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Abstract: SWitching from one task to another usually produces a cost in performance. This switch has been shown to interact with repetition priming. In the present study we use this interaction to investigate the response reperesentation involved in task switch. We find an interaction between switch cost and repetition priming even when the responses required in the two tasks are not the same bur are made with corresponding fingers of different hands. We conclude that an abstract response representation, based on right-left action codes, is responsible for the effects. Besides, response representation changes, as preparation time increases, from more physical, effector-related action codes to more bastract ones.

RESPONSE REPETITION IN TASK-SET SWITCH

Response repetition in task-set switch

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Abstract

Switching from one task to another usually produces a cost in performance. This switch has been shown to interact with repetition priming. In the present study we use this interaction to investigate the response representation involved in task switch. We find an interaction between switch cost and repetition priming even when the responses required in the two tasks are not the same but are made with corresponding fingers of different hands. We conclude that an abstract response representation, based on RIGHT-LEFT action codes, is responsible for the effect. Besides, response representation changes, as preparation time increases, from more physical, effector-related action codes to more abstract ones.

When one has to change from an activity to a new one, there is usually some transient impairment in performance which can be measured both as a decrease in accuracy and as an increase in reaction time. To study such an impairment in laboratory, participants are asked to alternate between two simple cognitive tasks. In order to perform each of those experimental tasks, participants must set up and link a number of component processes that connect the sensory analysis to the motor response. The same processes can be linked in different ways in different tasks, even if they share the same stimulus and response sets. Besides, These tasks may demand both common and specific processes. A task set is a particular set of processes, linked together in a certain way. When the task set has to be reconfigured to perform a new task we term it a set switch. A set switch, either voluntary or not, involves changing the processing priorities to face a new situation. Our everyday interaction with the environment demands us to continuously change our task sets or processing priorities to solve problems and adapt to it. Switch cost allows a precise measurement of the relative contribution of automatic tendencies and control mechanisms.

The study of set switch has been recently reopened by Allport, Styles and Hsieh (1994). Since this publication the topic has recovered importance and many studies have been published. Rogers and Monsell (1995) presented participants a pair of characters: a number and a letter. The two tasks were to categorize the letter as vowel or consonant (L task) and to categorize the number as odd or even (N task). Participants switched tasks every two trials – LLNNLL-, i. e., task switch was predictable. In every pair the first trial was a shift trial, the second was a repetition trial. The same two response keys were used for both tasks: a left key pressing might mean vowel or even, a right pressing consonant or odd. When reaction time for both types of trials were compared, a cost was found for shift trials. A reduction in cost was observed as the interval between response and stimuli was increased, the reduction reached significance at the 600-ms interval. The authors interpreted the reduction in cost as an index of the operation of an endogenous, anticipatory mechanism of reconfiguration.

Although there was a reliable reduction when the interval was manipulated between blocks, some switch cost remained even at 1200 ms. Rogers and Monsell proposed two components in switch cost: one endogenous or dependent on a central reconfiguration mechanism and another exogenous or stimulus-driven. Several subsequent studies have shown the existence of a non-residual cost that vanishes as the temporal interval between a task cue and the stimuli increases and a residual cost that never reduces (e. g., Meiran, 1996; Dreisbach et al., 1998; Gonzalez et al., in press) and which represents an absolute cognitive limitation for changing the current task set.

Switch cost and response factors

Rogers and Monsell (1995) also reported an interesting relationship between switch cost and repetition priming. Repetition priming (Bertelson, 1963) refers to the fact that responses are usually faster and more accurate when the correct response on a trial is the same as that of the previous one than when both responses are different. Rogers and Monsell found that repetition priming disappeared (and sometimes even reversed) when there was a task switch. The authors proposed three possible explanations of the effect and concluded by noting that “A phenomenon as robust as this interaction between response repetition and task-switching must be telling us something interesting about control processes!” (p. 227).

One of the mechanisms proposed by Rogers and Monsell (1995) that might account for the cited interaction is a learning mechanism (Meiran, 2000; Hommel, 1998): The association between the response and the target stimulus category is strengthened in repetition trials. In shift trials, response repetition implies that the same response has to be selected using a different stimulus category, it means, in shift trials the previous association between stimulus and response has to be overcome, wich results in costs (Schuch & Koch, 2004). All these strengthening accounts (associations between stimulus category and response) relate response repetition costs with the mental reconfiguration in shift trials. If the same response is required again with a new task, reconfiguration of the response is necessary. They consider that mental reconfiguration runs from the top level task representation to the lower levels, including the response (Kleinsorge, 1999; Hubner & Druey, in press). It means that response reconfiguration takes time and must occur with long RSIs, perhaps related to residual cost (Gonzalez et al., in press). At the same time, Schuch & Koch (2004) showed analogous response repetition effects that occur when subsequent motor responses are different but associated with the same response category. This suggests that response categories such as “left” or “right” are represented mentally and that response repetition effects can occur at this cognitive level.

Our purpose is to take the interaction reported by Rogers and Monsell as a starting point to study the relationship between response factors and task switch. A more specific objective has to do with the degree of abstraction of the action codes involved in task switch. Are they related to effector parameters or do they contain more abstract information? In particular, we will study whether the interaction between repetition priming and switch cost reported by Rogers and Monsell depend on low-level motor information (repetition of the exact physical response) or on more abstract action codes such as RIGHT and LEFT (repetition of the analogous response). The novel question addressed here was whether switch cost magnitude would be different in the condition with one hand of response for both alternating tasks with respect to the condition with two hands of response, one per task. In other words, in experiment 2, the two tasks were mapped onto different hands in order to find out whether the task switch x response repetition interaction is also found when response repetitions are “abstract” repetitions rather than exact repetitions. This manipulation is confounded with another factor: In this new condition a task switch is not just a task switch but also a hand switch. Dual switches (motor and cognitive) may or may not differ from single switches. In this framework of the multiple-switch task we originally should predict a bigger switch cost (in the two hands condition with respect to the one hand condition). But, in fact, in a different framework, we expected a smaller switch cost in the two hands condition whether switch cost is associated to response selection (exactly to response repetition) and response reconfiguration happens in the low-level motor information. At the same time, whether mental set reconfiguration in shift trials runs top-down, the interaction between switch cost and response repetition priming should occur latter in the condition with two hands of response because there is an extra-level (hand selection, left or right) previous to finger selection (left or right).

Experiment 1

In the first experiment we study the relationship between response repetition and switch cost. The main goal of the experiment is to make sure that the interaction reported by Rogers and Monsell (1995) can be obtained with our experimental paradigm (Tornay & Milán, 2001).

Participants

Fourteen persons (nine women, five men), with normal or corrected-to-normal vision, took part in the experiment for course credit. Their ages ranged from eighteen to twenty-nine years.

Method

Apparatus.

The experiments were designed using the MEL program (Schneider, 1990). They were run in dimly illuminated, black rooms, on IBM 486 computers with a SuperVGA graphics card. A chin-rest helped participants to keep their eyes 60 cm away from the screen.

Procedure.

On every trial a fixation point appeared on the center of the screen, it also served as a cue to signal which task was to be performed (Tornay & Milán, 2001). The fixation point remained on the screen until the end of the trial in order to minimize the memory load needed to keep track of the current task. Two hundred ms after the appearance of the fixation point a stimulus pair, consisting of a number and a letter (e. g., 5A, A7, 2B, P4,...), was presented for 500 milliseconds. The relative position (right or left) of the number and the letter was randomized. The stimulus pair subtended 4.76º x 4.76º of visual angle. The pair could appear either to the left or to the right of the fixation point, 4 degrees of visual angle away from it[1]. The positions were equaled across all experimental conditions and randomized within each condition. Participants were asked to carry out one of two possible tasks. They had either to indicate whether the number was odd or even (number task) or whether the letter was a vowel or a consonant (letter task). In both tasks participants responded by pressing the “b” and the “n” keys on the keyboard. This way, both tasks shared the same stimuli and responses. Half of the participants had to press “b” to indicate that the number was even or the letter was a vowel and “n” when the number was odd or the letter was a consonant. For the other half, the reverse stimulus-key mapping was used. Each participant was randomly assigned to either mapping. Participants were given a maximum of 3 seconds after the appearance of the stimulus pair to emit the response before proceeding to the next trial. The interval between trials was 1500 milliseconds. The interval between the response on one trial and the appearance of the target stimuli on the next one (response-stimulus interval or RSI) was thus, 1700 ms (a 1500-ms intertrial interval plus 200 ms SOA between the onset of the fixation point and the target stimuli).

Participants knew which task was to be carried out on a given trial by means of the fixation point: an "at" sign (@) signaled the number task, an asterisk (*) indicated that the letter task was required on that trial. Both signs subtended 2.86º x 2.86º of visual angle. Tasks shifted regularly every two trials. We will refer to the first trial in every pair as a shift trial and to the second as a repetition trial. There were as many shift as repetition trials. Each participant performed two different experimental sessions. All independent variables (kind of task, number or letter, and kind of trial, shift or repetition) were manipulated trial by trial. We will refer to these variables as task and switch, respectively. A third independent variable (also manipulated trial by trial) was the response repetition, which consisted in the difference between two kinds of trials: (a) trials which demanded the same response, i. e., moving the same finger (right or left), as the previous trial; (b) trials on which the correct response was different from the previous one.

The experiment consisted of two sessions, each one with ten trial blocks. The first block in both sessions was considered as practice and discarded from the analysis. Each block consisted of 24 trials, on which all possible combinations of stimuli (even-vowel, e.g. 4A, even-consonant, e.g. 4B, odd-vowel, e.g. 5A, odd-consonant, e. g. 5B, in the two possible orderings, number-letter and letter-number) were presented. All combinations of the three independent variables (task, switch and response repetition) occurred with the same frequency in every trial block. The stimuli were selected at random on a trial-by-trial basis.

Results and discussion

Reaction times (RT) for correct responses were submitted to a 2 (task) x 2 (switch) x 2 (response repetition) repeated measures ANOVA. We will mention the main results involving task but will postpone the discussion about task asymmetry to the final discussion. In this, as in all other experiments in this study we will be using an alpha level of 0.05.

Please insert Figure 1 about here

The only reliable main effect was that of task, $F(1, 13) = 22.77$, $MSE = 58403.68$, $p < 0.001$. The two-way interactions Switch x Task, $F(1, 13) = 12.48$, $MSE = 29608.21$, $p < 0.004$, and Switch x Response repetition, $F(1, 13) = 10.69$, $MSE = 17324.83$, $p < 0.007$, were also significant. No other source of variability reached statistical significance. The Switch x Task interaction was produced by a significant switch cost in the number task, $F(1, 13) = 14.78$, $MSE = 27587.5$, $p < 0.003$, which disappeared in the letter task, $F(1, 13) < 1$. In addition, the switch cost was reliable for repeated responses, $F(1, 13) = 6.73$, $MSE = 39148.7$, $p < 0.022$, but not for unrepeated ones, $F(1, 13) < 1$.

Please insert Figure 2 about here

As for accuracy (proportion of errors) results, an analogous ANOVA showed a similar pattern of results with only significant effects of task, $F(1, 13) = 4.70$, $MSE = 0.007$, $p < 0.05$, Switch x Task, $F(1, 13) = 5.03$, $MSE = 0.004$, $p < 0.043$, and Switch x Response repetition, $F(1, 13) = 18.11$, $MSE = 0.004$, $p < 0.001$. There was a reliable switch cost in the number task, $F(1, 13) = 3.58$, $MSE = 0.006$, $p < 0.081$, but not in the letter task, $F(1, 13) < 1$. Again, there was a significant cost for repeated responses, $F(1, 13) = 9.56$, $MSE = 0.005$, $p < 0.009$, but not for unrepeated responses, $F(1, 13) = 3.11$, $MSE = 0.006$, $p = 0.101$.

To sum up, the results of this experiment agree with the interaction reported by Rogers and Monsell (1995): Repetition priming can lead to a reduction in switch cost. This result holds both for RT and for accuracy results. We now turn to study this effect more deeply by considering what feature of the response must be repeated. Must exactly the same response be reproduced on the subsequent trial or is the effect dependent on some more abstract action code? In the next experiment we will repeat the same manipulation using different RSI levels. We want to find out whether the same conclusions can be applied to the non-residual and residual components of switch cost. In the second experiment we compare a condition in which participants emit the same responses for both tasks (as in the previous experiment) with a condition in which different hands are used for both tasks. The goal is to find out whether the Switch x Response repetition interaction found in experiment 1 depends on the repetition of the exact response or some more abstract action codes (such as RIGHT or LEFT) are involved. In addition, the experiment includes two different response-stimulus intervals (RSI) in order to study whether the Switch x Response repetition and the two response conditions (one hand versus two hands) differ in temporal course.

Experiment 2

In the following experiment we directly compare a very short RSI (200 ms) and a rather long one (1700 ms). We also compare a condition in which participants emit the same responses for both tasks (as in the previous experiment) with a condition in which different hands are used for both tasks.

Participants

Eight participants volunteered for the experiment. There were six women and two men, ages between 28 and 35 years, with normal or corrected-to-normal vision.

Method

The apparatus, stimuli and tasks were the same as in Experiment 1, again the tasks alternated predictably every two trials. However, in this experiment we increased the number of trials to guarantee the statistical stability of the data. Besides, participants practiced each task separately to make sure that the results are not restricted to early stages of learning.

There were two experimental sessions. Each of them began with two 60-trial blocks, in which participants practiced both tasks (number and letter) separately. The order of these two blocks was counterbalanced across participants and reversed across sessions. In each session participants carried out four groups of five trial blocks, each block consisting of 30 experimental trials. Block groups differed in the combination of two independent variables, each one manipulated at two levels: (a) The response-stimulus interval (RSI), which was 200 ms in two of the block groups and 1700 ms in the other two; (b) the number of keys that were to be pressed to respond to the tasks, in two of the trial groups only one hand was used for both tasks, the keys being “b” and “n”, just as in Experiment 1, in the other block groups the right hand was used for one of the tasks (the response keys were again “b” and “n”) and the left hand was used for the other task (response keys: “x” and “c”). We will refer to this variable as response hands.

We also manipulated the finger correspondence on every two consecutive trials. If participants had to respond with the left finger on one trial and also with the left finger (even if the hand was different) on the next one, we call that situation a corresponding finger condition. The same term applies, obviously, when two consecutive trials called for a right-finger response, no matter whether the hand was the same or not. Any other case is considered to be a non-corresponding finger condition. We will keep on using the term response repetition to refer to this variable. Therefore, the levels of this variable will be referred to as follows: when only one hand is used the levels are repeated or unrepeated responses (as in Experiment 1); when two hands are used for responding, its levels are called corresponding finger or non-corresponding finger conditions.

The order of presentation of the four blocks was (incompletely) counterbalanced across participants and sessions. The hands and keys for the two tasks were randomized across participants. In every five-block group the first block was considered practice and discarded from analysis, leaving a total of thirty-two experimental blocks. Participants had a break between block groups.

Every trial began with the appearance of a fixation point signaling the task to be performed, exactly in the same way as in Experiment 1. After the appropriate RSI interval the stimulus pair appeared to the left or to the right of the fixation point, in the same positions as in Experiment 1. Immediately after the response a new trial began with the appearance of a new fixation point (i. e., there was no ITI). Another difference with respect to Experiment 1 was related to the experimental instructions, which stressed the importance of responding accurately, this change intended to reduce the proportion of errors. All other procedural details were identical to Experiment 1.

Results

Please insert Figure 3 about here

In the RT analysis we found reliable main effects of switch, $F(1, 7) = 46.24$, $MSE = 77018.4$, $p < 0.001$, task, $F(1, 7) = 31.60$, $MSE = 40304.3$, $p < 0.001$, and response repetition, $F(1, 7) = 10.66$, $MSE = 4827.8$, $p < 0.014$. RSI produced a marginally significant effect, $F(1, 7) = 4.98$, $MSE = 58080.9$, $p < 0.061$. The effect of response hands was not reliable, $F(1, 7) < 1$. There was a reliable decrease in cost with RSI, $F(1, 7) = 7.14$, $MSE = 28144.8$, $p < 0.032$. The following two-way interactions were also significant: Switch x Task, $F(1, 7) = 14.07$, $MSE = 19565.7$, $p < 0.008$, Response hands x Response repetition, $F(1, 7) = 38.85$, $MSE = 1023.6$, $p < 0.001$, and Switch x Response repetition, $F(1, 7) = 33.81$, $MSE = 15391.9$, $p < 0.001$. Both Response hands x Switch x Response repetition, $F(1, 7) = 5.31$, $MSE = 15161.9$, $p < 0.055$, and RSI x Response hands x Switch x Response repetition, $F(1, 7) = 5.34$, $MSE = 4310.0$, $p < 0.055$, approached significance[2].

Further analyses showed a clear difference in the pattern of results between both levels of RSI. At the shorter RSI there was a significant Response hands x Switch x Response repetition interaction, $F(1, 7) = 9.34$, $MSE = 10146.9$, $p < 0.019$. This interaction stemmed from a smaller switch cost for unrepeated than for repeated responses when only one hand of response was used but not with two response hands:

Switch x Response repetition for one hand $F(1, 7) = 24.47$, $MSE = 12337.62$, $p < 0.002$, for two hands $F(1,7) = 1.44$, $MSE = 9066.02$, $p = 0.270$. However, at the longer RSI Response hands x Switch x Response repetition was not statistically reliable, $F(1, 7) < 1$.

Please insert Figure 4 about here

Accuracy data revealed a significant main effect of switch, $F(1, 7) = 15.02$, $MSE = 0.003$, $p < 0.007$. There were also the following significant interactions: Response hands x Switch, $F(1, 7) = 7.25$, $MSE = 0.002$, $p < 0.032$, Switch x Task, $F(1, 7) = 6.14$, $MSE = 0.006$, $p < 0.043$, Response hands x Switch x Task, $F(1, 7) = 9.87$, $MSE = 0.002$, $p < 0.017$, RSI x Response hands x Task x Response repetition, $F(1, 7) = 6.25$, $MSE = 0.002$, $p < 0.042$, and Response hands x Switch x Response repetition, $F(1, 7) = 8.36$, $MSE = 0.002$, $p < 0.024$. This interaction stemmed from a significant Switch x Response repetition interaction for one response hand, $F(1, 7) = 17.34$, $MSE = 0.004$, $p < 0.005$, which was not reliable for two response hands, $F(1,7) < 1$.

Discussion

The results of this experiment replicate two of the main findings reported by Rogers and Monsell: a) as in Experiment 1, the switch cost is smaller when the response is not the same as that on the previous trial; b) there is a decrease in switch cost as the RSI varied from 200 to 1700 ms. Our main interest in this experiment was the role of the response hands variable at each level of RSI. At short RSI, the results show that the effect in cost found when there is a repetition of the physical response is not present when the response is made with a different hand and a corresponding finger. We can conclude that the response code is “physical” or related to the particular effector used to emit the response. We want to find out whether the same conclusions can be applied to the residual component of switch cost. The very long RSI used allows us to conclude that switch cost has reached an asymptote and only the residual component is left. The role of the response hands variable is dramatically different from that in short RSI. There is a bigger switch cost when the response on one trial is not physically the same as that of the previous trial but it is made with a corresponding finger. Such an effect is not reliably different from that found when the same physical response is repeated. This result seems to support the idea that an abstract (RIGHT-LEFT) action code is used at this level of RSI. There might be a change in the response representation as the RSIs become longer so that the non-residual component of switch cost vanishes. At this stage, the data supporting such a change in representation depend on the comparison between short and long RSI.

For accuracy data the change of representation with RSI is not statistically reliable. However, the pattern of results is similar to that found in RT. There is a clear decrease in switch cost for non-corresponding-finger responses at the longer RSI. Such a reduction, however, is significantly less than the one obtained in the condition with one hand.

General discussion

The experiments presented above study the interaction between repetition priming and switch cost reported by Rogers and Monsell (1995). We can summarize the main results as follows: In all cases there is a clear interaction between response repetition and switch cost. Such an interaction is due to a smaller cost when the correct response on one trial is different from that on the previous trial than when there is a response repetition. At short RSIs, the exact response must be repeated for switch cost to increase. At longer RSIs, switch cost is bigger when the response on one trial is made with a corresponding finger, even if different hands are used. The magnitude of switch cost is shorter for two hands condition with respect to one hand condition in accuracy data of experiment 2, what is in favor of a role of response selection in mental set reconfiguration in task switching and against a motor hand shift interpretation of the switch cost in experiment 2. The temporal course of the interaction between switch cost and response repetition priming is different in the two hand condition with respect to the one hand condition and in favor of a top down flow of information processing in the mental set reconfiguration in shift trials.

Although task effects were not part of our focus of interest, we have presented the main results and interactions of task in every experiment. We can conclude that there were often task asymmetries, indicating a larger cost when changing from the letter task to the number task. Results also showed faster reaction times and more accurate responses in the number than in the letter task, which agrees with the findings of Allport et al. (1994): costs are larger when changing from a more difficult to an easier task than the other way around. In general, this effect seems to be independent from the Switch x Response hands x Response repetition interaction, which is our main interest in the present study.

As for the Switch x Response repetition interaction, we can say that it is, indeed, a robust phenomenon, as Rogers and Monsell (p. 227) emphasized. We have tried to use it as an index to find out what kind of response representation is responsible for the decrease in switch cost occurring after a response repetition. We interpret the results in the sense that a ‘physical’ or effector-related action code is involved in switch cost at short RSIs but is, at least partly, replaced by some more abstract representation, perhaps related to RIGHT and LEFT action codes, as the preparation time for the following task lengthens.

It is important to note that we do not claim that a response repetition is necessary for switch cost to occur. What may be important is the kind of representation used to respond to the task and to what extent the representations of two tasks differ. What we have shown is that action codes are an important part of that representation. We may hypothesize that, if the representations of two competing task-sets share a common feature, switching from one of them to the other becomes more difficult. Future research relating switch cost and stimulus-response compatibility effect may help to test the validity and generality of this hypothesis.

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Footnotes

1. The reason for presenting the stimuli right and left from the fixation point was twofold. First, we wanted to minimize the memory load required to keep track of the current task. One way of achieving this goal was to keep the informative fixation point on screen throughout the trial. Another reason was the possibility of future research relating stimulus-response compatibility effects (such as the Simon effect) and switch cost, which calls for the presentation of stimuli either to the right or to the left. To make sure that this eccentricity manipulation did not affect the results we ran an experiment comparing peripherally- and centrally-presented (replacing the fixation point) stimuli. There was no significant interaction between this variable and response repetition, switch or task, either for RT or for accuracy data. RT data showed a significant Switch x Response repetition interaction, $F(1, 10) = 17.59$, $MSE = 931.8$, $p < 0.002$. The main effect of eccentricity approached significance, especially for accuracy data, $F(1, 10) = 4.45$, $MSE = 0.058$, $p < 0.062$. The data showed better performance for centrally- than for peripherally - presented stimuli.

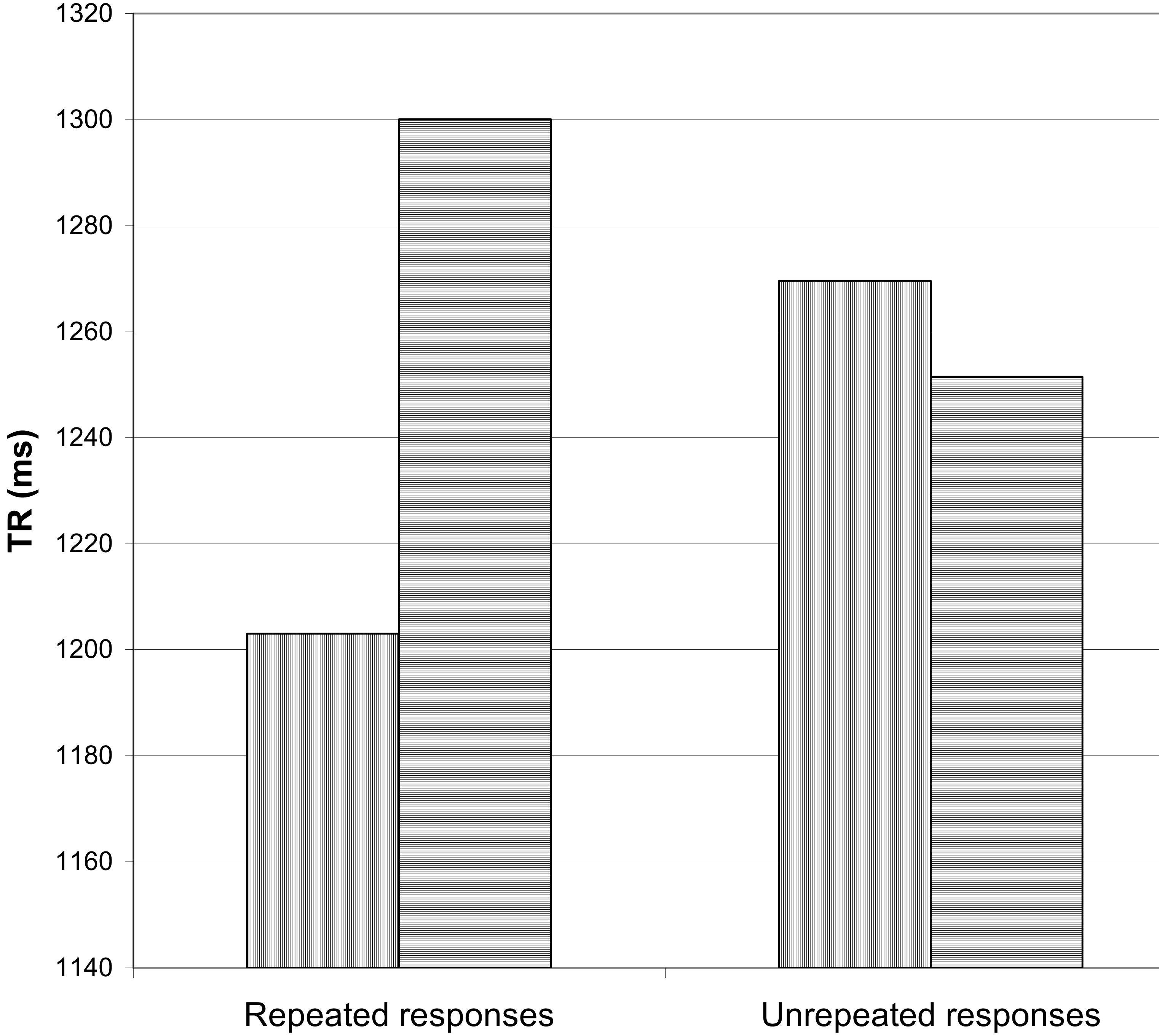
Figure Captions

<u>Figure 1.</u> Mean reaction times for repeated and unrepeated responses in Experiment 1. Bars with vertical strips represent mean reaction time on repetition trials. Bars with horizontal strips correspond to shift trials.

<u>Figure 2.</u> Percentage of errors for repeated and unrepeated responses in Experiment 1. Bars with vertical strips represent percentage of errors on repetition trials. Bars with horizontal strips correspond to shift trials.

<u>Figure 3.</u> Mean reaction time for both levels of RSI in Experiment 2. Bars with widely spaced strips show the mean reaction time for the conditions with one response hand; those with closer strips correspond to the conditions with two response hands. In both cases, the vertically stripped bars show the data for repeated-response (or corresponding-finger) trials and horizontally stripped ones show the data for unrepeated (or noncorresponding-finger) responses. There is always a pair of consecutive bars with the same pattern, the one on the left corresponds to repetition trials, that on the right is for shift trials.

<u>Figure 4.</u> Percentage of errors for both levels of RSI in Experiment 2. Bars with widely spaced strips show the error percentage for the conditions with one response hand; those with closer strips correspond to the conditions with two response hands. In both cases, the vertically stripped bars show the data for repeated-response (or corresponding-finger) trials and horizontally stripped ones show the data for unrepeated (or noncorresponding-finger) responses. There is always a pair of consecutive bars with the same pattern; the one on the left corresponds to repetition trials, that on the right is for shift trials.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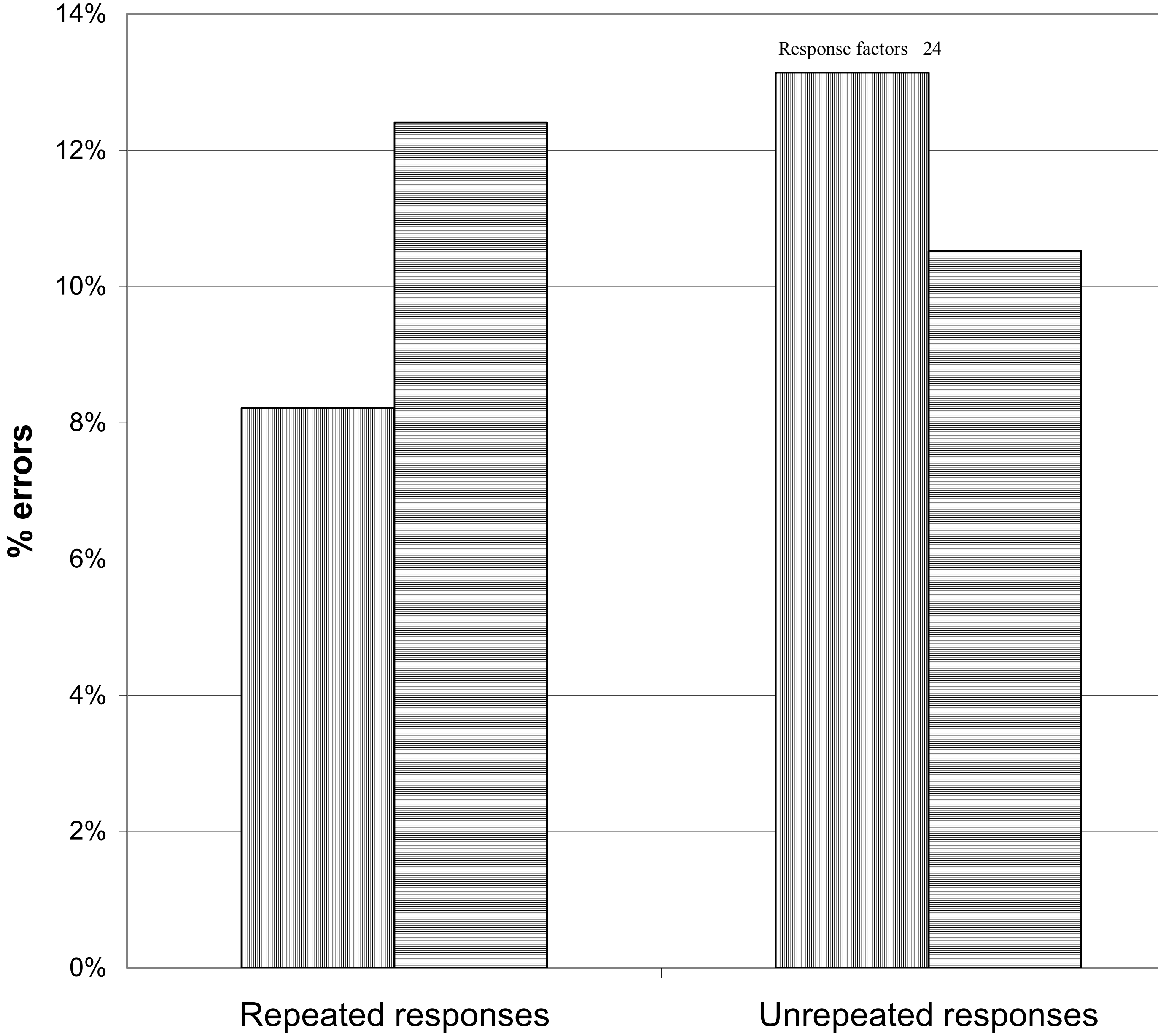
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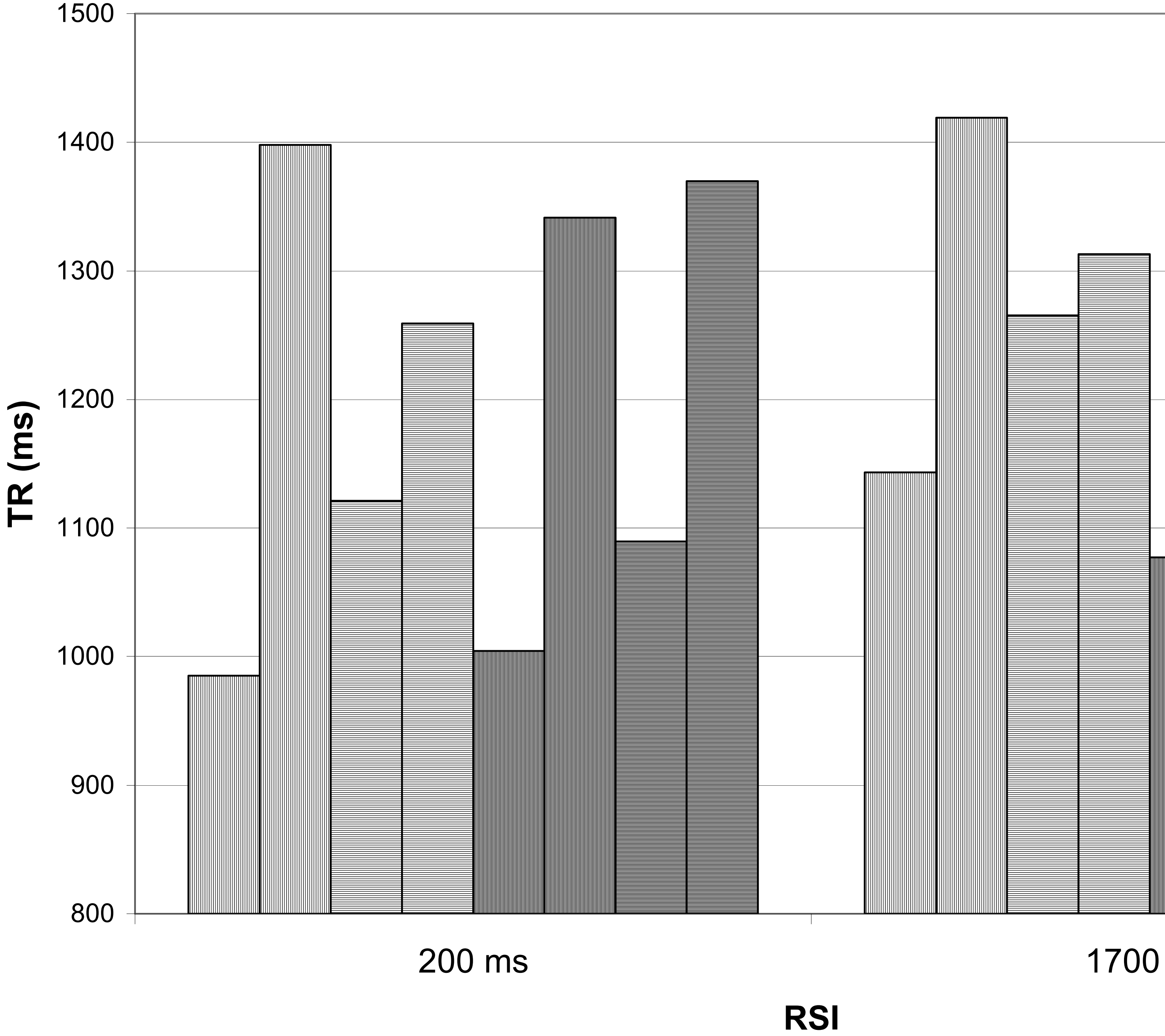
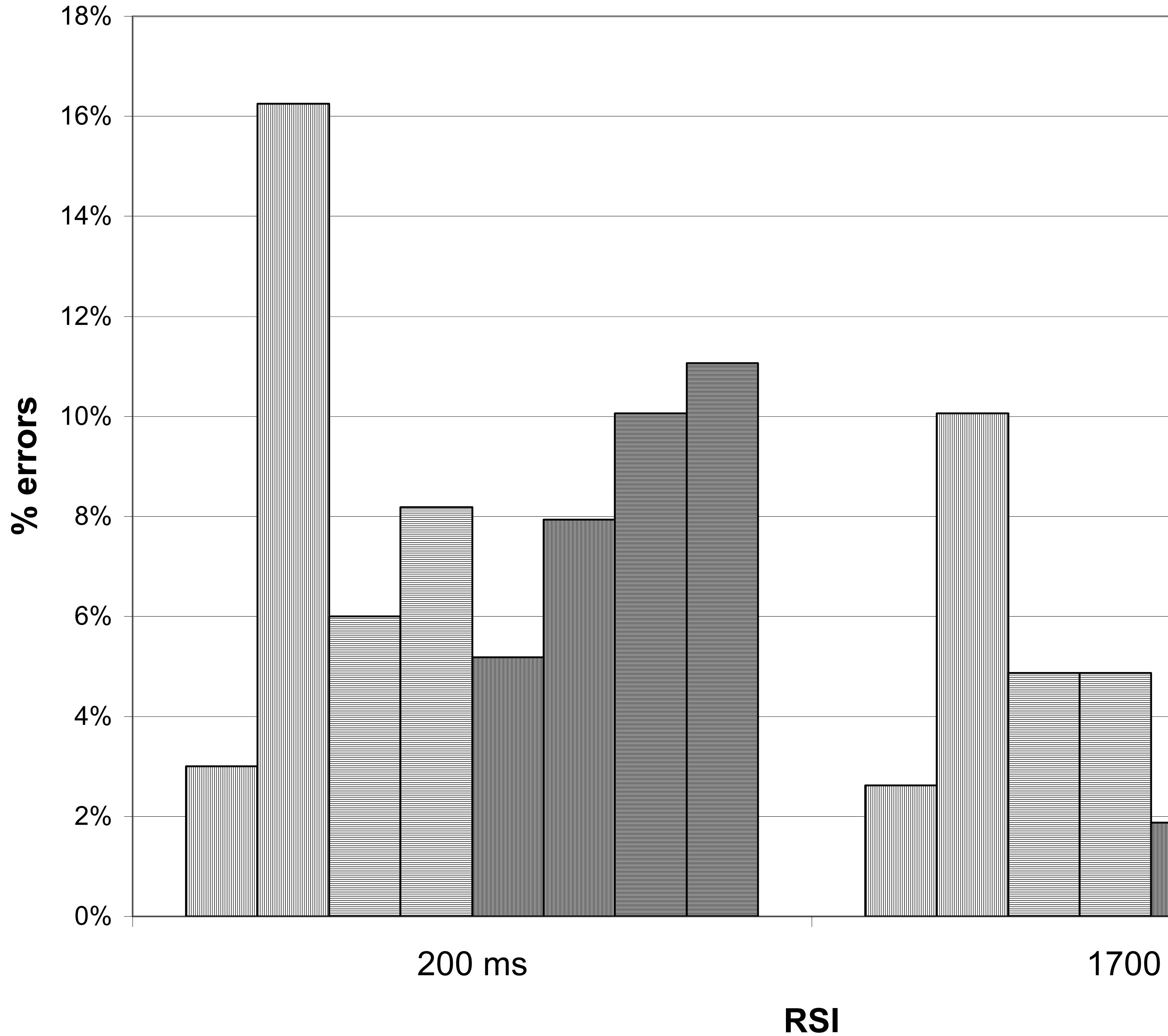
Repeated responses
Unrepeated responses


1500
1400
1300
1200
1100
1000
900
800
TR (ms)
200 ms
1700
RSI


18%
16%
14%
12%
10%
8%
6%
4%
2%
0%
% errors
200 ms
1700
RSI

Hello,
My name is Emilio Gómez Milán. I would like you consider the following submitted online ms: Response repetition in task set switch by Milán, Tornay, Quesada & Gonzalez for publication in Acta Psy.
Thanks

Yours

Emilio

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