily being the structuring factor of the interaction, as documented in another recent study (Meraz, 2016). The differences indicated may be due to the functional characteristics of each task type, as suggested by Ribes and Torres (2001). Whereas the identification of the matching criterion in the first order depends critically on feedback, in the second order this criterion is exemplified by second-order stimuli and the identification of the latter is facilitated by, although not dependent on, verbal recognition.

Regarding the behavioral adjustment to the change in matching criteria (extra-relational transfer), it was expected to be negatively affected by the LIT condition in both types of task, considering that this type of transfer test requires the linguistic recognition of the modalities and relevant criteria of matching during training (Peña et al., 2012; Ribes, 2005; Serrano & Ribes, 2006). In FOMST, the LIT condition not only interfered with the adjustment to criterion change, but also seemed to make it impossible, even in participants who had high performance in the first training and the first intra-modal and extra-modal tests. However, in SOMST, the LIT condition did not affect participants who had high performance in training, even though linguistic contact with the task was limited. These data are consistent with León (2015) and Peña et al. (2012) regarding the unnecessary nature of linguistic contact during training to respond satisfactorily in extra-relational tests in SOMST, and with the findings by Delgado et al. (2013) and Delgado et al. (2014), in which not linguistic, but perceptual arrangements associated with the task served as facilitators of success in the testing phase.

The apparent anomaly observed in Experiment II of this work can be understood if we consider that in SOMST the relation criterion is presented and updated between phases, trial by trial, with second-order stimuli. This explicitness enables contact with the matching criterion independently from feedback on the current trial, from exposure to previous trials, and even from the type of contact that may have occurred in them (i.e. limited linguistic or strictly visual-perceptual contact). In this sense, interaction in SOMST can be effective even if it is only circumscribed to the present trial. Paradoxically, in FOMST, which is typically considered a functionally less complex task, in order to identify the matching criterion, contact should generally be made with a collection of episodes, since there is nothing in a particular test trial that "contains" this criterion by itself. In fact, the contact with criterion change in FOMST always takes place after the participant's response, through feedback.

In conclusion, the analysis and the findings suggest that the extra-relational transfer test in SOMST is not a good indicator of linguistically mediated behavior. However, it acknowledges the need for studies with more robust methodological arrangements in order to obtain stronger empirical evidence regarding the relationship between linguistically mediated behavior and genuinely relational behavior.

On the other hand, an analogous effect is reported by Arismendi and Fiorentini (2014), when they compare the effectiveness of the standard FOMST procedure with other procedure that used instructions to indicate the criteria. In general, the performance of participants exposed to instructions (explicit explanation of the criterion before test) is superior to the performance of those who are not exposed to this criterion, but to the record of behavioral episodes of reinforcement (standard procedure). Taking into account procedural differences between the studies, it is arguable that an explicit explanation of the criterion of the task, either through second-order stimuli or instructions, might promote situationally linked interactions, which may not be good methodological examples for the evaluation of the abstraction of relations to other domains or relations (Pérez-Almonacid, 2012).

Regarding the limitation of linguistic contact and its differential effects on detachment and arrangement quality in tests, the findings suggest that in FOMST the limitation of linguistic interaction with the task restricted the contact

to a perceptual-visual level, through linking behavior to the particular matching criterion of the initial acquisition. At the same time, in SOMST, the LIT condition did not link behavior to a particular criterion; however, as the findings of the present study suggest, in this type of tasks, responding correctly to criterion changes may not necessarily be an indicator of an extra-episodic contact that was made possible linguistically.

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