

Associative and Categorical Priming in Recognition of Individuals

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Abstract

This paper reports an experiment which explores how our semantic representations of individual objects are organized and accessed in memory and how these representations are inter-linked with those of other individuals. A priming experiment was conducted to investigate the relations between singular representations of famous individuals from four categories (person, building, artwork and product), contrasting associative and categorical priming effects in visual recognition. The experiment adopted a familiarity decision task to compare priming by associates (e.g. Michelle Obama - Barack Obama; Paris - Eiffel Tower) and priming by non-associates from the same semantic category (e.g. Angelina Jolie - Johnny Depp; Golden Gate Bridge - Brooklyn Bridge) against an unrelated prime condition. The results of the experiment showed that there was a substantial priming effect from associates but no reliable priming from non-associates of the same semantic category. We propose that singular representations of unique individuals are more strongly inter-connected by networks of horizontal associative links rather than by categories.

Keywords: associative priming; categorical priming; singular concepts; entity familiarity decision task

Introduction

Humans appear to be remarkably capable at storing and retrieving knowledge about unique entities such as people, places, artworks, pets and other individual things relevant to their own existence. The way in which individual-specific information is structured in semantic memory and accessed from the perceptual input is a matter of considerable debate in cognitive research. Many studies in the literature focused on the problem to understand the organization of (and the access to) semantic memory for familiar people and several theoretical explanations have been proposed to explain person recognition and naming (Bruce & Young, 1986; Burton, Bruce, & Johnston, 1990; Bredart, Valentine, Calder, & Gassi, 1995).

However, little attempt has been made to compare the processes involved in person recognition and naming with those used for other kinds of entities. The few studies (Barry, Johnston, & Scanlan, 1998; Damian & Rahman, 2003) that have addressed this issue compared famous faces and generic objects studying the recognition process at two different levels of abstraction. For instance, a common task used in these studies is the *face naming task*. In this task, participants are asked to name a known person by producing her proper name. To perform such a task, it is necessary to access to the specific memory representation of that unique person and retrieve the proper name. In contrast, in the corresponding task used for objects, namely the *object naming task*, a generic exemplar of

an object category is shown and people are asked to name the object with the name of the category. In the first case, stored representations are accessed at the level of unique identity, in the second case they are accessed at basic or subordinate level. As yet, very few studies (Engst, Martin-Loeches, & Sommer, 2006; Gorno-Tempini & Price, 2001) have compared the organization of person-specific knowledge with that of other entities at the unique level of identity.

The primary rationale of the present research is to provide a contribution in this regard, comparing person and non-person entities that can likewise be accessed at the exemplar level in terms of recognition. More precisely, our aim is to investigate how our semantic representations of individual things are organized and accessed and how these representations are inter-linked with those of other individual things. To this purpose, we probe the semantic system using a priming experiment.

Categorical and associative relatedness between entities and priming effects

How semantic knowledge for individual entities is stored in long term memory is an open issue. One possible view - *categorical view* - is that semantic knowledge of individual entities has a categorical structure, as has been demonstrated to exist for generic objects (Barry et al., 1998; Humphreys, Ridgely, & Quinlan, 1988). The idea is that memory representations of unique entities are interconnected by belonging to common categories. This view holds that the category "politician", for example, exists as a node in a network and that all the exemplars of the category (e.g., Barack Obama, Bill Clinton, Nicolas Sarkozy) are connected to the corresponding node. The connection with the superordinate category creates an indirect link between these entities that share the properties inherited from the category.

An alternative view - *associative view* - holds that the semantic knowledge for unique entities is not structured according to categories. In this view, relationships between entities can be represented by networks of associative links but not by membership of a common category. According to this view, Barack Obama and Michelle Obama would be linked in memory because they are inter-connected by a direct associative link (i.e. a partnership relationship). Moreover, it is assumed that knowledge of entities which are identifiable at the level of unique identity is individual and attributes cannot be automatically inferred from category membership.

The two views described above (that are not necessar-

ily mutually exclusive) imply different predictions about the priming effects that can be observed in experiments of entity recognition and naming. In particular, a clear distinction should be made between priming based on categorical and associative relationships. Since in many studies no clear distinction has been made between these two forms of priming, we first clarify the distinction between *categorical* and *associative* priming.

The debate about whether priming effects in individual recognition and naming are in fact due to associative or categorical relationships has been addressed in face recognition literature, but the issue has not been fully investigated. Moreover, the two forms of primings are often confounded in this literature and there is an ambiguity about the locus of the effect. This is due to the fact that in many studies the stimulus pairs are simultaneously related by categorical and associative relationships and the term “semantic priming” is often used to include both kinds of relationships (McNeill & Burton, 2002; Carson & Burton, 2001).

In addition, the idea that a certain amount of semantic information must be shared between two associate faces in order to produce a priming effect is implicit in several models of face recognition. The Burton, Bruce, and Johnston IAC model of person recognition (Burton et al., 1990) proposes that when a known face or name is recognized, activation spreads from the face/name recognition unit (FRU/ NRU) to the corresponding person identity node (PIN) and then to the individual-specific semantic information stored in semantic information units (SIUs). Each SIU is connected to the PINs of other persons who share the same attribute and, therefore, when the face or name of a known person is presented, activation should spread to the representations of other persons sharing the same semantics. Since categorical information (e.g. occupation) is assumed to be stored in SIUs, this clearly predicts categorical priming. That is, the presentation of the face of a known politician (e.g. Barck Obama) should influence the speed of responses to a subsequently presented target person sharing the same occupational category with the prime (e.g. Nicolas Sarkozy).

To date, however, empirical evidence for categorical priming of person recognition has been inconclusive.

Bruce (1983), Brennen and Bruce (1991) and Stone and Valentine (2007) all reported categorical priming in person recognition as did Carson and Burton (2001), showing that it was possible to boost semantic priming effects when multiple primes were presented before the target. In some studies (Carson & Burton, 2001; Vitkovitch, Pottot, Bakogianni, & Kinch, 2006) semantic priming effect was found having similar characteristics to the associative effect and it was suggested that semantic priming behaves like a weak version of associative priming and it should not be considered as a different mechanism. However, the idea that associative and semantic priming can be explained by the same underlying mechanism has been recently challenged in a ERP study by Wiese and Schweinberger (2008) and the effects of

co-occurrence and semantic relatedness in face priming have been recently isolated using a learning paradigm with artificial, computer generated faces (Vladeanu, Lewis, & Ellis, 2006). Finally, other studies that tried to isolate categorical effects from associative effects within the same experiment, failed to observe categorical priming of person recognition (Young, Flude, Hellawell, & Ellis, 1994; Barry et al., 1998). The latter two papers both noted that the absence of categorical priming, compared with larger and statistically significant associative priming, challenged the Burton et al. (1990) model of organization of person knowledge.

We believe that one of the main reasons for these inconclusive results is that in face priming studies associated stimuli share also a lot of categorical information. John Lennon and Paul McCarty¹ are both persons, singers, male, British, as well closely associated members of the Beatles. It could be argued that they are indeed categorically related but also share a significant degree of co-occurrence. If we find a priming effect using this pair, it is difficult to separate the contribution of categorical relatedness from that of associative relatedness.

Moreover, in contrast to object priming studies, where associated prime-target pairs may belong to very different basic level categories (e.g. carrot-donkey), in all the face priming studies cited here, items from the same basic level category (e.g. two persons) or subordinate category (e.g. two actors) were used as stimuli. In other words, the only associative connections that have been studied to investigate the organization of person-specific information are associative links between entities belonging to the same category.

This is in line with a general view that considers people as “special entities” whose semantic knowledge differs in structure from that of other objects. This idea is supported, for example, by the results reported by Barry et al. (1998). The authors found that objects were primed reliably by both associates and semantically related non-associates. In contrast, for faces there was a substantial priming effect for associated but not for semantically related items. The authors suggested that semantic representations of objects are inter-connected by abstracted superordinate categories but that representations of people are interconnected by networks of inter-personal relatedness rather than by categories. Since the associative links, as proposed by the authors are “social” in nature, it seems obvious that they may interconnect only “social” entities (i.e. persons).

We argue that associative relationships may be established between entities belonging to different categories. A building, for example, may be strongly associated to the city where it is placed (e.g. Colosseum-Rome) or an artwork to its author (e.g. The Pietá-Michelangelo). In this study we will investigate these kinds of associative relationships. The advantage to extend the definition of associative connections across the category boundaries is that the semantic relatedness between the associated entities is kept to a minimum.

These considerations lead us to clarify our use of categor-

¹ A prime-target pair used by Barry et al. (1998)

ical and associative relationships between entities. Two entities are said *categorically* related if they share the same basic level or subordinate level category, whereas two entities are said to be “associatively” related if the first entity calls to mind the second entity and/or vice versa. We share with other authors the view that the primary mechanism for associative relatedness is that the two entities are routinely experienced together in the contexts in which they appear. Even though we acknowledge that a purely associative relation can be induced by repeated co-occurrence of two entities otherwise unrelated and become automatically registered in memory (Vladeanu et al., 2006), we argue that associative connections are in fact more likely to be determined by co-occurrence of entities related by meaningful horizontal relations (e.g. The President of).

The Entity Recognition Experiment

The major purpose of the present study is to contrast categorical and associative priming for entities from different categories (person, artwork, building and product) in a familiarity decision task. Our goal is to investigate whether there are qualitative differences in semantic and associative priming of individuals, comparing the priming effects for entities of the person category with those for entities of other three categories: artwork, building and product. In order to discriminate priming effects due to categorical relatedness from effects due to associative relatedness, in this study we investigated priming effects in associated pairs whose members belong to different categories. Since previous studies have demonstrated the importance of associative relationships between persons, only for this category we decided to compare the effects of associative priming within and across the person category. In this way, we explored how memory representations of individual entities are inter-linked with those of other individual entities of the same or different category and explore whether these connections are qualitative different.

To address these issues we examined associative and categorical priming effects in an entity familiarity decision task, comparing person recognition with object recognition when both processes involve individual exemplars of the category. In the task, people were asked to make a decision about the familiarity of a target entity. The target entity was preceded by a stimulus (a written word) that could be differently related (associatively or categorically) to the target or unrelated to it. Reaction Times were measured as Dependent Variables.

Method

Stimulus Selection For our experiment a) highly associated prime-target stimulus pairs, b) non-associated pairs belonging to the same category and c) unrelated pairs were required. To identify the prime-target pairs for use in the following experiment, we conducted a pilot study (15 participants) with the aim of identifying an initial set of associated pairs from which we generated the complete list of experimental stimuli. To create this set, we compiled a list of famous entity names (12 entities for each category) to be used in a free association

task. In this task, each name on the list had to be rated on a 4-point scale according to its familiarity to the participant in order to ensure that the entities selected were really familiar to participants. In addition participants were asked to write down as many entities as possible that came spontaneously to mind when they encounter a particular name. These spontaneously generated names were assumed to be associated to that particular name on the list. This means that we took an entity B to be associatively related to an entity A, if B was produced in response to A by the majority of participants. The most highly associated pairs were identified and combined into prime-target pairs for use in the following experiment. For each of the second member of these pairs of associates, an entity who was not associated but who was from the same basic level category as the first was selected. For the category person, pairs with the same occupational category were selected. That is, we took an entity B to be categorically related to an entity A if both entities belong to the same basic level category and B was not produced in response to A by any rater in the free association task. Then, an unrelated but famous entity was chosen for each entity target. To generate associated pairs whose both members belonged to the person category, a second group of 15 judges were presented with a different list of famous person names and they were specifically asked to write down as many other names of famous persons as possible that came spontaneously to mind when they encountered the target person name.

Participants Eighteen participants took part in the experiment (11 female). Mean age was 30.61 years ($SD=4.59$) ranging from 23 to 40 years. Each participant was tested individually in a quiet room.

Stimuli and Design For each category of the selected target entities (person, artwork, building and product), the experimental stimuli consisted of 12 pairs of closely associated famous entities, arranged into three sets of 4 pairs. In these sets the prime entities belonged to a different category than target entities. For the person category 12 pairs of closely associated famous entities from the same category (i.e. associated persons) were also used. In this way, we introduced a further condition, in which associated, categorical and unrelated primes were selected from the same category (i.e. Person). To distinguish between the two conditions in the person category, we named *Person Across* the condition in which associated prime and target were from different categories (e.g. location: USA - person: Barack Obama) and *Person Within* the condition in which prime and target were from the same category (e.g. person: Monica Lewinsky - person: Bill Clinton). Each participant saw the entities in one set in their close-associate pairs, the entities in a second set rearranged to form pairs whose members were from the same category but no close associated, and in the remaining set rearranged to form unrelated pairs. The allocation of the sets to the experimental conditions was counterbalanced across participants. In addition, 60 unfamiliar entities were selected to serve as targets

and combined with the same 60 primes. In this way, unfamiliar targets were also preceded by famous names and prime familiarity would have no predictive value for target familiarity.

The design of the experiment was a 5 (category: person across, person within, artwork, building and product) \times 3 (primes: associative, same category, unrelated) repeated measure factorial design. As a consequence of the adopted design, each prime was presented twice in the course of the experiment. We note that potential effects of prime repetition would have occurred in all experimental conditions in a comparable way and therefore cannot explain the differences between conditions. An example of the stimuli used in the experiment is shown in table 1. Prime stimuli consisted of written names of entities, whereas targets were gray-scale pictures (450 \times 600 pixels in size) depicting the target entities.

Table 1: An example of the stimuli used in the experiment.

	Prime		Target
Associate	Categorical	Unrelated	
USA (0.80) *	Nicolas Sarkozy	Florence	Barack Obama
Angelina Jolie (0.86) **	Johnny Depp	Bob Marley	Brad Pitt
Louvre (1)	Guernica	Vladimir Putin	Mona Lisa
Paris (0.93)	Leaning Tower of Pisa	Moscow	Eiffel Tower
Apple (0.86)	Black Barry	Martin Scorsese	Iphone

* Person Across
** Person Within

Numbers in the first column show the degree of association, measured as the proportions of participants ($n=15$), who gave the name as the "first that springs to mind" when presented with the target name in the pilot study.

Procedure Subjects were tested individually in a quiet room. In each trial, the prime was presented for 1000 ms followed by a fixation cross (200 ms) and the corresponding target picture. The target remained on the screen until the subjects made a manual yes/no response. Each trial was initiated by the response on the previous trial after an inter-trial interval of 1000 ms.

Participants were instructed to respond only to the target picture. The task was to decide as fast as possible whether the entity depicted on the picture was a familiar entity or not. They were told that although they were not to respond to the name which preceded the picture, they were to pay attention to it as "in some trials it may help you to make your familiarity decision". Response latency was taken as the delay between presentation of the stimulus target and initiation of a response. Each subject saw 120 experimental trials: 60 positive and 60 negative.

Results

The analysis was based on reaction times (RTs) of correct positive responses. Latencies over 2.5 s, which is equivalent to approximately 3 standard deviations from the mean ($M_{RT} = 1116$ ms, $SD_{RT} = 386$ ms) were discarded, as were outliers exceeding the participant mean by 2.5 standard deviations, for any particular condition. Mean RTs for correct responses are reported in Table 2.

A 5 \times 3 repeated-measures ANOVA was performed on mean RTs with category (factor levels: person across, person

Table 2: Mean Reaction Times (RT) in milliseconds (and Standard Errors (SE)) for Conditions.

Category	Measure	Primes		
		Associates	Same-category	Unrelated
Person Across	RT (SE)	937 (25)	1017 (21)	1082 (32)
Person Within	RT (SE)	919 (21)	1022 (33)	1045 (36)
Artwork	RT (SE)	954 (35)	1055 (42)	1052 (30)
Building	RT (SE)	998 (42)	1090 (46)	1098 (40)
Product	RT (SE)	961 (23)	1107 (44)	1148 (44)

within, artwork, building and product) and prime type (factor levels: associated, same-category, unrelated) as within subjects factors. The results indicated that only the main effect of prime type was significant ($p < 0.001$). Therefore, for each category we performed a one-way repeated-measures analysis of variance (ANOVA) with prime type as a within-subjects factor. Post hoc Tukey honestly significant difference (HSD) tests examined the differences between the factor levels.

The analysis for the category *Person Across* resulted in a significant main effect, $F(2, 34) = 11.39$, $p < 0.001$. RTs for the associated condition (937 ms) were significantly faster than for the same-category (1017 ms), ($q = 4.02$, $p < 0.05$) and unrelated conditions (1082 ms), ($q = 6.70$, $p < 0.001$). However, RTs in the same-category condition were not significantly different from those in the unrelated condition, ($q = 2.68$, $p = 0.15$). The same analysis for the *Person Within* category produced the same pattern of results. We found a significant main effect $F(2, 34) = 9.03$, $p < 0.001$ and faster responses for the associated condition (919 ms) than for the same-category condition (1022 ms) ($q = 5.13$, $p < 0.01$), but no significant difference between the same-category (1022 ms) and unrelated conditions (1045 ms; $q = 0.16$, $p = 0.99$).

A significant main effect was also found for the category *Artwork*, $F(2, 34) = 3.93$, $p < 0.05$. The post hoc analysis showed faster responses for the associated condition (954 ms) than for the same-category condition (1055 ms; $q = 3.44$, $p < 0.05$). The comparison between the same-category (1055 ms) and the unrelated conditions (1052 ms) did not show significant difference ($q = 1.09$, $p = 0.72$).

The main effect was not significant for the *Building* category, $F = 1.53$, $p = 0.22$, even though it shows a very similar trend than the other categories as also revealed by a post hoc analysis by items². In contrast, we found a significant main effect for the *Product* category $F(2, 34) = 5.63$, $p < 0.01$. The post hoc analysis revealed the same pattern of results found for the other categories (with the exception of the *Building* category). In particular, we found a significant difference between associative and same-category conditions with responses that were faster in the associative condition (961 ms) than in the same-category condition (1107 ms), ($q = 3.45$, $p < 0.05$), but no significant difference between same-category (1107 ms) and unrelated (1148 ms) con-

²To investigate possible differences between the stimuli used in the experiment, we performed a post hoc analysis by items, comparing the associative and same-category conditions. We found a significant difference ($p < 0.05$) in mean between the associative condition and the same-category condition for 7 of the 12 trials.

ditions, ($q = 1.09$, $p = 0.72$).

In order to test whether there are differences in semantic and associative priming for faces and objects, we collapsed person and object classes to form two general domains (i.e. Person and Object, respectively). The comparison between the two general domains was motivated as follows. First of all, we did not find a significant difference in the pattern of results obtained for the Across Person and the Within Person conditions. Therefore, the two person categories were collapsed to create a general Person category. Second, we tested for differences between the three non-face categories (artwork, building and product). Mean reaction times were submitted to two-way ANOVA using both variables (category and priming condition) as within-subject factors. The main effect of priming condition was significant, $F(2, 34) = 8.84$, $p < 0.001$. Neither the main effect of category, $F(2, 34) = 1.45$, $p = 0.24$, nor the interaction was significant, $F(4, 68) = 0.69$, $p = 0.60$. Due to the lack of the main effect for category and interaction, the three object categories were collapsed to obtain one individual mean RTs for the object-domain. As a consequence of the aggregation procedure, we were able to compare semantic and categorical primings for faces and objects, by a two-way (2×3) analysis of variance (ANOVA) on the mean reaction times, with the variables of stimulus category (face vs. object) and priming condition (associate vs. same category vs. unrelated). The analysis was conducted by subjects with both variable (stimulus category and priming condition) as within subjects factors. The main effect of stimulus category was significant, $F(1, 17) = 7.81$, $p < 0.05$. A post hoc one-tailed t-test showed that responses to faces were significantly faster (1004 ms) than those to objects (1060 ms), ($p < 0.05$). The main effect of priming condition was also significant, $F(2, 34) = 22.92$, $p < 0.001$. Post hoc Tukey honestly significant difference (HSD) tests revealed that: a) for faces the associate condition was significantly faster from both the same-category ($q = 5.58$, $p < 0.01$) and the unrelated condition ($q = 7.24$, $p < 0.001$), but the same-category condition did not differ significantly from the unrelated condition ($q = 1.76$, $p = 0.47$); b) for objects the same pattern of results was found, that is the associate condition was significantly different from the same-category, ($q = 4.37$, $p < 0.01$) and the unrelated condition, ($q = 4.93$, $p < 0.01$), but the same-category condition did not differ significantly from the unrelated condition, ($q = 0.60$, $p = 0.90$). The stimulus category \times priming condition was not significant, $F = 0.07$, $p = 0.93$. These results demonstrated that priming effects for faces were not significantly different (i.e. faster) from priming effects for objects. In particular, we found that for both categories, the associate condition was significantly different from the other two priming conditions, which did not differ significantly from each other.

Discussion and Conclusions

The entity recognition experiment produced a very clear and homogeneous pattern of results. For all the categories of en-

tities used in the experiment, with the exception of the Building category, we found that entity familiarity decision times were reliably primed by the prior presentation of associates. In contrast, non-associates from the same semantic category did not produce facilitation effects on familiarity decisions. This means that the time to recognize a familiar person, an artwork or a product was significantly and robustly facilitated by the prior presentation of the name of an associate entity, but was not reliably facilitated by the name of an entity from the same category but not associated.

Interestingly, the comparison between face and object categories did not reveal a significant difference between the two domains in the amount of facilitation in the three conditions of priming. The only difference between the two domains was that the responses to faces were significantly faster than those to objects in all the priming conditions, confirming the astonishing ability of humans to recognize person identity from faces.

These results can be compared with those of Barry et al. (1998). The authors conducted two experiments which examined whether there exist differences in semantic and associative priming for faces and objects. Differently from our experiment, object stimuli used in their experiments represented generic objects (e.g. a table) which could not be recognized at the unique level of identity, but only as members of a general category. The authors found that faces were substantially primed by associates but not by non-associates of the same category. In contrast, they found that objects were primed reliably by both associates and categorically related non associates. The results were interpreted as evidence for a different organization of the semantic knowledge of objects and people. We argue that to draw the conclusion that different processes underlie the organization and the access to semantic representation of faces and objects, a comparison between faces and objects at the same level of identity (i.e. as semantically unique entities) is required. To the best of our knowledge, our study is the first that performed this comparison in a priming experiment. Our results confirmed those of Barry et al. for faces, showing that face familiarity decisions were significantly facilitated by the prior presentation of associates from both the same and different category, but not by non-associated stimuli from the same category. However, contrary to Barry's et al. results, we found that object familiarity decisions presented the same priming effects as faces when the stimuli were recognized at the unique level of identity. These findings challenge the conclusion by Barry et al. about a different organization of semantic representations of objects and faces and suggest a common mechanism to organize knowledge about individuals from different categories.

Another important result is about the Person category. In our study we tested for differences between two different kinds of associative priming: priming *Across* category and priming *Within* category. We found that associated primes from different categories were as good as associated primes from the same category to produce priming facilitation, giv-

ing evidence in favor of a pure associative facilitation not overlapped with categorical membership effects. Therefore, it is clear that priming of entity familiarity decisions is associative but not reliably categorical and, at least for the Person category, both associated entities within the category and associated entities from different categories may facilitate the familiarity decision. The failure to consistently observe categorical priming of person recognition is a challenge to the model of Burton et al. (1990) of face recognition. In this model a word prime would activate its PIN and corresponding SIUs. As there are proposed excitatory, bi-directional connections between PINs and SIUs, priming is interpreted in the terms of feedback activation from SIUs to increase the activation of PINs which are connected to the same SIUs. As we found priming effects from close associates but none from non-associated members of the same occupational category, then it would appear that only activation from the SIUs of associates feeds back to the PINs. Therefore, these results raise some questions about the nature of the elements of stored biographical knowledge and in particular whether it is correct to propose that these are represented by general categorical units (SIUs) such as “politician” or “actor” as proposed by the Burton et al. model. Moreover, the model can not explain the priming effects from associates belonging to different categories since SIUs are assumed to code only person-specific knowledge.

Our results are more compatible with a model in which singular representations of entities (i.e. singular concepts) from different categories can be connected directly through associative links so that the activation of one of this singular concept spreads to all the associated singular concepts without the mediation of categorical units which are assumed to organize the knowledge of singular conceptual representations. In terms of priming, this model predicts that we should obtain a priming effect when prime and target entities are associatively related even when they do not share category membership. Contrary to the Barry et al. (1998) model for face processing, we argue that horizontal links can be established not only within the person category as a consequence of “social” and “interpersonal” relationships (e.g. who is married to whom or who works with whom), but also between entities from different categories which are connected by binary relationships reinforced by co-occurrence.

To conclude, we propose that singular concepts are organized within a network of horizontal associative links that can be stronger than vertical links with shared higher-level conceptual representations and this organization mechanism is not peculiar of singular concepts about people but it is the common way to connect singular concepts of individuals from different categories.

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