



## Current psychology letters

Behaviour, brain & cognition

Vol. 26, Issue 1, 2010 | 2010

Varia

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### Electronic version

URL: <http://journals.openedition.org/cpl/4975>

DOI: 10.4000/cpl.4975

ISSN: 1379-6100

### Publisher

Centre PsyCLÉ

### Electronic reference

Ali Oker and Rémy Versace, « Distinctiveness effect due to contextual information in a categorization task », *Current psychology letters* [Online], Vol. 26, Issue 1, 2010 | 2010, Online since 01 September 2010, connection on 08 September 2020. URL : <http://journals.openedition.org/cpl/4975> ; DOI : <https://doi.org/10.4000/cpl.4975>

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# Distinctiveness effect due to contextual information in a categorization task

Ali Oker and Rémy Versace

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## Introduction

- 1 Many studies on memory have shown that the more distinctive an item is compared to the other items to be learned, the easier and more accurately it can be recalled. This phenomenon, known as the distinctiveness effect (for a recent review, see Hunt & Worthen, 2006) has traditionally been considered to highlight the episodic nature of knowledge in episodic memory. The distinctiveness effect is also known as the von Restorff effect, named after the publication of Hedwig von Restorff's results in 1933 (von Restorff, 1933, cited in Koffka, 1935; for a review, see Wallace, 1965). Participants in a typical von Restorff experiment may have to learn a list of items, all of which are nonwords except one which is a word, or all of which are words written in black capital letters except one which is written in red capital letters (e.g., Rabinowitz & Andrews, 1973).
- 2 Until now, studies of distinctiveness effects have essentially manipulated the properties of the item itself. However, the importance of contextual information in the distinctiveness effect has often been evoked in many accounts of serial position effects in free recall. For example, according to the contextual retrieval hypothesis (Glenberg, Bradley, Stevenson, Kraus, Tkachuk, Gretz, Fish & Turpin, 1980), recall efficiency depends on the efficiency of reactivation of the encoding context of the items by the test context and therefore on the specificity of the encoding context. In the temporal distinctiveness hypothesis proposed by Neath (1993; see also Nairme, Neath, Serra, & Byun, 1997), the context is the temporal position of an item, and it is assumed that the probability of recalling an item is proportional to its temporal distinctiveness, as estimated by its summed temporal distance from the other items in the list. In all these

studies, however, contextual information is assumed to influence explicit retrieval. According to the multiple traces memory models (e.g., Hintzman, 1986; Logan, 1988; Whittlesea, 1987), which describe memory as a unique system composed of an accumulation of traces representing every single specific experience, explicit and implicit retrieval result from a reactivation of multiple memory traces. Therefore, both explicit and implicit retrieval should benefit from an increase in trace distinctivity. Moreover, as contextual information is one of the many components of the traces, it should also be possible to observe the distinctiveness effect in implicit and explicit retrieval by manipulating contextual information of the item (or spatial information; see Oker, Versace & Ortiz, 2009).

- 3 However, the distinctiveness effect is still considered observable only in explicit memory tasks. For example, Smith and Hunt (2000) assumed that distinctive processes would be ineffectual in retrieval unless the original encoding context is reinstated. Therefore, intentional memory instructions at test phase are crucial to reinstatement of the original context. In two experiments, half the participants were asked in a study phase to judge the similarity of highly similar items, while the other half were asked to make difference judgments. They were then tested in explicit (cued recall) and implicit memory tests (word association and category exemplar production). Their performance in the explicit tests showed, as expected, that difference judgments had the advantage over similarity judgments, whereas manipulation affected implicit tests only when subjects claimed awareness of the relationship between study and test. For Smith and Hunt, these results demonstrate the critical role of cues provided by intentional instructions at the time of testing. According to Weldon and Coyote (1996), because the category-production and word-association tests do not require participants to discriminate between items in the way the item-specific study task does, manipulations affecting distinctive processing will not transfer to the implicit tests.
- 4 Geraci and Rajaram (2004) have already shown by manipulating the type of processing that the distinctiveness effect can be apparent in the absence of recollection during testing. They suggested it could emerge with recapitulation of the type of processing that occurred at study even in the absence of recollection (see also Hunt & McDaniel, 1993). However, they used a classic isolation paradigm involving two lists presented to participants. With the isolation list, subjects studied a word isolated by category. For example, the word "table" appeared along with other words such as "salmon, tuna, cod". The word then appeared on another list in which none of the words was isolated. In the test phase, subjects were asked to perform a category verification task, but in two versions: explicit or implicit. In the implicit category verification task, they were given the name of a category (for example, fish) and had to decide whether "table" fell within that category or not. In the explicit version of the task, the category names were the same, but subjects had to recognize whether or not the target had been seen in the encoding phase.
- 5 Regarding the results of the explicit task, Geraci and Rajaram obtained a classic distinctiveness effect: isolated items were recognized more quickly than non-isolated items. In the implicit version, faster reaction times were observed for isolated items. These results confirmed that refusal of an exemplar's membership of a given category was faster in the case of isolated items as opposed to non-isolated items. Consequently, the authors found a distinctiveness effect via a category verification task which they called implicit.

- 6 However, in this study by Geraci and Rajaram, isolation has been created by means of an intrinsic semantic context (category membership) which is particularly relevant for performing the required task (category verification) in order to find a distinctiveness effect with an implicit task. This gives the impression that the material and the task have been tailor-made and the conceptual material of the study phase fits perfectly to the implicit conceptual task for testing this material. Geraci and Rajaram therefore postulate that the distinctiveness effect can be obtained by implicit memory tasks only if the test phase summarizes the conceptual process in place, according to the theory of the transfer appropriate processing view (Roediger, 1990; Roediger, Weldon & Challis, 1989). By doing so, they created material which is wholly relevant for completing the task.
- 7 Thus, on the basis of our experience, our main objective will be to demonstrate the following points:
- 8 First of all, the properties of the item itself do not have to be manipulated for the distinctiveness effect to be obtained. In our experiment, we manipulated only an extrinsic context associated with the item and did not change any of the item's properties.
- 9 The distinctiveness effect can occur with an implicit memory task (here, categorization), contrary to what is postulated by Smith and Hunt (2000). Our paradigm uses no explicit instructions. Therefore, we assume that the intentional recollection effort is not required to obtain the distinctiveness effect in the case of categorization as reported by Weldon and Coyote (1996).
- 10 The distinctiveness effect can also occur even if contextual information used to isolate a number of items is irrelevant for executing the task, as opposed to Geraci and Rajaram's (2004) experiments. We aim here to obtain this effect without manipulating a category link between words but by manipulating (visual) contextual information associated with the target word which is irrelevant for the categorization task. In our view, one way of making a memory trace more distinct from others is to make some items more distinct from others by manipulating the visual context. This confirms that is possible to find an influence exerted by contextual information in encoding and implicit recovery.
- 11 During the incidental encoding phase and the test phase of the present experiment, participants had to categorize target words as referring to items found in the natural environment or artifactual objects (produced or shaped by human craft). The context was the color (red or yellow) of a frame within which the target words were presented, and the distinctiveness of the context was manipulated by varying its frequency. 75 % of the words were encoded with the same contextual information (frequent context) and the other quarter with different contextual information (rare context). All the target words presented during the encoding phase were repeated during the test phase, when, however, they could be presented with the same color frame as in the encoding phase, or a frame of the other color.
- 12 Our first hypothesis was that, compared to the more frequent context, the less frequent (more specific) context should increase the distinctiveness of the memory traces of the items associated with it. We therefore predicted that when the context in the encoding and test phases is the same, items presented with the less frequent context should be more rapidly categorized in the test phase than those presented with the more

frequent context. Our second hypothesis was that if the distinctiveness effect is due to the contextual information (as extrinsic visual context in our experiment), then a change in contextual information between the encoding and the test phase should be more detrimental for items encoded with a rare context. We therefore predicted an interaction between encoding context (frequent or rare) and test context (same or different from encoding context).

## Experiment

### Method

#### Participants

- 13 40 native French-speaking students from the University of Lyon 2, France, were tested. All had normal to corrected-to-normal vision and none suffered from Daltonism (this was important because the experiment used colored frames). No participant was familiar with the issues under investigation in this study.

#### Stimuli

- 14 We used a set of 100 frequent French words selected from the MANULEX database (Lété, Sprenger-Charolles, & Colé, 2004). All were nouns of between 5 and 7 letters, and they were selected on the basis of their lexical frequency in French, which ranged between 35.66 and 1128.46 occurrences per million, with an average of 582.06 (U-index from the Manulex lemma lexicon). No one word was the orthographic neighbour of any other word in the set, and all were chosen as having a single meaning. Half of the words were feminine in gender ("la") and the other half were masculine ("le"). They were all presented in lowercase in "Chicago" font with a font size of 48. The (extrinsic) context was a 3 mm deep, 13.75 x 5.25 cm red or yellow frame in which the word were presented.

#### Apparatus and procedure

- 15 Each participant was tested individually in a session lasting approximately 20 minutes. At the beginning of the session, they sat in front of a computer (Apple eMac, 1024 x 768 screen resolution, 89 Hz, Millions of color in a 17" screen), nearly 45 cm from the screen. This distance was kept constant for all subjects by means of a chin rest. The participants were told they would see words referring to items commonly found in the natural environment or to artifactual objects, and that their task was to distinguish between them by pressing the appropriate key on the keyboard ("X" and "." on a French keyboard), as quickly and as accurately as possible using the index fingers of their left and right hands. The experiment was run using Psyscope software (Cohen, McWhinney, Flatt and Provost, 1993) and was divided into three phases: encoding phase, distracting phase, and test phase.

## Design

### *Incidental encoding phase*

- 16 48 of the 100 words were used as experimental words, the remaining 52 as distractors. 24 of the experimental words were presented in a yellow (or red) frame, whereas the other 24 and the 48 distractors were presented in a red (or yellow) frame. Thus, 24 experimental words were associated with one of the two colors (rare context) and the other 76 items (24 experimental words and 52 distractors) with the other color (frequent context). Half of 24 words used in rare context were natural items and the other half were artifact items. Again, half of 76 items used in frequent context were natural items and the other half were artifact items. Consequently, the color of the context could not help the subject predict the nature of the item. An experimental word that was in the rare context condition for half the subjects was in the frequent context condition for the other half. The colors of the rare and frequent contexts were yellow and red respectively for half the subjects and red and yellow for the other half. The order in which the 100 words were presented was randomized for each participant, but the first 16 items were always distractors. To reinforce context, all the words were repeated twice in two blocks of 100 items.
- 17 The encoding and test phases were separated by a distractor task lasting approximately 5 minutes and consisting of simple mental calculations. Subjects were told to read the calculation questions and to respond out loud. We therefore produced a task not only involving memorization processes, but also not involving conceptual information.

### *Test phase*

- 18 During the test phase, half of the 48 experimental items (24) were presented with the same context as in the encoding phase, and the other half with the color of the other encoding context. In each experimental condition half of the words (12) were in the frequent context condition during the encoding phase and the other half (12) in the rare context condition. The words in the different experimental conditions were counterbalanced across all participants. Like in the encoding phase, half of the words in each context condition were natural items and the other half artifact items.
- 19 In the encoding phase and test phases, each trial consisted of the following sequence: first a colored frame and a fixation point were presented simultaneously for 750 ms to give participants enough time to process the frame color before starting to process the target. The fixation point was then replaced by a target word which stayed on the screen for 1500 ms. The colored frame stayed on the screen while the word was being presented. Even if a participant took less than 1500 ms to respond, the word and colored frame which constituted context were left on the screen for a better encoding process. The intertrial interval was 1000ms. All the stimuli were presented in the center of the screen.

## Results

- 20 Mean correct response latencies and error rates were calculated across subjects for each experimental condition. Latencies more than three standard deviations above or below the mean were discarded (less than 5% of the data). In the incidental encoding

phase, the overall error rate was less than 5% of the data; therefore these data are not included in the analysis. The mean correct latencies and error rates for the different experimental conditions in the test phase are shown in Table 1.

**Table 1.** Mean Response Times (RTs) and Error Rates (ERs) obtained in the experiment. Standard errors are given in brackets.

	Test Context			
Encoding	Same Context		Different Context	
Context	RT (ms)	ER (%)	RT (ms)	ER (%)
Frequent	682 (19.7)	5,5 (1.1)	687 (19.9)	4,6 (1)
Rare	665 (17.8)	4,7 (0.9)	691 (21.8)	3,4 (0.7)

- 21 Separate repeated measures analyses of variance were performed on the latencies and error rates with subjects as random variables, and Encoding Context (frequent versus rare) and Test Context (same context, different context) as within-subject variables. The error rates analysis revealed no main effect or interaction. The latency analysis revealed a significant main effect of test context,  $F(1,39)=4.045$  ;  $MSE=9348.3$  ;  $p<0.05$ . Words in the same context conditions were categorised more rapidly (673.5 ms) than words in the different context condition (689 ms). The analysis also revealed a significant interaction between Encoding Context (frequent versus rare) and Test Context (same versus different)  $F(1,39)=4.791$ ;  $MSE=4316$ ;  $p<0.05$ . Planned comparisons showed that in the rare encoding context condition words presented with the same context were categorized more rapidly (665 ms) than words presented with a different context (691 ms),  $F(1,39) = 14.635$ ;  $MSE= 13184.1$ ;  $p<0.001$ , whereas in the frequent encoding context condition there was no difference between words presented with a different context (687 ms) and words presented with the same context (682 ms),  $F< 1$ . Moreover, planned comparisons also showed that for words presented in the same context condition, those encoded in the rare context were categorised more rapidly (665 ms) than those encoded in the frequent context (682 ms),  $F(1,39) = 6.118$  ;  $MSE= 5511.2$  ;  $p<0.05$ .

## Discussion and Conclusion

- 22 One of the characteristics of our experiment is that we used long-term repetition priming to test the distinctiveness effect. In addition, the only change between contexts is a visual one (colored frames) while subjects were asked to perform a semantic task. It is widely acknowledged that priming reflects a mechanism that involves the memory implicitly, in that it involves the non-conscious retrieval of information by the subject. Consequently, subject's performance in the test phase depends on how the targets (here, words) and its attributes (here, colored frames) were encoded together during the study phase. It typically results in a lower latency needed to process (here, categorization) the stimulus if these attributes are presented in a different condition (change of the color). In all the well-known experiments using a

repetition priming paradigm with perceptive cues (Graf, Shimamura, & Squire, 1985; Jacoby & Dallas, 1981; Roediger & Blaxton, 1987), hypotheses were formulated not in terms of accuracy, but in terms of latency as in the case of our experiment.

- 23 As pointed out in the Introduction, distinctiveness effects have been studied essentially via experiments which manipulate the properties of the item itself. While context manipulation is not unheard of in this subject area, to the best of our knowledge our use of extrinsic visual context is rather innovative.
- 24 We have also pointed out on a number of occasions that the effect of distinctiveness was generally considered to be exclusively reserved for explicit memory tasks. The main aim of the present study was to show that distinctiveness effects could be observed in implicit memory tasks if the contextual information associated with the item was manipulated during encoding. This is clearly demonstrated by the observation, in the same context condition, of faster responses for words encoded in a rare context than for those encoded in a frequent context condition. Another aim of our study was to demonstrate that if the distinctiveness effect is due to the contextual information a change in contextual information between the encoding phase and the test phase should be more detrimental for items encoded with a rare (or specific) context than for those encoded with a frequent context. The interaction observed between encoding context (frequent or rare) and test context (identical to or different from the encoding phase) confirms these predictions. Clearly, words presented with the same context were categorized more rapidly than words presented with a different context if they were in the rare condition at encoding, whereas no significant context effect appeared for words initially presented in the frequent context condition.
- 25 Some authors have considered that intentional memory instructions are crucial at testing if a distinctiveness effect is to be observed. For Weldon and Coyote (1996), it is not possible to demonstrate the distinctiveness effect with an incidental study phase. And, for Smith and Hunt (2000), intentional memory instructions allow for reinstatement of the original context, which they assume to be at the origin of the distinctiveness effect. However, our incidental encoding phase clearly sets in motion a process of incidental and non-intentional learning. Furthermore, in our experiment, we used no intentional instructions that could allow for any explicit recovery of the initial context. We also used a distractor task (a series of simple mathematical calculations) between the incidental learning and test phases to prevent subjects from mentally rehearsing or remembering cues about the relationship between colored frames and items. Nevertheless, we still observed the distinctiveness effect within an implicit memory task.
- 26 Another contribution made our research study is that it supplements Geraci & Rajaram's (2004) work about the distinctiveness effect and implicit memory tasks. Although they were successful in observing this effect with an implicit category verification task, they suggest it can be obtained by implicit memory tasks if, and only if, the test phase summarizes the conceptual process in place, according to the theory of the transfer appropriate processing view (Roediger, 1990; Roediger, et al., 1989). We, however, clearly showed this effect without having to manipulate a categorical link between words, but by manipulating (visual) contextual information associated with the target word which is totally irrelevant to the categorization task. Hence, we think that while respecting transfer appropriate processing between the learning and test



phases may facilitate some manifestation of the distinctiveness effect, it is definitely not the only way of obtaining this phenomenon, as our experiment has shown.

- 27 Demonstrating both the context effect and distinctiveness effect in an implicit memory test is highly problematic for the structural memory approach (for a review see Tulving, 1995). It supposes that these effects should typically be observed in episodic memory, which generally requires explicit recollection, but not semantic memory, which relies on more implicit memory processes. Conversely, these results can be interpreted as providing strong evidence in favor of an episodic or situational memory model (e.g., Barsalou, 2005; Glenberg, 1997; Whittlesea, 1987), where memory is described as a unique system that continuously stores the traces of single specific experiences. In episodic or situational memory models, the explicit and implicit recovery of any form of knowledge from a stimulus is described as an emergence of the activation of all the (episodic) traces related to the stimulus. Therefore, reinstatement of the original encoding context, and more broadly the encoding episode, should be also a characteristic of implicit memory tests. That is why, in order to show both the distinctiveness effect and the context effect in an implicit test, we chose to manipulate the distinctiveness of the contextual information in a semantic categorization task.

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## ABSTRACTS

The main objective of our study was to confirm that the distinctiveness effect could emerge in implicit memory tasks and to show that the specificity of an item can be varied by manipulating the contextual information associated with the item during encoding. In an encoding phase and

test phase, participants had to categorize target words as referring to artificial or natural items. Each target word was associated with a context consisting of a colored frame in which the word was presented. To manipulate the distinctiveness of the contextual information, 75 % of the words were encoded with the same color (frequent context) and the remaining 25 % with a different color (rare context). We tested the context effect by presenting words in the test phase with a context of either the same color as in the encoding phase or the other color. The results confirmed our predictions and are discussed in the theoretical framework of episodic memory models.

L'objectif principal de notre étude était de confirmer que l'effet de distinctivité peut se manifester dans les tâches de mémoire implicite et de montrer que la spécificité d'un élément peut être modifiée par la manipulation de l'information contextuelle associée à un élément lors de l'encodage. Au cours d'une phase d'encodage et une phase de test, les participants avaient à catégoriser les mots cibles comme se référant à des éléments naturels ou des artefacts. Chaque mot cible était associée à un contexte qui se composait d'un cadre coloré dans lequel un mot a été présenté. Pour manipuler le caractère distinctif de l'information contextuelle, les trois quarts des mots ont été codés avec la même couleur (contexte fréquent), tandis que l'autre quart a été encodé avec une autre couleur (contexte rare). L'effet de contexte a été testé en présentant des mots dans la phase test avec la même couleur de la phase d'encodage ou avec la couleur inverse. Les résultats ont confirmé nos prédictions et sont discutés dans le cadre théorique des modèles de la mémoire purement épisodique.

## INDEX

**Keywords:** distinctiveness effect, context effect, categorization, Multiple-Trace Memory Model

**Mots-clés:** effet de distinctivité, effet du contexte, catégorisation, Mémoire à traces multiples

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