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The Role of Decision Biases in Semantic Priming Effects

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At least a part of semantic priming effects observed in binary decision tasks is supposed to be caused by decision biases. A semantic relationship between prime and target could positively bias a "yes" response, whereas the absence of a relationship would instead favour a "no" response to the same target. We tested this assumption with a semantic categorization task in which participants were induced to associate different values – positive, negative, or neutral – to each of the categorization decisions. Although semantic priming effects were obtained even with negatively valued decisions, they were substantially enhanced with positively valued decisions, confirming the influence of a decision bias induced presumptively by a post-lexical relatedness judgement.

Keywords: Priming paradigm, decision biases, binary responses, post-lexical processes

When discussing semantic priming effects obtained in lexical decision studies, experimenters often concede that at least a part of these effects may have their origin in post-lexical decision biases. The general idea is that a target decision with a positive or a negative value can be biased by the relatedness status of the prime and the target stimuli, and thus, eventually, boost priming effects stemming from other processes, like automatic spreading activation or selective preparation (cf. Neely, 1991, for review). As a consequence, authors are sometimes cautious about relying too heavily on priming effects obtained with binary decision tasks; nevertheless, to the present day, the empirical evidence for the involvement of decision biases in priming effects is at best indirect. For that reason we decided to investigate whether empirical evidence confirming the modulation of semantic priming through decision values can be found. In the remainder of this introduction we will successively outline the different processes that have been proposed in terms of post-lexical decision processes affecting priming effects, present the different modulations of priming effects these processes predict, review the experimental data at hand and explicate the rationale of the present study.

Processes Underlying Post-Lexical Decision Bias

West and Stanovich (1982; see also Stanovich & West, 1983) and de Groot (1984, de Groot, 1985; de Groot, Thomassen, & Hudson, 1982) suggest that in a standard reading situation, after word recognition has occurred, an automatic semantic integration process confirms whether the recognized word is consistent with the preceding semantic context or not. When participants are asked to perform a lexical decision task on a word target, the final decision, positive or negative, depends on both the positive or negative outcome of the word recognition process and this semantic coherence check. Accordingly, a lack of semantic coherence in unrelated prime and target trials can slow down the time it takes to translate the word recognition into the appropriate positive lexical decision response. In contrast, for related trials, both the recognition process and the semantic coherence check will rapidly come up with a positive result, prompting faster lexical decision responses. As a consequence, differences in response latencies between related and unrelated trials, which are gen-

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erally reported as priming effects, may actually stem from an irrepressible semantic coherence check occurring after the target word recognition has been completed.

A somewhat different mechanism has been proposed by Holender (1992), discussing the origin of congruity effects in various experimental situations. Holender suggests that participants, once they have become aware of the existence of semantic relationships in the stimulus material of a priming experiment, cannot avoid noticing, on each trial, if the prime and the target word are semantically related or not. As both the value of this incidental relatedness judgment (related: yes or no) and the lexical decision about the target (word: yes or no) are associated with a positive and a negative value, a congruency between both decisions (yes, the words are related – yes, it is a word) could cause faster responses to related trials, while an incongruency between the two decisions (no, the words are not related – but, yes, it is a word) could cause slower responses to unrelated trials.

Finally, for Neely and Keefe (1989; Neely, Keefe, & Ross, 1989) participants can strategically take advantage of the correlation between the relatedness status of the experimental trial and the positive lexical decisions. Detecting a semantic relationship between the prime and the target does indeed indicate, or confirm, that the target requires a positive decision, as only word targets can bear a semantic relationship with the foregoing prime. As a result, a retrospective semantic matching strategy could again induce faster positive lexical decisions for related than for unrelated trials.

All three above-mentioned processes thus rely on a post-lexical relatedness judgment participants perform between the prime and the target stimulus. Each process predicts faster positive lexical decisions for related than for unrelated trials. As a consequence, the resulting decision biases could increase existing positive semantic priming effects, or even entirely account for their existence. While such decision biases have mainly been discussed in the context of the lexical decision task, it has to be noted they can also occur in other tasks with binary responses. The post-lexical process proposed by Neely and collaborators (Neely, 1991; Neely & Keefe, 1989; Neely et al., 1989) requires for instance only the existence of a correlation between the relatedness status of the trial and of one of the target decisions. Fortunately, this also means that it is possible to prevent the strategic use of the prime-target relation by merely counterbalancing the relatedness status of the trial and the target response (McRae, de Sa, & Seidenberg, 1997), which can be achieved quite easily when a semantic categorization task instead of a lexical decision task is used (cf. Experiment 1).

In contrast, if, as suggested by West and Stanovich (1982; see also Stanovich & West, 1983), de Groot (1984, de Groot, 1985; de Groot et al., 1982) or Holender (1992) the decision biases are induced by irrepressible processes, occurring independently or even against participants' strategies and intentions, they will be much harder to prevent, especially as little is known about their actual properties. Theoretically, they can only arise if at least one of the target decisions is, as the outcome of the relatedness judgment, associated with a positive or a negative value, which lead several experimenters to favour naming tasks over binary decision tasks with the priming paradigm. Other attempts to avoid decision biases focus mainly on making it harder for participants to detect the relations between primes and targets, by choosing, for example, a sequential instead of a paired presentation the stimuli (e.g., McNamara & Altarriba, 1988; Shelton & Martin, 1992). Surprisingly few studies have however attempted to assess the nature of these irrepressible decision biases, or, even more astonishingly, tried to assemble some direct evidence confirming the actual existence of such a phenomenon. Nevertheless, taken together, several results in the priming literature seem to provide at least indirect evidence for their existence.

For instance, semantic priming effects can be obtained with asymmetrically related word pairs, that is, pairs in which the target word is associated to the prime word, while the reverse is not necessarily the case, as in STICK and LIP or DOG and FLEA. These backward semantic priming effects (Koriat, 1981) are not easily accounted for by prospective processes such as automatic spreading activation or selective preparation, but can be explained straightforwardly by a process relying on a post-lexical and retrospective relatedness judgment. As the aforementioned non-strategic decision biases can only occur if at least one of the decisions about the target is associated with a positive or negative value, they cannot take place in tasks with neutrally valued responses or naming tasks. This could thus explain not only why backward priming effects are easier to obtain with lexical decision than with naming tasks (i.e., Seidenberg, Waters, Sanders, & Langer, 1984; but see Kahan, Neely, & Forsythe, 1999), but also why semantic priming effects with symmetrically related word pairs are generally larger in lexical decision than in naming tasks (de Groot, 1984, de Groot, 1985; Lorch, Balota, & Stamm, 1986; Lupker, 1984; Sereno, 1991).

Another piece of indirect evidence is provided by a series of experiments by Schaeffer and Wallace (1969), Schaeffer and Wallace (1970), in which participants decide whether two simultaneously presented names belong to the same semantic category (requiring the response "same") or not (requiring the response "different"). In a first experiment (Schaeffer & Wallace, 1969), two semantic categories are defined, living and non living items: The living category comprises names of flowers and mammals, and the non living category names of metals and tissues. With this task, "same" responses turn out to be faster when the names of the word pair belong to the same subcategory: a word pair like TULIP-ROSE induces on average faster positive responses than a word pair like TULIP-LION. More interestingly, in a second experiment (Schaeffer & Wallace, 1970), this pattern of results is reversed for "different" responses. This time, participants have to decide whether two simultaneously presented names belong to one of four pre-specified semantic categories, namely flowers, trees, mammals or birds. Hence, the exemplars of the two former categories are all plants, while the exemplars of the two latter categories are all animals. "Different" responses tend to be slower when the names belong to the same super-category like in LION-CHICKEN than when they belong to different super-categories like in LION-OAK. To sum up, the existence of a semantic relationship between two words seems to favour a positive response, while for unrelated word pairs a negative response seems to be easier (see also Hampton & Taylor, 1985; Schvaneveldt, Durso, & Mukherij, 1982). This pattern of results fits perfectly with the post-lexical decision bias process propounded by Holender (1992).

Rationale of the Present Study

The aim of the present study is to assess more directly if irrepressible decision biases do indeed intervene in semantic priming effects. To do so, we use a semantic categorization task, in which participants have to judge the semantic category of the target word. As can be seen in the upper part of Table 1, in the lexical decision task, word targets, whether in related or unrelated word pairs, are always associated with a positive decision, while pseudo-word targets are always associated with a negative decision. Put simply, when using a lexical decision task, a target word like CHICKEN will always require a positive "yes" response. Moreover, even when participants are asked to respond "yes" to pseudo-word targets and "no" to word targets, the "natural" tendency of the participants to encode the pseudo-word targets as negative and the word targets as positive is difficult to reverse (Wentura, 1998, Wentura, 2000; see also Duscherer, 2001).

In comparison, when using a semantic categorization task, it is very easy to associate, through the use of different instructions, a positive, a negative, or a neutral value to the decision and this both for related and for unrelated word pairs. Imagine seeing the target word CHICKEN and having to answer each of the following questions: (a) "Is it a bird?", (b) "Is it blue?", or (c) "Is it an animal or a plant?". Depending on the semantic property upon which the categorization question is based, the same word target can elicit a positive or a negative categorization decision, as with Questions a and b, respectively. Moreover, it is possible to choose categorization tasks that will elicit only neutral decisions, as with Question c, in which neither the decision "animal" nor the decision "plant" are, a priori, associated with a positive or a negative value. Thus, through the use of a semantic categorization task, we can achieve a perfect counterbalancing of the relatedness status of the experimental trial (unrelated or related prime and target words) and of the value of the decision (positive, negative or neutral).

The bottom part of Table 1 summarizes the different kind of trials that were used in the present semantic categorization experiments. On the one hand, the counterbalancing between relatedness status and target decision should exclude any strategic use of the prime-target relationship to predict the target response. On the other hand, it is still possible that participants will judge, incidentally, whether the prime and the target stimuli are related or not. Thus, if, and only if, positive or negative values are associated with the categorization decisions, the result of this relatedness judgment could induce a congruency effect. If this happens, we would always predict a larger semantic priming effect for decisions associated with a pos-

Table 1
Congruency Relationships Between the Value of a Relatedness Judgment and the Values Associated with Target Decisions, in a Lexical Decision and a Semantic Categorization Task

Experimental trial	Value of target decision	Value of relatedness judgment	Target response
		Lexical decision	
Related	positive	positive	faster
Unrelated	positive	negative	slower
		Semantic categorization	
Related	positive	positive	faster
Related	negative	positive	slower
Unrelated	positive	negative	slower
Unrelated	negative	negative	faster

itive value than for decisions associated with a negative value. In fact, for positive decisions, a congruency effect would speed up the decisions for related trials and would slow down decisions for unrelated trials. In contrast, for negative decisions, this congruency effect would have exactly the opposite effect, speeding up the decisions for unrelated trials and slowing down decisions for related trials. Finally, if neither decision is associated with a positive or a negative value, the value of a hypothetical relatedness judgement would have no influence on the response latencies.

We tested these predictions in two experiments in which participants were to associate different values – neutral, positive, or negative – to the decisions given to the same word targets. If the congruity between the value of the relatedness status of the experimental trial and the value of the target decisions matters at all, faster reaction times should be observed when the value of the required decision matches that of the relatedness judgement. In contrast, the other alleged components of semantic priming effects – such as automatic spreading activation or selective preparation – should not be affected by the modulation of the value associated with the target decision: they always predict faster reaction times for related than for unrelated trials.

Before trying to modulate priming effects, we needed to ascertain that the selected word pairs induced significant semantic priming. Hence, we ran a pilot study in which we asked participants to perform a lexical decision on each word target. As all reported experiments use the same basic procedure, we shall present the general method of the experiments in the next section, then the pilot study using a lexical decision task and finally the two experiments using semantic categorization tasks.

General Method

Participants

Participants were undergraduate students at the Université Libre de Bruxelles taking part in the experiments as part of a course requirement. All participants were in their late teens or early twenties, had normal or corrected-to-normal vision, and all of them had French as their first language.

Stimuli

The material used in each experiment consisted of the same 72 French semantically related word pairs, containing a prime and a target word. In 36 pairs, the target word was the name of a food item, while in the other 36 pairs, it was the name of a manufactured object. All 72 prime words were names of manufactured objects. For the word pairs containing food targets, the prime words had on average 6.25 letters (*SD* = 1.82) and 1.78 syllables (*SD* = 0.72), while the target words had on average 5.64 letters (*SD* = 1.87) and 1.58 syllables (*SD* = 0.65). For the word pairs containing object targets, the prime words had on average 6.67 letters (*SD* = 1.96) and 1.92 syllables (*SD* = 0.77), while the target words had on average 6.42 letters (*SD* = 1.75) and 1.81 syllables (*SD* = 0.82). We created 72 unrelated word pairs by re-pairing randomly the prime and the target words of the related word pairs and by correcting for any remaining association. Hence the experimental material encompassed four different types of trials: related food trials (i.e., GRATER-CHEESE), unrelated food trials (i.e., BOW-FISH), related object trials (i.e., HAMMER-NAIL), and unrelated object trials (i.e., PEN-PILLOW).

Apparatus

The experiments were designed using Micro Experimental Laboratory (MEL; Version 2.01) software (Schneider, 1988). Stimuli were presented on a NEC Multisync XE17 colour monitor controlled by a Pentium IBM-compatible computer, which also recorded the RTs in milliseconds via an MEL manual response box.

Design and Procedure

The set of 72 related word pairs was split into two subsets of 36 pairs, each subset containing 18 food trials and 18 object trials being matched as closely as possible in terms of letter length, syllable length, and frequency. The split of the set of 72 unrelated word pairs was fully determined by that of the related word pairs, as the targets had to be the same in the corresponding subsets of related word pairs and unrelated word pairs. List 1 contained one subset of 36 related word pairs and the subset of unrelated word pairs containing the remaining target words. List 2 had the other subset of 36 related word pairs and the other subset of unrelated word pairs. The 144 trials in each list were pseudo-randomized with the constraint that there were never more than three consecutive trials of the same kind. A practice block of 20 unrelated word trials, half with food targets and half with object targets, was also constructed. Each participant was tested individually in one session of about 20 min, consisting of the practice block followed by the two lists of experimental trials, which were separated by a resting period. Two warm up trials were added at the beginning of each experimental list and the order of the two lists was counterbalanced between participants.

All stimuli were presented in light grey on a black background, using the lowercase standard font of the computer. At a viewing distance of 60 cm, the visual angle of each character was 0.52° in height. One experimental trial comprised the presentation at the centre of the screen of: (a) A 500-ms fixation display, consisting of a central plus (+) sign; (b) the prime word for 150 ms; (c) a black screen for 850 ms; (d) the target word until the recording of the response or for a maximum of 3,000 ms; and, finally, (e) a 3,000-ms black screen until the fixation display of the next trial. Participants were asked to categorize the target word – specific categorization instructions depending on the experimental condition – and urged to respond rapidly, while avoiding any errors. Responses were always binary and given by pressing Buttons 1 and 5 of the MEL response box.

Data Analysis

The training block, the two warm up trials, as well as the trials for which no response was recorded were excluded from the analysis. We replaced participants for which either non responses, errors, or the cut-off procedure exceeded 10% of the data. For each participant, we first computed the error rates for the semantic decision, separately for each type of experimental trial. Only trials with correct responses were included in the RTs analysis: we first computed the average RT and the standard deviation, separately for each participant and the two semantic decision responses. Then, trials with RTs exceeding 2.5 standard deviations above and below the mean RT were eliminated from further analysis. Table 2 shows the average and the standard deviation of the individual mean RTs, and the average of the individual error rates for each kind of experimental trial and for a pilot study with a lexical decision task and for each of the categorization tasks. An alpha level of .05 was used for all statistical tests.

Pilot Study

We tested in a pilot study, with 20 different participants, whether the selected word pairs induced a significant semantic priming effect with a lexical decision task. This pilot study used the same design and procedure than the experiments described below, but because of the nature of the task we added 72 additional pseudo-word trials to the two experimental lists. The RTs data of the word targets were entered into an ANOVA containing as factors Relatedness (related or unrelated trial) and Target Category (food or object name)[1]. There is a marginally significant main effect of target category, $F(1, 19) = 3.546$, $MSE = 561$, $p < .08$, food targets producing slightly faster mean RTs ($M = 603$ ms) than object targets ($M = 613$ ms). We find a significant priming effect of 24 ms over the 72 word targets overall, $F(1, 19) = 29.828$, $MSE = 376$, $p < .001$, but there is no interaction with the target category, $F(1, 19) = .081$, $MSE = 311$, $p = .78$. Additional analyses, conducted separately for each target category, show that the food targets induce a semantic priming effect of 23 ms, $t(19) = 4.2$, $p < .001$, while the object targets induce a semantic priming effect of 25 ms, $t(19) = 4.0$, $p < .001$. We can thus be positive that both the object and the food targets induce significant and comparable semantic priming effects.

Experiment 1

In this first experiment, participants had to make a binary decision, judging whether the target word was a name belonging to the semantic category of foods items or to the semantic category of manufactured objects.[2] As, a priori, no negative or positive value is associated with either semantic category, no congruity relationship can appear with the value of a hypothetical relatedness judgement. Moreover, as no correlation exists between the relatedness status of the word pair and the target category, participants cannot use the prime target relationship to predict or to confirm their target decision (cf. Neely, 1991; Neely & Keefe, 1989; Neely et al., 1989). Consequently, we expect response latencies in this first experiment to be unaffected by decision biases; any priming effect we may find must originate in different cognitive processes. Based on the results of our pilot study with a lexical decision task, we do not expect huge differences in effect size for one or the other semantic target category.

Specific Procedure

Forty students participated in this experiment; four additional participants were replaced because less than 10% of their experimental data were available. Participants were asked to judge whether the target word was the name of a food item or the name of a manufactured object and to respond by pressing one of the two response buttons. Response mapping – food/object and left/right – was coun-

1 In all experiments, parallel item analyses, with the RTs averaged over participants, yielded essentially the same pattern of results.

2 Note that the target words belonging to the semantic category of food items could either be names of food items or beverages. This was specified to the participants.

terbalanced between participants. No positive or negative value was thus associated to the food or object targets in this experiment.

Results

The cut-off procedure entailed an overall elimination rate of 2.72% of the trials. The RTs data were entered into an ANOVA containing the following 3 factors: Relatedness (related or unrelated trial), Target Category (food or object name) and Response Mapping (food response on the left or on the right). Responses are faster for related (M = 658 ms) than for unrelated trials (M = 677 ms), inducing over the 72 targets a significant semantic priming effect of 19 ms; $F(1, 38) = 32.002$, $MSE = 469$, $p < .001$. Responses are also faster on food (M = 654 ms) than on object targets (M = 681 ms), $F(1, 38) = 27.518$, $MSE = 1053$, $p < .001$; the Relatedness × Target Category interaction is however not significant, $F(1, 38) = 1.277$, $MSE = 530$, $p = .27$. Significant priming effects of 24 ms and 16 ms are obtained for the food, $t(39) = 4.7$, $p < .001$, and the object targets, $t(39) = 3.0$, $p < .01$, respectively. Response mapping does not have a significant effect, $F(1, 38) = 1.888$, $MSE = 24152$, $p = .18$, and does not interact with any other factor. The outcomes of the same analysis conducted on the error rates, which were generally fairly low, were either non significant or conformed to the RTs data.

Discussion

Although neither categorization decision was associated with a positive or a negative value, significant semantic priming was observed both for the food and the object targets. Thus, the chosen task, word material, and experimental design are appropriate for generating semantic priming, and the target words of both semantic categories induce significant and comparable effects. As no decision biases can occur in this experiment, we can, quite reassuringly, rule out that all semantic priming effects obtained in binary decision tasks can be reduced to post-lexical decision biases.

Experiment 2

In this experiment, half of the participants had to perform a food categorization task, in which they had to decide whether the target word was a name of a food item or not, while the other half of the participants had to perform an object categorization task, in which they had to decide whether the target word was a name of a manufactured object or not. The same word pairs as in Experiment 1 were presented in both categorization tasks. In the food categorization, the food targets were thus associated with a positive decision and the object targets with a negative decision. In contrast, in the object categorization, the food and object targets were associated with a negative and a positive decision, respectively.

If participants tend to judge the relatedness status of the word pair, the value of this relatedness judgment can now bias a positive or a negative decision. More precisely, positive categorization decisions (that is, to food targets in the food categorization and to object targets in the object categorization) could be easier for related than for unrelated word pairs and negative categorization decisions (that is, to object targets in the food categorization and to food targets in the object categorization) could be easier for unrelated than for related word pairs. Our predictions are thus straightforward: The same word pairs should induce larger semantic priming effects when they are associated with a positive than with a negative decision or, in other words, we predict a significant interaction between decision value and condition. Considering the two target categories separately, we expect larger priming effects for food targets in the food categorization than in the object categorization task and larger priming effects for object targets in the object categorization than in the food categorization task.

Specific Procedure

We selected 40 students, 20 for each categorization task, from the same pool as in the other experiment. Five additional participants, having more than 10% of their data unavailable were replaced. In the food categorization task, participants were asked to judge whether the target word was the name of a food item, or not; thus adding a positive value to the food names and a negative value to the object names. In the object categorization task, participants were asked to judge whether the target word was the name of a manufactured object, or not; thus adding a positive value to the object names and a negative value to the food names. In both tasks, participants gave the positive response by pressing the right-sided button, and the negative response by pressing the left-sided button (note that Experiment 1 showed no interaction between Response Mapping and Relatedness or Target Category). To reinforce the positive and negative value of the decisions, two labels saying NEGATIVE and POSITIVE were placed over the left and right response button, respectively. Participants were not informed that all names requiring a negative response belonged also to a single semantic category.

Results

The cut-off procedure entailed an overall elimination rate of 2.10% of the trials in the food categorization task and of 3.15% of the trials in the object categorization task. The RTs data were analyzed by an ANOVA containing the following 3 factors: Relatedness (related or unrelated trial), Decision Value (positive or negative) and Categorization Task (food or object). The main factor of Relatedness is significant, $F(1, 38) = 63.232$, $MSE = 19536$, $p < .01$, showing that related trials induce faster RTs ($M = 686$ ms) than unrelated trials ($M = 708$ ms). Positive decisions are generally faster ($M = 682$ ms) than negative decisions ($M = 710$ ms), $F(1, 38) = 11.911$, $MSE = 29485$, $p < .01$, and the food categorization induces faster responses ($M = 659$ ms) than the object categorization ($M = 733$ ms), $F(1, 38) = 5.596$, MSE = 215502, $p < .05$. Decision Value interacts significantly with the type of Categorization Task, $F(1, 38) = 4.697$, $MSE = 11628$, $p < .05$, and, decisively for the present study, with Relatedness, $F(1, 38) = 8.186$, $MSE = 3312$, $p < .01$. This last result reflects the fact that the same word pairs induce more semantic priming – that is faster RTs for related than for unrelated trials – when they are associated with a positive than with a negative decision. Neither the interaction between Relatedness × Categorization Task, $F(1, 38) = 3.237$, $MSE = 1000$, $p = .08$, nor the triple interaction between the three main factors, reaches significance, $F(1, 38) = .748$, $MSE = 303$, $p = .39$. Additional analyses showed that both the 31-ms priming effect for the positive decisions, $F(1,38) = 64.098$, $MSE = 19469$, $p < .001$, as well as the 13-ms priming effect for the negative decisions, $F(1,38) = 8.246$, $MSE = 3380$, $p < .01$, reached significance.

Note that the previous analysis averages RTs over target category. To extricate whether decision value modulates semantic priming effects for both target categories, we conducted a second ANOVA with the factors of Relatedness (related or unrelated trial), Target Category (food or object name) and Categorization Task (food or object). Again significant main effects of Relatedness, $F(1, 38) = 63.232$, $MSE = 309$, $p < .001$, and of Categorization Task, $F(1, 38) = 5.596$, $MSE = 38507$, $p < .05$, are observed. Participants are faster to respond to food targets ($M = 688$ ms) than to object targets ($M = 705$ ms), $F(1, 38) = 4.697$, $MSE = 2475$, $p < .05$. The significant Target Category × Categorization Task interaction, $F(1, 38) = 11.911$, $MSE = 2475$, $p < .01$, reflects that while, in the food categorization task, food targets ($M = 637$ ms) induce faster responses than object targets ($M = 681$ ms), in the object categorization task the opposite pattern of results is obtained, food targets ($M = 738$ ms) inducing slower responses than object targets ($M = 728$ ms). While Relatedness does not interact with Categorization Task, $F(1, 38) = 3.237$, $MSE = 309$, $p = .08$, nor Target Category, $F(1, 38) = .748$, $MSE = 405$, $p = .39$, the triple interaction between the three main factors, $F(1, 38) = 8.186$, $MSE = 3312$, $p < .001$, reaches significance. Considering the two target categories separately, the main effect of Condition is significant for both the food, $F(1, 38) = 25.559$, $MSE = 12350$, $p < .01$, and the object targets, $F(1, 38) = 32.501$, $MSE = 7488$, $p < .01$, but the interaction between Condition × Categorization Task is significant only for the food, $F(1, 38) = 8.229$, $MSE = 3976$, $p < .01$, and not for the object targets, $F(1, 38) = 1.459$, $MSE = 336$, $p = .23$. Additional analyses show that in the food categorization both the 39 ms-priming effect for food targets, $t(19) = 6.7$, $p < .001$, and the 15 ms-effect for object targets, $t(19) = 3.5$, $p < .001$, are significant; while in the object categorization, the semantic priming effect of 23 ms for the object targets is significant, $t(19) = 4.5$, $p < .001$, the 11 ms-effect for the food targets is not, $t(19) = 1.3$, $p = .19$.

Discussion

Several conclusions can be drawn from the present set of data. First, we want to stress that participants seem to comply with the specific instructions they were given: food targets induced faster responses when they had to be accepted as "good" exemplars than when they had to be rejected as "bad" exemplars in the categorization task. The same pattern of results, if less strong, is obtained for the object targets that were categorized faster in the object than in the food categorization task.

Participants were in general faster to decide if a target was the name of a food item or not than to decide if it was the name of a manufactured object or not. Also, in Experiment 1, the object targets induced slower categorization responses than the food targets, while targets of both categories yielded comparable lexical decision latencies in the pilot study. We assume that this is a consequence of the fact that the semantic category of food items is smaller, or perhaps better defined, than the semantic category of manufactured objects and thus it could be easier to decide if something is edible than if it is manufactured (Landauer & Freedman, 1968). On the other hand, food targets induce slightly more categorization errors than object targets (cf. Table 2). Hence, the faster reaction times may simply be an indication of a speed-accuracy trade-off.

For our purposes, the most important result is that the semantic priming effects can be modulated by the positive or negative value of the required target decision (cf. Figure 1). As predicted, the same word pairs induce significantly larger semantic priming effects when they are associated with a positive than with a negative categorization decision, effects sizes being of 31 and 13 ms, respectively. As can be seen in Table 2, this pattern of re-

Table 2
Mean Reaction Times (in ms), Error Percentages and Semantic Priming Effects for each Task

	Target category			
	Food		Object	
	RTs	Errors	RTs	Errors
	Pilot study. Word: yes or no?			
Related	592 (54)	1.3 (2.6)	601 (67)	0.7 (1.5)
Unrelated	615 (53)	1.8 (2.1)	626 (66)	3.2 (3.2)
Priming effect	23* (24)	0.5 (2.7)	25* (28)	2.5* (3.4)
	Experiment 1. Food or object?			
Related	642 (84)	3.8 (3.6)	673 (83)	1.0 (2.1)
Unrelated	666 (74)	4.4 (4.0)	689 (86)	2.2 (2.6)
Priming effect	24* (31)	0.6 (5.1)	16* (32)	1.1* (2.6)
	Experiment 2. Food: yes or no?			
Related	618 (104)	1.3 (1.7)	674 (93)	1.0 (2.1)
Unrelated	657 (102)	4.0 (3.7)	689 (95)	1.9 (2.2)
Priming effect	39* (26)	2.7* (3.8)	15* (20)	0.9 (2.7)
	Experiment 2. Object: yes or no?			
Related	732 (98)	5.0 (4.4)	716 (109)	3.8 (3.4)
Unrelated	743 (106)	5.1 (4.9)	739 (109)	3.6 (3.8)
Priming effect	11 (35)	0.1 (5.6)	23* (23)	0.1 (5.7)

Note. Corresponding standard deviations are indicated in parentheses.
$^*p < .05$.

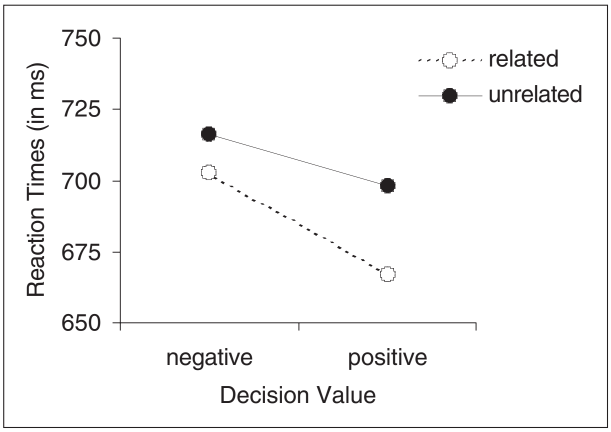

Figure 1. Reaction times for related and unrelated trials and positive and negative decision values in Experiment 2.

sults was obtained for both target categories, even though the corresponding interaction reached significance only for the food targets. These results corroborate the hypothesis that semantic priming effects can be modulated by the value of the target decision. Note that if post-lexical decision biases were the sole components of semantic priming effects in binary decision tasks, an inversion of the priming effects for negative decisions was to be expected, as unrelated trials should endorse faster negative responses than related trials. Yet we found a reduced but significant positive priming effect even for negative decisions. Also, when considering both target categories separately, a small but significant effect was obtained for the object targets in the food categorization task, and while not significant, the small priming effect for food targets in the object categorization task was certainly not inversed. These smaller but positive priming effects thus confirm the conclusion of Experiment 1, namely that other components than decision biases do intervene in semantic priming effects.

General Discussion and Conclusion

1. A significant semantic priming effect is found with the semantic categorization task in Experiment 1, using neutrally valued decisions, an effect that cannot be reduced to post-lexical decision biases.

2. Likewise, in Experiment 2, negatively valued decisions do not produce a negative semantic priming effect, an inversion that would have been expected if post-lexical processes were the sole determinants of priming effects.

3. In Experiment 2, the same word pairs induce stronger semantic priming effects when the word targets require a positive rather than a negative decision.

The modulation of semantic priming effects through the positive or negative values associated with the target decisions corroborates the hypothesis that priming effects observed on positive decisions can in part stem from decision bias originating in a post-lexical relatedness judgment of the trial. In the introduction we outlined the different forms of post-lexical decision bias that have been proposed, with one of the main distinctions being whether the underlying processes are strategic or irrepressible in nature. Given that, in the present experiments, the relatedness status of the trial and the target decision are completely counterbalanced, participants cannot strategically use the relatedness status of the trial to predict the target response (Neely, 1991; Neely & Keefe, 1989; Neely et al., 1989). The post-lexical decision biases observed in Experiment 2 are thus non strategic in nature, stemming from a congruity effect between the positive or negative value of the target decision and the positive or negative value of a relatedness judgment between the prime and the target. Consequently, priming effects observed on positive target decisions can be caused, at least in part, by irrepressible decision biases.

This result does not imply that all priming effects obtained with lexical decision or other binary decision tasks have to be refuted. First of all, the observation of significant semantic priming effects with neutrally and (in one case) negatively valued categorization decisions reveals that decision biases are not the sole, nor the most potent, underlying component of semantic priming effects. We also need to stress that while our results show priming effects to be modulated by decision bias this result can not simply be generalized to every experimental setting. For instance, in the present experiments prime words were presented at fixation for 150 ms and separated by a 1000-ms onset asynchrony from the target word. This presentation procedure made it particularly easy for participants to identify the prime words and to detect possible relations between prime and target words. In contrast, the occurrence of a relatedness judgment between prime and target stimuli is far less likely in experiments using masked or parafoveally presented prime stimuli. Moreover, note that for the relatedness judgement to have any effect on the target decision, the outcome of this relatedness judgment must be available before the target decision is completed. While this seems to be unlikely with short stimulus onset asynchronies of the order of 200 ms, this is indeed possible with stimulus onset asynchronies stretching from 500 to 1000 ms (Duscherer, 2001), which was the initial reason we chose such a long asynchrony for the present study. Using a fast paced presentation procedure could thus reduce the probability of decision biases altering priming effects.

A safer method to avoid the "contamination" of the sought-after priming effects, however, is to select target tasks with neutrally valued decisions, such as a naming task or a semantic categorization of the kind present in Experiment 1. The use of the naming task is, nonetheless, often criticized for the study of semantic priming effects because it is theoretically possible to pronounce a word without necessarily retrieving the underlying meaning. Similarly, selecting semantically related word pairs that permit the construction of two equivalent semantic categories for the target words can be very tricky. Hence, another option is to use a categorization task which has the characteristics of that used in present Experiment 2, namely a task which permits counterbalancing of the relatedness status of the word pairs and the value of the target decisions, and thus, if not avoiding, at least controlling the part of the priming effects due to decision bias. Finally, we want to stress that, even if this study focussed on semantic priming effects, congruity effects between target decisions and relatedness status can also occur with different relationships – phonological, orthographic, affective... – between the prime and the target stimulus.

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