To what extent does typicality boost semantic priming effects between members of their categories?

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Abstract:

Atypical items of their semantic category yield more generalization than their typical members when relearning in connectionist networks (Plaut, 1996) and in empirical studies (Kiran & Thompson, 2003). It seems therefore that atypical words provide more information about the overall structure of the semantic category due to their specific and shared features. In this view, atypical primes could strongly facilitate the processing of targets compared to typical primes, because typical primes contain little information about the variation between members within a category. In contrast, three semantic priming experiments in visual word recognition showed an advantage with the typical context, but not with the atypical one. These findings were observed in a variety of tasks, including lexical decision, categorization and semantic judgment. Our results do not support the findings about generalization in relearning and suggest that typicality effects in semantic priming mostly come from the activation of representative features of categories.

Count: 150 words

Keywords: Typicality, semantic priming, semantic category, word recognition

Introduction

Cat indicates a typical mammal (as does *dog*) while *mink* refers to an atypical mammal. The typical or atypical character of an entity depends on its distance from the prototype of its semantic category (Rosch, 1975). The prototype of a category is conceived as its central tendency, its centralized representation, or its core. The present study was designed to determine how category structure, in particular, the typicality of words within a category, affects word recognition, e.g. within the category of mammals, between *cat* and *dog*, or between *mink* and *dog*. The most widely studied effect to explore the organization of semantic representations and the dynamics of spreading activation in semantic memory (for reviews, Hutchison, 2003; Lucas, 2000) is the so-called "semantic priming effect". The semantic priming effect is traditionally measured by comparing performances in two priming contexts: one with semantically related prime–target pairs (e.g., *cat–dog*), and the other with unrelated prime–target pairs (e.g., *scythe–dog*). This refers to the observation that a target word is recognized faster when it is preceded by a semantically related prime rather than by an unrelated prime. Therefore, we explored whether semantic priming effects were affected by typicality in categorical priming.

According to the prototype theory (Rosch, 1975), the perceptual and functional features appearing frequently among members of a given category have a high probability of being integrated into its prototype. They are shared features and are distinguished from specific features. For example, the land-based lifestyle is a feature shared by many mammals. In contrast, the aquatic lifestyle is a specific feature of a few members of this category (e.g., whales). Thus, the members of a given category are

distributed at greater or lesser distances from its core according to the number of features shared between a given member and the prototype: the members near the core are typical while the members rather on the periphery are atypical.

In reference to Rosch's prototype model (1975), Plaut (1996) developed a connectionist simulation to test the hypothesis that the degree of generalization to new words produced by new training should be influenced by the relative typicality of learned words. It was hypothesized that after lesions in an artificial neural network, a new training of the network with words referring to typical concepts should give rise to a greater recovery of memory than the same type of training with words referring to atypical concepts. The results of the simulation were unexpected. In fact, new training on atypical words in their category gave rise to a greater generalization than new training on more typical words. Plaut (1996) concluded that atypical words, as a whole, provide more information about the overall structure of the category due to their specific and shared features. Atypical words include how semantic properties may vary between members of a category and provide a good approximation of the central tendency of the category. Thus, new training on atypical words can produce a generalization on all untrained words, both typical and atypical. On the other hand, new training on the typical words is generalized only to the other typical words. In the latter case, the performance on the atypical words decreased. These findings were explained by the fact that atypical words provide a better estimate of both the central tendency and the variation within the category on each semantic dimension, whereas typical words provide only information about the central tendency.

Plaut's results (1996) were confirmed by Kiran and Thompson (2003) in empirical studies. They studied the effect of the typicality of members of two superordinate categories (birds, vegetables) in a naming task (i.e., naming birds and vegetables presented in a pictorial format) administered to four patients with Wernicke's aphasia, a group of young adults, and a group of older adults. They found that training on atypical items, including relevant variables for typical items, facilitated a greater access to untrained items than training on typical items. It is important to extend these findings in terms of spreading activation during word recognition. While Plaut (1996) and Kiran and Thompson (2003) targeted learning and retrieving information processes in semantic memory, the present study investigated how the typicality of members of a given semantic category affects the recognition of other members within the same category in healthy populations. According to the hypotheses proposed by Plaut (1996) and Kiran and Thompson (2003), the initial processing of an atypical prime (with shared and specific features) would be more effective than that of a typical prime (with many shared features), regardless of which target is subsequently processed.

Contrary to this view, some authors have repeatedly found a more beneficial effect with typical members than with atypical ones in category membership verification tasks. When participants are asked to verify whether a member of a category (*dog*) belongs to a given category (*mammals*), faster reaction times are observed with typical than with atypical members. The two items are usually presented as a sentence or a word pair (Hampton, 1997; Larochelle & Pineau, 1994; Mervis & Rosch, 1981; Räling, Holzgrefe-Lang, Schröder, & Wartenburger, 2015; Smith,

Shoben, & Rips, 1974). The effects observed in category membership verification tasks plead in favor of a strong direct link between high typicality members and their superordinate semantic category. Based on the prototype model (Rosch, 1975), smaller distances according to the number of features shared between a given member and the prototype could explain the ability to verify whether a member belongs to a given semantic category. Nonetheless, these effects mostly reflect the degree to which a member (e.g., *dog*) is more or less representative of a given category (e.g., *mammals*) and were obtained with a presentation of the named category. Interestingly, a stronger beneficial effect with typical members than with atypical ones was also observed with fixation duration of target members when they were preceded by the category name in sentence-reading, without the participants performing an explicit category membership verification task (Carroll & Slowiaczek, 1986). This finding could be evidence of the spreading activation of the more representative members of a given category after the recognition of its name. Although Chumbley (1986) and Casey (1992) studied the time taken to verify category membership for both member-category and category-member orders, one unresolved question is to know to what extent a member prime (e.g., *cat* or *mink*) might serve the same function as a named category (e.g., mammal) on the processing of a member target. Therefore, it is not clear whether and how the typicality of a member of a given semantic category affects the recognition of another member within the same category.

The present study was conducted with young French adults using the visual procedure of semantic priming. Three experiments with a 166-ms stimulus-onset asynchrony (SOA) were used either in an implicit task (i.e. not forcing participants to

focus on semantic information) such as a lexical decision task (Experiment 1) or in explicit tasks (i.e., forcing participants to focus on semantic information) including a categorization task (i.e., whether the prime and the target belong to 'the same category' vs. 'different categories', Experiment 2) or a semantic judgment task (i.e., whether the prime is semantically related or not with the target, Experiment 3). To highlight the impact of the typicality of primes on the recognition of other members within the same category, the three experiments included four semantic priming conditions: typical and atypical related priming contexts (e.g., related typical primes conditions, *cat–dog* and *cat–jackal* versus related atypical primes conditions, *mink–dog* and *mink–jackal*) and their respective unrelated priming contexts (e.g., unrelated primes matching with related typical primes, *scythe–dog* and *scythe–jackal* versus unrelated primes matching with related atypical primes, *nut–dog* and *nut–jackal*). To avoid confounding with typicality, the unrelated priming contexts were matched with related priming contexts for a variety of psycholinguistic variables such as lexical frequency and length. Moreover, the impact of the typicality of primes on semantic priming effects was examined either during the processing of typical targets (e.g., *dog*), or during the processing of atypical targets (e.g., *jackal*).

Experiment 1: Lexical decision task

Method

Participants

Fifty-two healthy native French speakers with normal or corrected-to-normal vision participated in this experiment. They were recruited at the University of Lille. The participants included 48 women and 4 men with a mean age of 21.1 years (range: 18–29 years). All participants signed a written consent form before beginning the experiment,

which was conducted in accordance with the Declaration of Helsinki. The experiment was approved by the Research Ethics Committee of the University of Lille.

Material

The selection of items was made from the French database of Dubois and Poitou[1] (2002). This database was constructed by asking 75 young French adults to list, in the order in which they came to mind, the names of objects belonging to 22 semantic categories: 9 categories of "natural" objects, 11 categories of "artificial" objects or artifacts and 2 categories of activities. From this database, 80 typical items and 80 atypical items were selected in order to be presented as targets. Each target was associated with four semantic priming conditions (related typical primes, related atypical primes, unrelated primes matching with related typical primes, and unrelated primes matching with related atypical primes). The same primes were presented with the typical targets and the atypical targets. The complete set of French stimuli is listed in Appendix A. In total, 480 words (80 x 2 targets + 80 x 4 primes) selected from the database belonged to 20 semantic categories: 9 categories of "natural" objects (birds, fishes, insects, mammals, metals and materials, flowers, fruits, trees, vegetables), 9 categories of "artificial" objects or artifacts (weapons, buildings, clothing, containers and utensils, drinks, furniture, musical instruments, tools, vehicles) and 2 categories of activities (professions, sports). There was the same number of typical and atypical targets within each semantic sub-category. Typical items should have been cited by at least 20% of participants (mean: 49.2; max: 97.33%), while atypical items should have been cited by at least 1.33% and at most 6.67% of them (mean: 2.17%). Semantic distances were extracted between each item and its named category from semantic representations for words obtained from statistical co-occurrences in texts (for more

details, https://magnet.gitlabpages.inria.fr/mangoes/). The semantic distances based on the French corpus of Wikipedia were weaker between typical items and their named category than those between atypical items and their named category. Semantically related and unrelated primes were matched for lexical frequency, word length and orthographical neighbors (see Table 1) obtained from the Lexique database (New, Pallier, Brysbaert, & Ferrand, 2004). When prime-target pairs were semantically related, primes and targets belonged to the same semantic category. Moreover, prime-target pairs were matched for co-occurrence frequency, orthographical, phonological, and morphological similarity. The co-occurrence frequency was collected from large language corpora of film subtitles (New, Brysbaert, Veronis, & Pallier, 2007) accessible on the Lexique website (www.lexique.org, for a similar approach, Brunellière, Perre, Tran, & Bonnotte, 2017).

< Insert Table 1 here >

The 80 typical targets and the 80 atypical targets were divided into four lists so that each target was associated with the four priming conditions across all participants, but was presented only once per condition to a given participant. To make the relations between primes and targets difficult to discern and to avoid some attentional strategies, 160 additional unrelated prime–target word pairs were also presented. Each list was composed of 640 prime–target pairs, such that the semantically related pairs represented 25% of word-word pairs. For the purposes of the task, 320 word–pseudoword pairs were added and were not further analyzed. Pseudoword targets were orthographically legal and were constructed by replacing a letter in French words other than those in the experimental set. The word and pseudoword targets were matched for length. Moreover,

32 practice trials were built according to the same criteria.

Procedure

Each participant was randomly assigned to one list. The 640 trials were divided into five blocks of 128 trials each. Trial order within each block was randomized and a break was provided between the blocks. In each trial, participants were first presented with a fixation cross for 500 ms, followed by a prime word for 150 ms. After presentation of the prime, a black screen was presented for 16 ms, creating an SOA of 166 ms (for a similar approach in semantic priming, Brunellière, Perre, Tran, & Bonnotte, 2017). Thereafter, the target stimulus, either a real word or a pronounceable pseudoword, was displayed and remained on the screen until the participants' response. The primes and the targets, in lowercase, were presented synchronously in white font on a black background on a computer monitor with the screen refresh (refresh rate = 16.67 ms). Participants were instructed to indicate, as quickly and accurately as possible, whether the target stimulus was a real word or not. Responses were given by pressing one of two buttons on a button box, the button responses being assigned according to the participants' handedness. The inter-trial interval (a black screen) lasted 1500 ms. Before the experimental task, participants first received instructions and 32 practice trials. It took approximately 40 min to complete the task. The duration of prime presentation in the present study allowed us to explore categorical priming in the conscious presentation of primes, as assessed by a prime visibility test that participants performed after the priming task. The hit rates of prime recognition (mean hit rates: .91) were substantially higher than the false-alarm rates (mean false alarm rates: .1). At the end of the prime visibility test, all participants reported that they had consciously recognized

the letters of primes.

Results

Nine items giving rise to more than 30% of errors were excluded from the analyses in the lexical decision task (for a similar approach, e.g., Havelka, Bowers, & Jankovic, 2006; Kouider & Dupoux, 2005). Response times (RTs) longer than 1600 ms (based on RT distribution, see Baayen, McQueen, Dijkstra, & Schreuder, 2003) in correct trials and those greater than three standard deviations above and below the participant's overall responses were excluded from the analyses (in total, 2.1%). Mean error rates and RTs are shown in Table 2. Based on the aim of the study, ANOVAs with Prime Typicality (Atypical vs. Typical) and Priming Context (Related vs. Unrelated) as factors were conducted by each type of target. The analyses were performed on error rates and RTs by participants (F_1) and by items (F_2). On atypical targets, the analysis of error rates revealed a main effect of Priming Context, $F_1(1,51) = 6.85$, $p < .05$; $F_2(1,71) = 5.76$, $p < .05$. Participants recognized atypical targets better when they were preceded by a semantically related context than by an unrelated context. The interaction between Priming Context and Prime Typicality was not significant, $F_1(1,51) = 1.19$, $p > .2$; $F_2(1,71) = .8$, $p > .2$. The size of the priming effect for atypical primes (2.9%) was thus similar to that for typical primes (1.5%). Contrary to atypical targets, neither a main effect of Priming Context, $F_1(1,51) = 1.39$, $p > .2$; $F_2(1,78) = 1.54$, $p > .2$, nor an interaction between Priming Context and Prime Typicality, $F_1(1,51) = .01$, $p > .2$; $F_2(1,78) = .01$, $p > .2$, were found for typical targets.

Similar to error rates, separate analyses on RTs were conducted on each type of target. On atypical targets, a main effect of Priming Context, $F_1(1,51) = 4.74$, $p < .05$; $F_2(1,71) = 5.62$, $p < .05$, was found but there was no interaction between Priming Context and

Prime Typicality, $F_1(1,51) = 0.039$, $p > .2$; $F_2(1,71) = 0.001$, $p > .2$. RTs were shorter when atypical targets were preceded by a semantically related context than by an unrelated context. The size of the priming effect for atypical primes (10 ms) was thus similar to that for typical primes (12 ms). Similar to atypical targets, a main effect of Priming Context, $F_1(1,51) = 27.82$, $p < .001$; $F_2(1,78) = 28.87$, $p < .001$, was found for typical targets. Contrary to atypical targets, the interaction between Priming Context and Prime Typicality was significant, $F_1(1,51) = 4.88$, $p < .05$; $F_2(1,78) = 4.34$, $p < .05$, with a higher semantic priming effect with typical primes (26 ms) than with atypical ones (11 ms). After applying the post-hoc Tukey test by participants (q_1) and by items (q_2), it appeared that a semantic priming effect was found significantly with typical primes, $q_1(4,51) = 7.28$, $p < .001$; $q_2(4,78) = 7.57$, $p < .001$, (597 ms for related typical primes, 623 ms for unrelated matching typical primes), but not with atypical ones, $q_1(4,51) = 3.12$, $p = .13$; $q_2(4,78) = 3.15$, $p = .12$, (604 ms for related atypical primes, 615 ms for unrelated matching atypical primes).

Discussion

Experiment 1 showed a similar-sized semantic priming effect for both atypical and typical primes during the processing of atypical targets on error rates and response times. In contrast, a semantic priming effect was found only with typical primes during the processing of typical targets from response times. These findings did not confirm the hypothesis proposed by Plaut (1996) and Kiran and Thompson (2003). While there was indeed no beneficial effect of prime typicality during the processing of atypical targets, a beneficial effect was found with the typical primes during the processing of

typical targets. To evaluate whether the lexical decision task, which is an implicit task not forcing participants to focus attention on semantic information, could have led to divergent findings from those of Plaut (1996) and Kiran and Thompson (2003), we conducted a second visual semantic priming experiment during which new participants performed a categorization task that explicitly probed into the semantic level (Experiment 2).

< Insert Table 2 here >

Experiment 2: Categorization task

Method

Participants

Fifty-six healthy native French speakers with normal or corrected-to-normal vision took part in this experiment and had not participated in Experiment 1. They were recruited at the University of Lille. They included 43 women and 13 men with a mean age of 20.8 years (range = 17–29 years). As in Experiment 1, all participants signed a written consent form before beginning the experiment, which was conducted in accordance with the Declaration of Helsinki. The experiment was approved by the Research Ethics Committee of the University of Lille.

Material and procedure

The stimulus sets and sequence of events remained identical to those in Experiment 1 except for the task. Participants were instructed to indicate, as quickly and accurately as possible, whether the target stimulus belonged to the same category as the prime or not. The button responses were counterbalanced across participants. For the purposes of the task, we removed the additional unrelated prime-target word pairs and the word–

pseudoword pairs, so that the responses "same category" and "different categories" presented the same probability. The four lists were composed of 160 word-word pairs, which were divided into five blocks (i.e., 32 trials per block, with randomized trial order within each block; 4 breaks) and were preceded by 8 practice trials. As in Experiment 1, participants reported that they had consciously recognized the letters of primes (mean hit rates: .92; mean false alarm rates: .1).

Results

As in Experiment 1, items giving rise to more than 30% of errors were excluded from the analyses (seventeen items). Response times (RTs) longer than 2590 ms (based on RT distribution, see Baayen, McQueen, Dijkstra, & Schreuder, 2003) in correct trials and those greater than three standard deviations above and below the participant's overall responses were excluded from the analyses (in total, 3.1%). In addition, analyses on error rates were conducted for each type of target. Mean error rates and RTs are shown in Table 3. A main effect of Priming Context was found on atypical targets, $F_1(1,55) = 134.24$, $p < .001$; $F_2(1,65) = 115.32$, $p < .001$. Interestingly, a significant interaction between Priming Context and Prime Typicality was found, $F_1(1,55) = 24.48$, $p < .001$; $F_2(1,65) = 12.05$, $p < .001$. We reported a simple effect analysis comparing YES responses (related primes and targets belonging to the same category) and another comparing NO responses (unrelated control and targets belonging to different categories). After applying the post-hoc Tukey test by participants (q_1) and by items (q_2), it appeared that participants' performances were better when atypical targets were preceded by semantically related typical primes than by semantically related atypical primes, $q_1(4,55) = 10.4$, $p < .001$; $q_2(4,65) = 7.42$, $p < .001$, (21.2% for related typical primes; 32.5% for related atypical primes). On the contrary, they were identical when

atypical targets were preceded by unrelated primes that matched either with typical primes or atypical primes, $q_1(4,55) = 0.5$, $p > .2$; $q_2(4,65) = 0.48$, $p > .2$, (3.6% for unrelated matching typical primes, 4.1% for unrelated matching atypical primes). Since no significant difference was found between the two types of unrelated primes, we then reported the statistical results after post-hoc Tukey comparisons between the related and unrelated conditions by participants (q_1) and by items (q_2). A negative semantic priming effect between related and unrelated context was observed independently of the typicality of primes (for typical primes, $q_1(4,55) = 16.29$, $p < .001$; $q_2(4,65) = 10.69$, $p < .001$; for atypical primes, $q_1(4,55) = 26.19$, $p < .001$; $q_2(4,65) = 17.63$, $p < .001$). This negative semantic priming effect was smaller with typical primes than with atypical ones (respectively, 17.6% and 28.4% of errors more than in the unrelated priming context), $t_1(55) = 4.94$, $p < .001$, $t_2(65) = 3.47$, $p < .001$. Similar to atypical targets, a main effect of Priming Context, $F_1(1,55) = 86.87$, $p < .001$; $F_2(1,77) = 65.11$, $p < .001$, and a significant interaction Priming Context x Prime Typicality, $F_1(1,55) = 128.29$, $p < .001$; $F_2(1,77) = 60.21$, $p < .001$, were found for typical targets. After applying the post-hoc Tukey test by participants (q_1) and by items (q_2), it appeared that participants' performances were better when typical targets were preceded by semantically related typical primes than by semantically related atypical primes, $q_1(4,55) = 23.86$, $p < .001$; $q_2(4,77) = 16.35$, $p < .001$, (5.7% for related typical primes; 27.3% for related atypical primes). On the contrary, performances were identical when typical targets were preceded by unrelated primes that either matched with typical primes or atypical primes, $q_1(4,55) = 1.2$, $p > .2$; $q_2(4,77) = 0.83$, $p > .2$, (3.3% for unrelated matching typical primes, 4.4% for unrelated matching atypical primes). Moreover, whereas a negative semantic effect between related and unrelated context was observed when typical

targets were preceded by atypical primes, $q_1(4,55) = 25.28$, $p < .001$; $q_2(4,77) = 17.31$, $p < .001$, (27.3% for related atypical primes, 4.4% for unrelated matching atypical primes), no significant semantic effect between related and unrelated context was found when typical targets were preceded by typical primes, $q_1(4,55) = 2.6$, $p > .2$; $q_2(4,77) = 1.79$, $p > .2$, (5.7% for related typical primes, 3.3% for unrelated matching typical primes). There were 22.9% errors in the related context more than in the unrelated one when typical targets were preceded by atypical primes.

Consistent with error rates, separate analyses on RTs were conducted on each type of target. A main effect of Priming Context and a significant interaction Priming Context x Prime Typicality were found on atypical targets, respectively $F_1(1,55) = 4.81$, $p < .05$; $F_2(1,65) = 7.1$, $p < .01$; $F_1(1,55) = 22.77$, $p < .001$; $F_2(1,65) = 15.31$, $p < .001$. The post-hoc Tukey test by participants (q_1) and by items (q_2) was performed to interpret the significant interaction. Response times were shorter when atypical targets were preceded by semantically related typical primes than by semantically related atypical primes, $q_1(4,55) = 8.81$, $p < .001$; $q_2(4,65) = 7.55$, $p < .001$, (946 ms for related typical primes; 1062 ms for related atypical primes). Response times did not significantly differ between the two types of unrelated primes, $q_1(4,55) = 0.73$, $p > .2$; $q_2(4,65) = 0.27$, $p > .2$, (977 ms for unrelated matching typical primes, 968 ms for unrelated matching atypical primes). Moreover, whereas response times were longer when atypical targets were preceded by semantically related atypical primes than by unrelated primes, $q_1(4,55) = 7.15$, $p < .001$; $q_2(4,65) = 7.74$, $p < .001$, (94 ms more than unrelated matching atypical primes), they did not significantly differ between semantically related typical primes and unrelated primes, $q_1(4,55) = 2.39$, $p > .2$; $q_2(4,65) = 0.09$, $p > .2$. Similar to atypical targets, a main effect of Priming Context and a significant interaction

Priming Context x Prime Typicality were found on typical targets, respectively $F_1(1,55) = 12.76$, $p < .05$; $F_2(1,77) = 3.81$, $p = .05$; $F_1(1,55) = 90.7$, $p < .001$; $F_2(1,77) = 44.68$, $p < .001$. After applying the post-hoc Tukey test by participants (q_1) and by items (q_2), it appeared that response times were shorter when typical targets were preceded by semantically related typical primes than by semantically related atypical primes, $q_1(4,55) = 19.59$, $p < .001$; $q_2(4,77) = 13.37$, $p < .001$, (803 ms for related typical primes; 982 ms for related atypical primes). Response times did not significantly differ between the two types of unrelated primes, $q_1(4,55) = 0.54$, $p > .2$; $q_2(4,77) = 0.003$, $p > .2$, (943 ms for unrelated matching typical primes, 948 ms for unrelated matching atypical primes). In addition, whereas response times were longer when typical targets were preceded by semantically related atypical primes than by unrelated primes, $q_1(4,55) = 4.71$, $p < .05$; $q_2(4,77) = 4.46$, $p < .05$, (34 ms more than unrelated matching atypical primes), they were shorter when typical targets were preceded by semantically related typical primes than by unrelated primes, $q_1(4,55) = 15.3$, $p < .001$; $q_2(4,77) = 8.91$, $p < .001$, (140 ms less than unrelated matching typical primes).

< Insert Table 3 here >

Discussion

Unlike in Experiment 1, the processing of typical primes was more beneficial to the processing of targets than that of atypical primes in Experiment 2, regardless of the typicality of the targets. This advantage of target processing due to typical primes took the form of a facilitation of processing with respect to atypical primes. Moreover, it produced a reduction in negative semantic priming effect on error rates and a facilitation of semantic priming effect on response times. This pattern was particularly evident when the target and the prime were typical. In that case, a negative semantic priming

effect on error rates disappeared and a semantic priming effect, facilitating the processing of targets, was observed from response times. A categorization task is not usually used in the semantic priming paradigm, although it is very relevant when the nature of the semantic relationship to be explored is categorical. To confirm the beneficial effect of typical primes and their impact of priming effects, we conducted a third semantic priming experiment with another explicit task that probed into the semantic level. Instead of a categorization task, we used a semantic judgment task.

Experiment 3: Semantic judgment task

Method

Participants

Fifty-four healthy native French speakers with normal or corrected-to-normal vision took part in this experiment and had not participated in Experiments 1 or 2. They were recruited at the University of Lille. They included 48 women and 6 men with a mean age of 21.4 years (range = 18–30 years). As in Experiments 1 and 2, all participants signed a written consent form before beginning the experiment, which was conducted in accordance with the Declaration of Helsinki. The experiment was approved by the Research Ethics Committee of the University of Lille.

Material and procedure

The stimulus sets and the procedure were identical to those in Experiment 2 except for the task. Participants had to decide, as quickly and accurately as possible, whether the prime and the target were semantically related. The experimental session ended with the prime visibility test. As in Experiments 1 and 2, the hit rates of prime recognition (mean hit rates: .92) were substantially higher than the false-alarm rates (mean false

alarm rates: .09). At the end of the prime visibility test, all participants reported that they had consciously recognized the letters of primes.

Results

As in Experiment 2, items giving rise to more than 30% of errors were excluded from the analyses (twelve items). Response times (RTs) longer than 3035 ms (based on RT distribution, see Baayen, McQueen, Dijkstra, & Schreuder, 2003) in correct trials and those greater than three standard deviations above and below the participants' overall responses were excluded from the analyses (in total, 3.5%). Analyses on error rates were conducted for each type of target. On atypical targets, a main effect of Priming Context, $F_1(1,53) = 227.94$, $p < .001$; $F_2(1,68) = 157.62$, $p < .001$, and a significant interaction Priming Context x Prime Typicality, $F_1(1,53) = 23.82$, $p < .001$; $F_2(1,68) = 19.37$, $p < .001$, were found. Moreover, participants' performances were better when atypical targets were preceded by semantically related typical primes than by semantically related atypical primes, $q_1(4,53) = 9.09$, $p < .001$; $q_2(4,68) = 8.18$, $p < .001$, (21.1% for related typical primes; 32.6% for related atypical primes), as shown in Table 4. On the contrary, they were identical when atypical targets were preceded by unrelated primes that either matched with typical primes or atypical primes, $q_1(4,53) = 0.67$, $p > .2$; $q_2(4,68) = 0.62$, $p > .2$, (2.3% for unrelated matching typical primes, 1.5% for unrelated matching atypical primes). Additionally, the negative semantic priming effect was observed independently of the typicality of primes (for typical primes, $q_1(4,53) = 14.69$, $p < .001$; $q_2(4,68) = 13.75$, $p < .001$; for atypical primes, $q_1(4,53) = 24.46$, $p < .001$; $q_2(4,68) = 22.55$, $p < .001$). This negative semantic priming effect was smaller with typical primes than with atypical ones (respectively, 18.8% and 31.1% of errors more than with the unrelated priming context), $t_1(53) = 4.88$, $p < .001$, $t_2(68) =$

4.4, $p < .001$.

Similar to atypical targets, a main effect of Priming Context, $F_1(1,53) = 88.36$, $p < .001$; $F_2(1,78) = 61.29$, $p < .001$, and a significant interaction Priming Context x Prime Typicality, $F_1(1,53) = 132.2$, $p < .001$; $F_2(1,78) = 60.47$, $p < .001$, were found for typical targets. Moreover, participants' performances were better when typical targets were preceded by semantically related typical primes than by semantically related atypical primes, $q_1(4,53) = 24.28$, $p < .001$; $q_2(4,78) = 16.49$, $p < .001$, (4.2% for related typical primes; 26.4% for related atypical primes), as shown in Table 4. On the contrary, they were identical when atypical targets were preceded by unrelated primes that either matched with typical primes or atypical primes, $q_1(4,53) = 1.28$, $p > .2$; $q_2(4,78) = 0.94$, $p > .2$, (2.6% for unrelated matching typical primes, 3.7% for unrelated matching atypical primes). Besides, whereas a negative semantic priming effect between related and unrelated context was observed when typical targets were preceded by atypical primes, $q_1(4,53) = 24.84$, $p < .001$; $q_2(4,78) = 16.85$, $p < .001$, (26.4% for related atypical primes, 3.7% for unrelated matching atypical primes), no significant semantic priming effect between related and unrelated context was found when typical targets were preceded by typical primes, $q_1(4,53) = 1.84$, $p > .2$; $q_2(4,78) = 1.3$, $p > .2$, (4.2% for related typical primes, 2.6% for unrelated matching typical primes). There were 22.7% errors in the related context more than in the unrelated one when typical targets were preceded by atypical primes.

Similar to error rates, separate analyses on RTs were conducted on each type of target. A significant interaction Priming Context x Prime Typicality was found on atypical targets, $F_1(1,53) = 65.8$, $p < .001$; $F_2(1,68) = 19.17$, $p < .001$. Although a main effect of

Priming Context was found in the items' analysis, $F_2(1,68) = 7.03$, $p < .01$, this effect was not observed in the participants' analysis, $F_1(1,53) = 1.96$, $p = 0.17$. Response times were shorter when atypical targets were preceded by semantically related typical primes than by semantically related atypical primes, $q_1(4,53) = 17.02$, $p < .001$; $q_2(4,68) = 9.34$, $p < .001$, (1035 ms for related typical primes; 1219 ms for related atypical primes). Response times did not significantly differ between the two types of unrelated primes, $q_1(4,53) = 0.79$, $p > .2$; $q_2(4,68) = 0.59$, $p > .2$, (1091 ms for unrelated matching typical primes, 1100 ms for unrelated matching atypical primes). Moreover, whereas response times were longer when atypical targets were preceded by semantically related atypical primes than by unrelated primes, $q_1(4,53) = 11.03$, $p < .001$; $q_2(4,68) = 7.22$, $p < .001$, (119 ms more than unrelated matching atypical primes), they were shorter when atypical targets were preceded by semantically related typical primes than by unrelated primes, $q_1(4,53) = 5.19$, $p < .01$; $q_2(4,68) = 5.54$, $p < .01$, (56 ms less than unrelated matching typical primes).

As for typical targets, a main effect of Priming Context and a significant interaction Priming Context x Prime Typicality were found, respectively $F_1(1,53) = 23.03$, $p < .001$; $F_2(1,78) = 13.31$, $p < .001$; $F_1(1,53) = 57.33$, $p < .001$; $F_2(1,78) = 52.27$, $p < .001$. After applying the post-hoc Tukey test by participants (q_1) and by items (q_2), it appeared that response times were shorter when typical targets were preceded by semantically related typical primes than by semantically related atypical primes, $q_1(4,53) = 15.58$, $p < .001$; $q_2(4,78) = 14.79$, $p < .001$, (874 ms for related typical primes; 1057 ms for related atypical primes). Response times did not significantly differ between the two types of unrelated primes, $q_1(4,53) = 0.44$, $p > .2$; $q_2(4,78) = 0.33$, $p > .2$, (1052 ms for unrelated matching typical primes, 1057 ms for unrelated matching atypical primes). In addition,

whereas response times were shorter when typical targets were preceded by semantically related typical primes than by unrelated primes, $q_1(4,53) = 15.15, p < .001$; $q_2(4,78) = 11.86$, $p < .001$, (178 ms less than unrelated matching atypical primes), they did not differ between semantically related atypical and unrelated primes, $q_1(4,53) = 0.007, p > .2$; $q_2(4,78) = 2.6$, $p > .2$.

< Insert Table 4 here >

Discussion

As in Experiment 2, the processing of typical primes was more beneficial to the processing of targets than that of atypical primes, regardless of the typicality of the targets. In particular, the pattern observed on error rates was identical to that found in Experiment 2, the advantage due to typical primes on target processing being shown by a reduction in the negative semantic priming effect. On the contrary, the pattern of response times observed in Experiment 2 was somewhat different from that found in Experiment 3. During the processing of atypical targets in Experiment 3, a negative semantic priming effect was found when atypical targets were preceded by semantically related atypical primes with respect to the matching unrelated condition, while a facilitatory semantic priming effect was observed when atypical targets were preceded by semantically related typical primes with respect to the matching unrelated condition. Although a negative semantic priming effect was also found when atypical targets were preceded by semantically related atypical primes in Experiment 2, there was no facilitatory effect in semantic priming due to the typical primes. The semantic judgment task in Experiment 3 seemed to reveal the semantic level differently from the categorization task. In addition, we observed a negative semantic priming effect when typical targets were preceded by semantically related atypical primes compared to the

matching unrelated condition in Experiment 2, an effect that was not found in Experiment 3. The semantic judgment task facilitated the detection of features common to primes and targets, while the categorization task forced participants to focus on the nature of these shared features, thereby forming a semantic category. Taken together, in the tasks probing explicitly the semantic level, typical primes facilitated the processing of targets compared to atypical primes. Meta-analyses have already shown that semantic similarity affects the strength of semantic priming effects (Hutchison, 2003; Lucas, 2000). To show whether the semantic priming effects observed in the three preceding experiments are coherent with the notion of semantic similarity, we measured the latter for each prime-target pair using a Likert-type rating scale.

Experiment 4: Semantic similarity measures

Method

One hundred and twenty-one native French-speaking participants different from those included in the three semantic priming experiments performed a semantic similarity task between both words in a prime-target pair using a Likert-type rating scale on which 1 = unrelated and 7 = very strongly related.

Results

Results with the semantic similarity task are displayed in Table 5. We performed the same statistical analyses on values of semantic similarity as those in the preceding experiments. On pairs with atypical targets, the analysis revealed a main effect of Priming Context, $F(1,79) = 1674.73$, $p < .001$, and a significant interaction between priming context and typicality of primes, $F(1,79) = 16.83$, $p < .001$. After applying the post-hoc Tukey test, we could interpret the significant interaction Priming Context x

Prime Typicality. The values of semantic similarity were greater with semantically related typical primes than with semantically related atypical primes, $q(4,79) = 9$, $p < .001$, (5.82 with semantically related typical primes, 5.18 with semantically related atypical primes). No significant difference in semantic similarity was found between the unrelated prime pairs, $q(4,79) = 0.79$, $p > .2$, (1.34 with unrelated matching typical primes; 1.29 with unrelated matching atypical primes). Moreover, the difference in semantic similarity between unrelated and related pairs was greater with typical prime pairs (difference in semantic similarity: 4.48) than with atypical prime pairs (difference in semantic similarity for atypical targets: 3.89, $t(79) = 6.92$, $p < .001$). Similar to pairs with atypical targets, a main effect of Priming Context, $F(1,79) = 3644.17$, $p < .001$, and a significant interaction between the priming context and the typicality of primes, $F(1,79) = 47.9$, $p < .001$, were found for pairs with typical targets. Moreover, the values of semantic similarity were greater with semantically related typical primes than with semantically related atypical primes, $q(4,79) = 13.81$, $p < .001$, (6.62 with semantically related typical primes, 5.72 with semantically related atypical primes). No significant difference in semantic similarity was found between the unrelated prime-target pairs, $q(4,79) = 0.05$, $p > .2$, (1.32 with both unrelated conditions). Additionally, the difference in semantic similarity between unrelated and related pairs was greater with typical prime pairs (difference in semantic similarity for typical targets: 5.3) than with atypical prime pairs (difference in semantic similarity for typical targets: 4.4, $t(79) = 4.1$, $p < .001$).

< Insert Table 5 here >

Discussion

Taken together, these results are somewhat convergent with those of our semantic priming experiments. Interestingly, the assessment of semantic similarity was influenced by the typicality of primes. The condition with the strongest semantic similarity was the typical prime-typical target pairs (6.62), a condition with the most efficient processing in the three priming experiments with regard to the value of semantic priming effects. Nonetheless, the findings in Experiments 2 and 3 appear to be more coherent with the semantic similarity measures than those found in Experiment 1. For instance, in Experiment 1, the semantic priming effects were not affected by the typicality of primes during the processing of atypical targets, whereas the values of semantic similarity were greater with typical prime pairs than with atypical prime pairs. On the contrary, the semantic priming effects observed in Experiments 2 and 3 were affected by the typicality of primes for both atypical and typical targets, as in the semantic similarity measures.

General Discussion

Three semantic priming experiments were conducted with conscious presentations of primes in a lexical decision task, a categorization task, or a semantic judgment task. In the lexical decision task, the same size of semantic priming effect was observed for typical and atypical primes during the processing of atypical targets. On the contrary, a semantic priming effect was found only with typical primes during the processing of typical targets. In the categorization and semantic judgment tasks, the typical primes facilitated the processing of targets with respect to atypical primes. Moreover, this advantage of target processing produced a reduction in negative semantic priming effect on error rates and a facilitation of semantic priming effect on

response times. Altogether, our findings point to an advantage of the processing of typical primes as compared to that of atypical primes.

In an implicit task when participants were not forced to focus attention on semantic information between the prime and the target (i.e., in lexical decision task), the initial processing of an atypical prime (with shared and specific features) was no more effective than that of a typical prime (with many shared features) during the processing of atypical targets. More exactly, the semantic priming effect observed during the processing of atypical target seems to be induced by shared features within semantic categories given by both atypical and typical primes, since the same size of semantic priming effect was observed for typical and atypical primes. During the processing of typical targets, it appeared that sharing many features with the members of the category caused a facilitatory effect of semantic priming. Whereas the typicality of primes affected the processing of targets only for typical targets in the lexical decision task, the typicality of primes strongly influenced the processing of atypical and typical targets in the categorization and semantic judgment tasks. In these two tasks explicitly probing the semantic level, sharing some features with the members of the category between the prime and the target made it more difficult to decide whether a target was semantically related with a prime or belonged to the same category than to decide whether a target was not semantically related or did not belong to the same category. Interestingly, judgments of category- or semantic-relatedness were improved when the prime was typical with respect to atypical primes. The negative semantic priming caused by the difficulty to decide whether a target was semantically related with a prime or belonged to the same category was reduced on error rates when the prime was typical during the processing of atypical and typical targets. One may wonder whether this reduction in

the negative semantic priming could simply be elicited when one member of a category is typical, independently of whether the member is presented as a prime or a target. However, supplementary analyses showed that the size of the negative semantic priming effect on error rates differed significantly between typical primes-atypical targets and atypical primes-typical targets in categorization and semantic judgment tasks. Therefore, the improvement in judgments of category- or semantic-relatedness was indeed due to the typicality of primes. Moreover, when both the target and the prime were typical, the negative semantic priming effect on error rates disappeared and a semantic priming effect facilitating the processing of targets was observed in response times. We therefore hypothesize that the main representative features provided by the typical primes and shared with the typical targets strengthen the beneficial effect of prime typicality on the recognition of targets compared to atypical primes.

These findings are thus not consistent with the view proposed by Plaut (1996) and Kiran and Thompson (2003). Their theory (Kiran, Sandberg, & Sebastian, 2011) was that "training items at the periphery would strengthen a more distributed set of featural representations of items that help fulfill the goal of the category, whereas training featural representations of items at the center of the category would reinforce only the core features that fulfill the goal but not the featural variations". If we extend this view to the spreading activation between the prime and the target, it could be predicted that the processing of typical and atypical targets in semantic priming would be facilitated by semantically related primes. This facilitation should be greater with atypical primes that have shared and specific features. The fact that we did not find this pattern in the three tasks could be because the stimuli belonged to 20 semantic

categories. Plaut (1996) used only one semantic category for simulation and Kiran and Thompson (2003) and Kiran (2008) used only two. Exposure to a low number of semantic categories could be advantageous when processing atypical members, since the latter are situated at the periphery of the semantic category, thereby creating a boundary. When participants are exposed to many semantic categories, they could tend to differentiate them more on the basis of their tendency towards a central meaning than on their semantic variation. This could explain the divergent findings between the present study and those by Plaut (1996) and Kiran and Thompson (2003). Moreover, Plaut (1996) and Kiran and Thompson (2003) targeted learning and information-retrieval processes in semantic memory with connectionist networks or patients, whereas we investigated information-retrieval processes in semantic memory with healthy individuals taking word recognition tasks. Interestingly, studies exploring the relearning of members within a semantic category in patients (Kiran, 2008; Kiran & Thompson, 2003; Kiran, Sandberg, & Sebastian, 2011) showed that training on typical items produced rapid results on trained typical items with limited generalization while training on atypical items produced slower results on trained atypical items with enhanced generalization on untrained typical and atypical items. The enhanced generalization of untrained items within one category was thus triggered by the repeated exposure on a variety of atypical items. Therefore, we hypothesize that exposure to single-item trials, as in the semantic priming paradigm, might not induce a beneficial effect of the initial processing of an atypical item on the recognition of a target by activating the representations of category features.

In studies investigating information-retrieval processes in the semantic memory of healthy populations, the advantage of processing typical primes is in line with

previous findings obtained in category membership verification tasks (Hampton, 1997; Larochelle & Pineau, 1994; Mervis & Rosch, 1981; Räling, Holzgrefe-Lang, Schröder, & Wartenburger, 2015; Smith, Shoben, & Rips, 1974). When a member of a category (e.g., *dog*) belongs to a given category (e.g., *mammal*), faster reaction times are observed for typical than for atypical members. This finding is consistent with the spreading activation theory (Collins & Loftus, 1975), the prototype model (Rosch, 1975), and with distributed feature-based models (O'Connor, Cree, & McRae, 2009). According to the spreading activation theory, a high typicality member has a stronger direct link to its superordinate semantic category in addition to multiple shared features than a low typicality member, which has a weak direct link to its superordinate semantic category. In the prototype model (Rosch, 1975), the members of a given category are distributed at greater or lesser distances from its core according to the number of features shared by a given member and the prototype. This means that the members near the core are typical while the members on the periphery are atypical. Lesser distances according to the number of features shared between a given member and the prototype should explain the ability to verify whether a member belongs to a given semantic category. Distributed feature-based models make the same prediction but propose that a typical member and its semantic category share many representative features while an atypical member and its semantic category share fewer features.

Unlike category membership verification tasks, the magnitude of priming does not increase with the typicality of members when their semantic category is presented as a prime in a semantic priming paradigm with simulated or empirical studies (O'Connor, Cree, & McRae, 2009; Schwanenflugel & Rey, 1986). It thus appears that the demands of paradigms strongly affect the way in which the relationship between the

superordinate semantic category and its members can be established. It may be assumed that according to the demands of the paradigms tested in the semantic priming and category membership verification tasks, the participants focused more on the general shared features between the superordinate semantic category and its members in the semantic priming paradigm when the superordinate semantic category was presented as a prime. When we investigated how the typicality of a member of a given semantic category affects the recognition of another member within the same category, the prime which provides shared representative features within a given semantic category seemed to facilitate the processing of the target. This was particularly evident in the two tasks explicitly probing the semantic level. This effect on semantic priming was coherent with semantic similarity between items within pairs. However, the semantic priming effects cannot be explained only by semantic similarity, since the difference in semantic similarity between unrelated and related pairs with typical primes and atypical targets was identical to that with atypical primes and typical targets. In addition to semantic similarity which is known to affect the strength of semantic priming effects (Hutchison, 2003; Lucas, 2000), the frequency of lexical co-occurrence appears to modulate semantic priming effects (e.g., Brunellière, Perre, Tran, & Bonnotte, 2017). For example, co-occurrence frequency was found to boost semantic priming effects (Brunellière, Perre, Tran, & Bonnotte, 2017). However, since this variable was controlled between the prime-target pairs in the present study, its influence may be ruled out. Moreover, the three tasks provided some assumptions about the use of shared semantic features between members varying as a function of task demands. The categorization task seemed to produce a finer analysis of shared semantic features and their nature.

In conclusion, the present study shows an advantage with typical priming but not with atypical priming during the spreading of information activation that occurs between words of the same semantic category.

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Footnote

[1]One hundred and twenty participants not participating in the three semantic priming experiments declared that they knew the selected words.

Table 1. Main psycholinguistic properties of primes and targets used in Experiments 1, 2, 3, and 4

	Related typical primes	Unrelated matching with typical primes	Related atypical primes	Unrelated matching with atypical primes	Typical targets	Atypical targets
Lexical Frequency	25.55	17.70	2.7	3.24	22.03	3.13
Word length	5.99	6.03	6.75	6.83	6.53	7.01
Orthographical neighbors	2.95	3.05	2.06	1.48	2.73	1.12

Lexical frequency in number of occurrences per million words; word length in number of letters; an orthographic neighbor is any word that can be created by changing one letter of the word while keeping the letter positions (Coltheart, Davelaar, Jonasson, & Besner, 1977).

Table 2. Mean error rates and response times (RTs in milliseconds) according to priming conditions, and priming effects in Experiment 1 (standard deviations in parenthesis).

Typical Targets	Errors	Priming effect on errors	RTs	Priming effect on RTs
Related typical primes	0.9 (2)	-0.5 (3.2)	597 (62)	-26 (41)
Unrelated matching with typical primes	1.4 (2.6)		623 (60)	
Related atypical primes	1.3 (2.6)	-0.4 (3.9)	604 (63)	-11 (33)
Unrelated matching with atypical primes	1.7 (2.6)		615 (59)	
Atypical Targets	Errors	Priming effect on errors	RTs	Priming effect on RTs
Related typical primes	5.8 (6)	-1.5 (7.7)	673 (73)	-12 (53)
Unrelated matching with typical primes	7.3 (6.8)		685 (71)	
Related atypical primes	4.7 (5.8)	-2.9 (8.3)	674 (71)	-10 (45)
Unrelated matching with atypical primes	7.6 (6.9)		684 (66)	

Table 3. Mean error rates and response times (RTs in milliseconds) according to priming conditions, and priming effects in Experiment 2 (standard deviations in parenthesis).

Typical Targets	Errors	Priming effect on errors	RTs	Priming effect on RTs
Related typical primes	5.7	+2.4 (7.7)	803 (161)	-140 (130)
Unrelated matching with typical primes	3.3		943 (189)	
Related atypical primes	27.3	+22.9 (15.5)	982 (197)	+34 (130)
Unrelated matching with atypical primes	4.4		948 (203)	
Atypical Targets	Errors	Priming effect on errors	RTs	Priming effect on RTs
Related typical primes	21.2	+17.6 (17.2)	946 (174)	-31 (139)
Unrelated matching with typical primes	3.6		977 (207)	
Related atypical primes	32.5	+28.4 (16.6)	1062 (224)	+94 (150)
Unrelated matching with atypical primes	4.1		968 (186)	

Table 4. Mean rates and response times (RTs in milliseconds) according to priming conditions, and priming effects in Experiment 3 (standard deviations in parenthesis).

Typical Targets	Errors	Priming effect on errors	RTs	Priming effect on RTs
Related typical primes	4.2 (6.2)	+1.6 (7.5)	874 (185)	-178 (152)
Unrelated matching with typical primes	2.6 (4.1)		1052 (206)	
Related atypical primes	26.4 (13.5)	+22.7 (14.9)	1057 (197)	0 (170)
Unrelated matching with atypical primes	3.7 (4.7)		1057 (197)	
Atypical Targets	Errors	Priming effect on errors	RTs	Priming effect on RTs
Related typical primes	21.1 (15)	+18.8 (16.2)	1035 (204)	-56 (190)
Unrelated matching with typical primes	2.3 (4.2)		1091 (230)	
Related atypical primes	32.6 (13.7)	+31.1 (14.4)	1219 (251)	+119 (178)
Unrelated matching with atypical primes	1.5 (3.5)		1100 (234)	

Table 5. Semantic similarity according to priming contexts per typicality of primes, and semantic similarity differences between related and unrelated pairs in Experiment 4 (standard deviations in parenthesis).

Typical Targets	Semantic similarity	Semantic similarity difference between related and unrelated pairs
Related typical primes	6.62 (0.5)	5.3 (0.7)
Unrelated matching with typical primes	1.32 (0.4)	
Related atypical primes	5.72 (0.9)	4.4 (1.1)
Unrelated matching with atypical primes	1.32 (0.6)	
Atypical Targets	**Semantic similarity**	**Semantic similarity difference between related and unrelated pairs**
Related typical primes	5.82 (0.9)	4.48 (1)
Unrelated matching with typical primes	1.34 (0.6)	
Related atypical primes	5.18 (1.1)	3.89 (1.1)
Unrelated matching with atypical primes	1.29 (0.5)	

Appendix A. Stimuli used in Experiments 1, 2, 3, and 4

Part 1. Primes accompanied by typical targets

Typical primes	Typical targets	Unrelated matching with typical primes	Typical targets
pie *magpie*	corbeau *raven*	tank *tank*	corbeau *raven*
thon *tuna*	requin *shark*	jeep *jeep*	requin *shark*
hareng *herring*	maquereau *mackerel*	carafe *carafe*	maquereau *mackerel*
abeille *bee*	bourdon *bumblebee*	tunique *tunic*	bourdon *bumblebee*
scarabée *beetle*	fourmi *ant*	salsifis *salsify*	fourmi *ant*
moustique *mosquito*	puce *chip*	lentilles *lentils*	puce *chip*
chat *cat*	chien *dog*	faux *scythe*	chien *dog*
lion *lion*	tigre *tiger*	four *oven*	tigre *tiger*
éléphant *elephant*	girafe *giraffe*	logement *housing*	girafe *giraffe*
lapin *rabbit*	chèvre *goat*	villa *villa*	chèvre *goat*
vache *cow*	cheval *horse*	voile *sail*	cheval *horse*
singe *monkey*	panthère *panther*	banque *bank*	panthère *panther*
bronze *bronze*	or *gold*	flèche *arrow*	or *gold*
zinc *zinc*	aluminium *aluminium*	arc *bow*	aluminium *aluminium*
plomb *lead*	acier *steel*	bœuf *beef*	acier *steel*
muguet *lily of the valley*	violette *violet*	massue *mace*	violette *violet*
iris *iris*	lilas *lilac*	sofa *sofa*	lilas *lilac*
jacinthe *hyacinth*	bleuet *cornflower*	chimiste *chemist*	bleuet *cornflower*
pomme *apple*	banane *banana*	lutte *fight*	banane *banana*
citron *lemon*	orange *orange*	expert *expert*	orange *orange*
framboise *raspberry*	fraise *strawberry*	carrosse *coach*	fraise *strawberry*
mandarine *mandarin*	cerise *cherry*	synagogue *synagogue*	cerise *cherry*
cerisier *cherry tree*	poirier *pear tree*	paquebot *liner*	poirier *pear tree*
chêne *oak*	érable *maple*	moule *mold*	érable *maple*
prunier *plum tree*	pommier *apple tree*	rentier *annuitant*	pommier *apple tree*
endive *endive*	betterave *beet*	mygale *tarantula*	betterave *beet*
poireau *leek*	chou *cabbage*	clavier *keyboard*	chou *cabbage*
navet turnip	céleri *celery*	venin *venom*	céleri *celery*
tomate *tomato*	haricot *bean*	tunnel *tunnel*	haricot *bean*
carotte *carrot*	persil *parsley*	antenne *antenna*	persil *parsley*
musée *museum*	cathédrale *cathedral*	bâton *stick*	cathédrale *cathedral*
église *church*	château *castle*	artiste *artist*	château *castle*
robe *dress*	jupe *skirt*	gare *station*	jupe *skirt*
manteau *coat*	imperméable *raincoat*	prison *jail*	imperméable *raincoat*
costume *suit*	pantalon *trousers*	console *console*	pantalon *trousers*
chapeau *hat*	bonnet *beany*	plateau *tray*	bonnet *beany*
slip *underpants*	chaussette *sock*	rhum *rum*	chaussette *sock*
maillot *shirt*	chemise *shirt*	taureau *taurus*	chemise *shirt*
blouson *jacket*	gilet *vest*	panier *basket*	gilet *vest*
écharpe *scarf*	gant *glove*	notaire *notary*	gant *glove*
tasse *cup*	bol *bowl*	grange *barn*	bol *bowl*

louche *ladle*
bouteille *bottle*
casserole *pan*
assiette *plate*
pot *pot*
bière *beer*
thé *tea*
cidre *cider*
whisky *whiskey*
eau *water*
liqueur *liqueur*
chaise *chair*
buffet *buffet*
lit *bed*
bureau *desk*
piano *piano*
guitare *guitar*
violon *violin*
pince *pliers*
tenaille *pincers*
pelle *shovel*
ciseaux *scissors*
pioche *pickaxe*
moto *motorbike*
train *train*
mobylette *moped*
camion *truck*
auto *car*
poignard *dagger*
canon *cannon*
carabine *carbine*
fusil *gun*
boucher *butcher*
infirmier *nurse*
rugby *rugby*
handball *handball*
ski *ski*
natation *swimming*
judo *judo*

cuillère *spoon*
vase *vase*
marmite *cooking pot*
verre *glass*
faitout *stew pot*
vin *wine*
café *coffee*
limonade *lemonade*
cognac *cognac*
lait *milk*
champagne *champagne*
canapé *couch*
armoire *wardrobe*
divan *couch*
table *table*
harpe *harp*
trompette *trumpet*
contrebasse *double bass*
tournevis *screwdriver*
marteau *hammer*
bêche *spade*
clé *key*
râteau *rake*
vélo *bike*
bateau *boat*
trottinette *scooter*
autocar *coach*
avion *aeroplane*
couteau *knife*
grenade *grenade*
mitraillette *submachine gun*
bombe *bomb*
boulanger *baker*
psychologue *psychologist*
football *soccer*
athlétisme *athletics*
cyclisme *cycling*
basket *basketball*
équitation *horse riding*

cirque *circus*
militaire *military*
ministère *ministry*
ceinture *belt*
poing *fist*
brique *brick*
loup *wolf*
taupe *mole*
crayon *pencil*
bas *stocking*
poulain *foal*
mine *mine*
hangar *hangar*
bois *wood*
combat *fight*
mouton *sheep*
piscine *swimming pool*
renard *fox*
chant *singing*
alouette *lark*
lustre *chandelier*
dauphin *dolphin*
caille *quail*
ciré *wax*
lance *spear*
églantine *eglantine*
palais *palace*
noyer *walnut*
chameau *camel*
pliant *folding*
guéridon *pedestal table*
marin *marine*
buisson *bush*
tablier *apron*
bison *bison*
sodium *sodium*
grue *crane*
ouistiti *marmoset*
alto *alto*

cuillère *spoon*
vase *vase*
marmite *cooking pot*
verre *glass*
faitout *stew pot*
vin *wine*
café *coffee*
limonade *lemonade*
cognac *cognac*
lait *milk*
champagne *champagne*
canapé *couch*
armoire *wardrobe*
divan *couch*
table *table*
harpe *harp*
trompette *trumpet*
contrebasse *double bass*
tournevis *screwdriver*
marteau *hammer*
bêche *spade*
clé *key*
râteau *rake*
vélo *bike*
bateau *boat*
trottinette *scooter*
autocar *coach*
avion *aeroplane*
couteau *knife*
grenade *grenade*
mitraillette *submachine gun*
bombe *bomb*
boulanger *baker*
psychologue *psychologist*
football *soccer*
athlétisme *athletics*
cyclisme *cycling*
basket *basketball*
équitation *horse riding*

Atypical primes	Typical targets	Unrelated matching with atypical primes	Typical targets
jars *gander*	corbeau *raven*	houx *holly*	corbeau *raven*
murène *moray*	requin *shark*	titane *titanium*	requin *shark*
piranha *piranha*	maquereau *mackerel*	habitat *habitat*	maquereau *mackerel*
grillon *cricket*	bourdon *bumblebee*	plongeon *plunge*	bourdon *bumblebee*
termite *termite*	fourmi *ant*	liseuse *bad jacket*	fourmi *ant*
morpion *crab*	puce *chip*	citerne *tank*	puce *chip*
vison *mink*	chien *dog*	écrou *nut*	chien *dog*
opossum *opossum*	tigre *tiger*	dériveur *sailing dinghy*	tigre *tiger*
okapi *okapi*	girafe *giraffe*	aïkido *aikido*	girafe *giraffe*
tapir *tapir*	chèvre *goat*	stylo *pen*	chèvre *goat*
poney *pony*	cheval *horse*	banjo *banjo*	cheval *horse*
renne *reindeer*	panthère *panther*	benne *skip*	panthère *panther*
opale *opal*	or *gold*	motel *motel*	or *gold*
nitrate *nitrate*	aluminium *aluminium*	cithare *zither*	aluminium *aluminium*
plutonium *plutonium*	acier *steel*	égouttoir *draining*	acier *steel*
pervenche *periwinkle*	violette *violet*	corneille *crow*	violette *violet*
amaryllis *amaryllis*	lilas *lilac*	caméléon *chameleon*	lilas *lilac*
pavot *poppy*	bleuet *cornflower*	robot *robot*	bleuet *cornflower*
kaki *khaki*	banane *banana*	maçon *builder*	banane *banana*
citrouille *pumpkin*	orange *orange*	claquettes *tap dance*	orange *orange*
pistache *pistachio*	fraise *strawberry*	éboueur *dustman*	fraise *strawberry*
olive *olive*	cerise *cherry*	sandale *sandal*	cerise *cherry*
grenadier *grenadier*	poirier *pear tree*	saladier *bowl*	poirier *pear tree*
caoutchouc *rubber*	érable *maple*	conducteur *driver*	érable *maple*
avocatier *avocado*	pommier *apple tree*	alligator *alligator*	pommier *apple tree*
soja soy	betterave *beet*	inox *stainless steel*	betterave *beet*
piment *chilli pepper*	chou *cabbage*	patins *skates*	chou *cabbage*
maïs *corn*	céleri *celery*	étau *vice*	céleri *celery*
cornichon *pickle*	haricot *bean*	tambourin *tambourine*	haricot *bean*
ciboulette *chive*	persil *parsley*	radiologue *radiologist*	persil *parsley*
hospice *hospice*	cathédrale *cathedral*	cuirasse *cuirass*	cathédrale *cathedral*
monastère *monastery*	château *castle*	parapluie *umbrella*	château *castle*
toge *toga*	jupe *skirt*	fève *bean*	jupe *skirt*
kimono *kimono*	imperméable *raincoat*	martini *martini*	imperméable *raincoat*
smoking *tuxedo*	pantalon *trousers*	caviar *caviar*	pantalon *trousers*
béret *beret*	bonnet *beany*	évier *sink*	bonnet *beany*
gaine *sheath*	chaussette *sock*	tique *tick*	chaussette *sock*
chandail *sweater*	chemise *shirt*	pinceau *brush*	chemise *shirt*
moufle *mitten*	gilet *vest*	loutre *otter*	gilet *vest*
perruque *wig*	gant *glove*	clinique *clinical*	gant *glove*
biberon *baby bottle*	bol *bowl*	acacia *acacia*	bol *bowl*
serviette *towel*	cuillère *spoon*	chapelle *chapel*	cuillère *spoon*

potiche *vase*	vase *vase*	pédiatre *pediatrician*	vase *vase*
chaudron *cauldron*	marmite *cooking pot*	clairon *bugle*	marmite *cooking pot*
gourde *gourd*	verre *glass*	fiacre *carriage*	verre *glass*
baril *barrel*	faitout *stew pot*	hibou *owl*	faitout *stew pot*
sangria *sangria*	vin *wine*	uranium *uranium*	vin *wine*
chicorée *chicory*	café *coffee*	chimpanzé *chimpanzee*	café *coffee*
menthe *mint*	limonade *lemonade*	chrome *chromium*	limonade *lemonade*
nectar *nectar*	cognac *cognac*	guépard *cheetah*	cognac *cognac*
potage *soup*	lait *milk*	tortue *turtle*	lait *milk*
rosé *rosé*	champagne *champagne*	bahut *credenza*	champagne *champagne*
strapontin *folding seat*	canapé *couch*	technicien *technician*	canapé *couch*
vitrine *showcase*	armoire *wardrobe*	cravate *tie*	armoire *wardrobe*
transat *deck chair*	divan *couch*	hamster *hamster*	divan *couch*
comptoir *counter*	table *table*	mouchoir *tissue*	table *table*
sifflet *whistle*	harpe *harp*	foulard *scarf*	harpe *harp*
cloche *bell*	trompette *trumpet*	barque *small boat*	trompette *trumpet*
timbale *kettledrum*	contrebasse *double bass*	gorille *gorilla*	contrebasse *double bass*
pointe *point*	tournevis *screwdriver*	charme *charm*	tournevis *screwdriver*
maillet *mallet*	marteau *hammer*	cigogne *stork*	marteau *hammer*
fourche *fork*	bêche *spade*	poivre *pepper*	bêche *spade*
bistouri *bistoury*	clé *key*	hérisson *hedgehog*	clé *key*
binette *hoe*	râteau *rake*	bécasse *woodcock*	râteau *rake*
traîneau *sled*	vélo *bike*	soufflet *bellows*	vélo *bike*
radeau *raft*	bateau *boat*	jasmin *jasmine*	bateau *boat*
caravane *caravan*	trottinette *scooter*	salopette *overalls*	trottinette *scooter*
van *van*	autocar *coach*	daim *suede*	autocar *coach*
voilier *sailing ship*	avion *aeroplane*	poivron *pepper*	avion *aeroplane*
glaive *sword*	couteau *knife*	cruche *jug*	couteau *knife*
mortier *mortar*	grenade *grenade*	chômeur *unemployed*	grenade *grenade*
pétard *petard*	mitraillette *submachine gun*	routier *truck driver*	mitraillette *submachine gun*
torpille *torpedo*	bombe *bomb*	absinthe *absinthe*	bombe *bomb*
herboriste *herbalist*	boulanger *baker*	dromadaire *dromedary*	boulanger *baker*
libraire *bookseller*	psychologue *psychologist*	autruche *ostrich*	psychologue *psychologist*
squash *squash*	football *soccer*	coing *quince*	football *soccer*
cricket *cricket*	athlétisme *athletics*	beffroi *belfry*	athlétisme *athletics*
surf *surf*	cyclisme *cycling*	lynx *lynx*	cyclisme *cycling*
marathon *marathon*	basket *basketball*	myosotis *myosotis*	basket *basketball*
canoë *canoe*	équitation *horse riding*	baobab *baobab*	équitation *horse riding*

Part 2. Primes accompanied by atypical targets

Typical primes	Atypical targets	Unrelated matching with typical primes	Atypical targets
pie *magpie*	pintade *guinea fowl*	tank *tank*	pintade *guinea fowl*
thon *tuna*	espadon *swordfish*	jeep *jeep*	espadon *swordfish*
hareng *herring*	anchois *anchovy*	carafe *carafe*	anchois *anchovy*
abeille *bee*	cousin *gnat*	tunique *tunic*	cousin *gnat*
scarabée *beetle*	éphémère *ephemeral*	salsifis *salsify*	éphémère *ephemeral*
moustique *mosquito*	blatte *roach*	lentilles *lentils*	blatte *roach*
chat *cat*	chacal *jackal*	faux *scythe*	chacal *jackal*
lion *lion*	jaguar *jaguar*	four *oven*	jaguar *jaguar*
éléphant *elephant*	buffle *buffalo*	logement *housing*	buffle *buffalo*
lapin *rabbit*	marcassin *boar*	villa *villa*	marcassin *boar*
vache *cow*	mulet *mule*	voile *sail*	mulet *mule*
singe *monkey*	panda *panda*	banque *bank*	panda *panda*
bronze *bronze*	rubis *ruby*	flèche *arrow*	rubis *ruby*
zinc *zinc*	lithium *lithium*	arc *bow*	lithium *lithium*
plomb *lead*	potassium *potassium*	bœuf *beef*	potassium *potassium*
muguet *lily of the valley*	lavande *lavender*	massue *mace*	lavande *lavender*
iris *iris*	glycine *wistaria*	sofa *sofa*	glycine *wistaria*
jacinthe *hyacinth*	sauge *sage*	chimiste *chemist*	sauge *sage*
pomme *apple*	papaye *papaya*	lutte *fight*	papaye *papaya*
citron *lemon*	rhubarbe *rhubarb*	expert *expert*	rhubarbe *rhubarb*
framboise *raspberry*	gland *glans*	carrosse *coach*	gland *glans*
mandarine *mandarin*	cacahuète *peanut*	synagogue *synagogue*	cacahuète *peanut*
cerisier *cherry tree*	magnolia *magnolia*	paquebot *liner*	magnolia *magnolia*
chêne *oak*	amandier *almond*	moule *mold*	amandier *almond*
prunier *plum tree*	manguier *mango*	rentier *annuitant*	manguier *mango*
endive *endive*	cresson *cress*	mygale *tarantula*	cresson *cress*
poireau *leek*	asperge *asparagus*	clavier *keyboard*	asperge *asparagus*
navet turnip	pissenlit *dandelion*	venin *venom*	pissenlit *dandelion*
tomate *tomato*	avocat *lawyer*	tunnel *tunnel*	avocat *lawyer*
carotte *carrot*	riz *rice*	antenne *antenna*	riz *rice*
musée *museum*	abbaye *abbey*	bâton *stick*	abbaye *abbey*
église *church*	palace *luxury hotel*	artiste *artist*	palace *luxury hotel*
robe *dress*	kilt *kilt*	gare *station*	kilt *kilt*
manteau *coat*	parka *parka*	prison *jail*	parka *parka*
costume *suit*	guêtre *gaiter*	console *console*	guêtre *gaiter*
chapeau *hat*	casquette *cap*	plateau *tray*	casquette *cap*
slip *underpants*	chausson *slipper*	rhum *rum*	chausson *slipper*
maillot *shirt*	pantoufle *slipper*	taureau *taurus*	pantoufle *slipper*
blouson *jacket*	poncho *poncho*	panier *basket*	poncho *poncho*
écharpe *scarf*	lunettes *glasses*	notaire *notary*	lunettes *glasses*
tasse *cup*	gobelet *cup*	grange *barn*	gobelet *cup*

louche *ladle*
bouteille *bottle*
casserole *pan*
assiette *plate*
pot *pot*
bière *beer*
thé *tea*
cidre *cider*
whisky *whiskey*
eau *water*
liqueur *liqueur*
chaise *chair*
buffet *buffet*
lit *bed*
bureau *desk*
piano *piano*
guitare *guitar*
violon *violin*
pince *pliers*
tenaille *pincers*
pelle *shovel*
ciseaux *scissors*
pioche *pickaxe*
moto *motorbike*
train *train*
mobylette *moped*
camion *truck*
auto *car*
poignard *dagger*
canon *cannon*
carabine *carbine*
fusil *gun*
boucher *butcher*
infirmier *nurse*
rugby *rugby*
handball *handball*
ski *ski*
natation *swimming*
judo *judo*

écuelle *bowl*
amphore *amphora*
terrine *terrine*
saucière *sauceboat*
couvercle *lid*
grog *grog*
décoction *decoction*
grenadine *grenadine*
scotch *scotch*
verveine *verbena*
mousseux *sparkling wine*
balancelle *lounger*
desserte *desert*
berceau *cradle*
établi *workbench*
lyre *lyre*
maracas *maracas*
grelots *bells*
scalpel *scalpel*
fraiseuse *milling*
trident *trident*
épingle *pin*
grattoir *scraper*
solex *solex*
cargo *cargo*
poussette *stroller*
navire *ship*
wagon *wagon*
javelot *javelin*
boulet *drag*
cartouche *cartridge*
roquette *rocket*
confiseur *confectioner*
historien *historian*
polo *polo*
randonnée *hiking*
luge *luge*
kayak *kayak*
escalade *climbing*

cirque *circus*
militaire *military*
ministère *ministry*
ceinture *belt*
poing *fist*
brique *brick*
loup *wolf*
taupe *mole*
crayon *pencil*
bas *stocking*
poulain *foal*
mine *mine*
hangar *hangar*
bois *wood*
combat *fight*
mouton *sheep*
piscine *swimming pool*
renard *fox*
chant *singing*
alouette *lark*
lustre *chandelier*
dauphin *dolphin*
caille *quail*
ciré *wax*
lance *spear*
églantine *eglantine*
palais *palace*
noyer *walnut*
chameau *camel*
pliant *folding*
guéridon *pedestal table*
marin *marine*
buisson *bush*
tablier *apron*
bison *bison*
sodium *sodium*
grue *crane*
ouistiti *marmoset*
alto *alto*

écuelle *bowl*
amphore *amphora*
terrine *terrine*
saucière *sauceboat*
couvercle *lid*
grog *grog*
décoction *decoction*
grenadine *grenadine*
scotch *scotch*
verveine *verbena*
mousseux *sparkling wine*
balancelle *lounger*
desserte *desert*
berceau *cradle*
établi *workbench*
lyre *lyre*
maracas *maracas*
grelots *bells*
scalpel *scalpel*
fraiseuse *milling*
trident *trident*
épingle *pin*
grattoir *scraper*
solex *solex*
cargo *cargo*
poussette *stroller*
navire *ship*
wagon *wagon*
javelot *javelin*
boulet *drag*
cartouche *cartridge*
roquette *rocket*
confiseur *confectioner*
historien *historian*
polo *polo*
randonnée *hiking*
luge *luge*
kayak *kayak*
escalade *climbing*

Atypical primes	Atypical targets	Unrelated matching with atypical primes	Atypical targets
jars *gander*	pintade *guinea fowl*	houx *holly*	pintade *guinea fowl*
murène *moray*	espadon *swordfish*	titane *titanium*	espadon *swordfish*
piranha *piranha*	anchois *anchovy*	habitat *habitat*	anchois *anchovy*
grillon *cricket*	cousin *gnat*	plongeon *plunge*	cousin *gnat*
termite *termite*	éphémère *ephemeral*	liseuse *bad jacket*	éphémère *ephemeral*
morpion *crab*	blatte *roach*	citerne *tank*	blatte *roach*
vison *mink*	chacal *jackal*	écrou *nut*	chacal *jackal*
opossum *opossum*	jaguar *jaguar*	dériveur *sailing dinghy*	jaguar *jaguar*
okapi *okapi*	buffle *buffalo*	aïkido *aikido*	buffle *buffalo*
tapir *tapir*	marcassin *boar*	stylo *pen*	marcassin *boar*
poney *pony*	mulet *mule*	banjo *banjo*	mulet *mule*
renne *reindeer*	panda *panda*	benne *skip*	panda *panda*
opale *opal*	rubis *ruby*	motel *motel*	rubis *ruby*
nitrate *nitrate*	lithium *lithium*	cithare *zither*	lithium *lithium*
plutonium *plutonium*	potassium *potassium*	égouttoir *draining*	potassium *potassium*
pervenche *periwinkle*	lavande *lavender*	corneille *crow*	lavande *lavender*
amaryllis *amaryllis*	glycine *wistaria*	caméléon *chameleon*	glycine *wistaria*
pavot *poppy*	sauge *sage*	robot *robot*	sauge *sage*
kaki *khaki*	papaye *papaya*	maçon *builder*	papaye *papaya*
citrouille *pumpkin*	rhubarbe *rhubarb*	claquettes *tap dance*	rhubarbe *rhubarb*
pistache *pistachio*	gland *glans*	éboueur *dustman*	gland *glans*
olive *olive*	cacahuète *peanut*	sandale *sandal*	cacahuète *peanut*
grenadier *grenadier*	magnolia *magnolia*	saladier *bowl*	magnolia *magnolia*
caoutchouc *rubber*	amandier *almond*	conducteur *driver*	amandier *almond*
avocatier *avocado*	manguier *mango*	alligator *alligator*	manguier *mango*
soja soy	cresson *cress*	inox *stainless steel*	cresson *cress*
piment *chilli pepper*	asperge *asparagus*	patins *skates*	asperge *asparagus*
maïs *corn*	pissenlit *dandelion*	étau *vice*	pissenlit *dandelion*
cornichon *pickle*	avocat *lawyer*	tambourin *tambourine*	avocat *lawyer*
ciboulette *chive*	riz *rice*	radiologue *radiologist*	riz *rice*
hospice *hospice*	abbaye *abbey*	cuirasse *cuirass*	abbaye *abbey*
monastère *monastery*	palace *luxury hotel*	parapluie *umbrella*	palace *luxury hotel*
toge *toga*	kilt *kilt*	fève *bean*	kilt *kilt*
kimono *kimono*	parka *parka*	martini *martini*	parka *parka*
smoking *tuxedo*	guêtre *gaiter*	caviar *caviar*	guêtre *gaiter*
béret *beret*	casquette *cap*	évier *sink*	casquette *cap*
gaine *sheath*	chausson *slipper*	tique *tick*	chausson *slipper*
chandail *sweater*	pantoufle *slipper*	pinceau *brush*	pantoufle *slipper*
moufle *mitten*	poncho *poncho*	loutre *otter*	poncho *poncho*
perruque *wig*	lunettes *glasses*	clinique *clinical*	lunettes *glasses*
biberon *baby bottle*	gobelet *cup*	acacia *acacia*	gobelet *cup*
serviette *towel*	écuelle *bowl*	chapelle *chapel*	écuelle *bowl*
potiche *vase*	amphore *amphora*	pédiatre *pediatrician*	amphore *amphora*

chaudron *cauldron*
gourde *gourd*
baril *barrel*
sangria *sangria*
chicorée *chicory*
menthe *mint*
nectar *nectar*
potage *soup*
rosé *rosé*
strapontin *folding seat*
vitrine *showcase*
transat *deck chair*
comptoir *counter*
sifflet *whistle*
cloche *bell*
timbale *kettledrum*
pointe *point*
maillet *mallet*
fourche *fork*
bistouri *bistoury*
binette *hoe*
traîneau *sled*
radeau *raft*
caravane *caravan*
van *van*
voilier *sailing ship*
glaive *sword*
mortier *mortar*
pétard *petard*
torpille *torpedo*
herboriste *herbalist*
libraire *bookseller*
squash *squash*
cricket *cricket*
surf *surf*
marathon *marathon*
canoë *canoe*

terrine *terrine*
saucière *sauceboat*
couvercle *lid*
grog *grog*
décoction *decoction*
grenadine *grenadine*
scotch *scotch*
verveine *verbena*
mousseux *sparkling wine*
balancelle *lounger*
desserte *desert*
berceau *cradle*
établi *workbench*
lyre *lyre*
maracas *maracas*
grelots *bells*
scalpel *scalpel*
fraiseuse *milling*
trident *trident*
épingle *pin*
grattoir *scraper*
solex *solex*
cargo *cargo*
poussette *stroller*
navire *ship*
wagon *wagon*
javelot *javelin*
boulet *drag*
cartouche *cartridge*
roquette *rocket*
confiseur *confectioner*
historien *historian*
polo *polo*
randonnée *hiking*
luge *luge*
kayak *kayak*
escalade *climbing*

clairon *bugle*
fiacre *carriage*
hibou *owl*
uranium *uranium*
chimpanzé *chimpanzee*
chrome *chromium*
guépard *cheetah*
tortue *turtle*
bahut *credenza*
technicien *technician*
cravate *tie*
hamster *hamster*
mouchoir *tissue*
foulard *scarf*
barque *small boat*
gorille *gorilla*
charme *charm*
cigogne *stork*
poivre *pepper*
hérisson *hedgehog*
bécasse *woodcock*
soufflet *bellows*
jasmin *jasmine*
salopette *overalls*
daim *suede*
poivron *pepper*
cruche *jug*
chômeur *unemployed*
routier *truck driver*
absinthe *absinthe*
dromadaire *dromedary*
autruche *ostrich*
coing *quince*
beffroi *belfry*
lynx *lynx*
myosotis *myosotis*
baobab *baobab*

terrine *terrine*
saucière *sauceboat*
couvercle *lid*
grog *grog*
décoction *decoction*
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