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Level of categorisation effect: A novel effect in the picture-word interference paradigm

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In four experiments we explored the effects of two variables in the picture-word interference paradigm: semantic relatedness and the level of categorisation of distractors relative to pictures' names. Experiment 1 addressed whether the contrasting effects of semantically related distractors in category- and basic-level naming have a methodological origin (i.e., differences in the number of responses and the number of repetitions of responses between experiments). Experiments 2, 3 and 4 explored the effect of the level of categorisation of distractor words relative to the level of categorisation of the response, independent of semantic relatedness. Two main results are reported. First, the effect of semantically related distractors depends on the level of categorisation at which the response has to be given. Second, semantically unrelated distractors at the same level of categorisation as that of the response interfere more than unrelated distractors at a different level of categorisation. The implications of these results for the interpretation of picture-word interference effects and their implications for models of lexical access in speech production are discussed.

INTRODUCTION

Spontaneous and elicited speech errors provide important evidence for constraining theories of lexical access (Dell, 1986; Fay & Cutler, 1977;

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Fromkin, 1973, 1980; Garrett, 1975). However, the assumptions and hypotheses that one may test with analyses of speech errors are limited (Meyer, 1992). Researchers have proposed other experimental paradigms that could be used to address finer-grained assumptions regarding the processes involved in lexical access. The picture-word interference task is one such paradigm (Meyer, 1996; Miozzo & Caramazza, 1999; Schriefers, Meyer, & Levelt, 1990; Starreveld, 2000; Starreveld & La Heij, 1995). This paradigm is a Stroop-like task (MacLeod, 1991, for a review) in which participants are asked to name a picture while ignoring the presentation of a distractor word. Two main factors affect the amount of interference produced by a distractor in this paradigm. First, intrinsic properties of the distractor can slow down or speed up the retrieval of the picture's name. For example, distractors that are abstract interfere less than concrete distractors (Lupker, 1979). Second, the relationship between the picture's name and the distractor affects naming latencies. When distractors are phonologically related to the names of the pictures ''dog'', *doll*)[1] responses are faster than when they are unrelated—the phonological facilitation effect (Costa & Sebastian-Galles, 1998; Damian & Martin, 1999; Lupker, 1982; Meyer & Schriefers, 1991; Rayner & Springer, 1986). In contrast, when the target and distractor are from the same semantic category (e.g., ''dog'', *mouse*) naming latencies are slower than when they are from different semantic categories—the semantic interference effect (Glaser & Glaser, 1989; La Heij, 1988; Lupker, 1979; Roelofs, 1992, 1993). These effects are usually assumed to reflect processes involved in lexical access in speech production. In this article we further explore the conditions under which the semantic interference effect arises and their implications for the interpretation of the phenomenon.

Although the effect of semantically related distractors has traditionally been referred to as the ''semantic interference effect'', there are indications that both the labels ''semantic'' and ''interference'' may be more general than is warranted by the phenomenon itself. This is because not all semantic relationships cause semantic interference and not all aspects of semantics seem to be relevant in determining the magnitude of the phenomenon. While a categorical relationship between target and distractor (e.g., ''dog'', *mouse*) produces the semantic interference effect, other types of semantic relationships do not. No semantic interference is obtained with an associative relationship (e.g., ''mouse''; *cheese*) (Alario, Segui, & Ferrand, 2000; Lupker, 1979). Although one may object that associative relationships are not really semantic but ''pragmatic'' (or

[1] Words in italic represent distractors; words in double quotation marks represent the pictures, and words in single quotation marks represent the response.

syntagmatic), there are other cases in which the relationship is clearly semantic, but the semantic interference effect does not arise. These special cases involve changing the level of categorisation at which subjects have to name the picture. When participants are asked to produce a category-level name to the picture (e.g., ''dog'' has to be named as 'animal'), a semantically related distractor (e.g., *mouse*) does not produce semantic interference but speeds up naming latencies (e.g., Glaser & Glaser, 1989).[2]

Recently, Vitkovitch and Tyrrell (1999) extended this observation to basic-level distractors and subordinate responses (e.g., *dog* did not interfere with 'poodle'). Given these results, one might conclude that semantic interference arises only when responses are given at the basic-level of categorisation (e.g., 'dog'). However, Vitkovitch and Tyrrell (1999) obtained semantic interference in a task involving subordinate-level responses and subordinate-level distractors (e.g., *spaniel* interfered with 'poodle' more than *sedan*). Thus, the semantic interference effect is found both when responses are given at the subordinate level and when they are given at the basic-level of categorisation.

The relationship between target and distractor that appears to be necessary for obtaining semantic interference is the level of categorisation of the response relative to that of the distractor. The semantic interference effect is found when the response and the distractor are semantic coordinates; that is, when response and distractor share the same level of categorisation (e.g., basic level) and belong to the same semantic category (e.g., animal). In other words, it appears that the semantic interference effect is really a ''coordinate interference effect''. Further support for this supposition comes from the observation that the semantic interference effect is still observed when distractors are categorically related but share few semantic properties with the target (Lupker, 1979). For example, compared with an unrelated distractor, the related distractor *worm* interferes with naming a picture of a ''dog'', even though ''worm'' and ''dog'' arguably do not share very many semantic attributes. This means that being of the same semantic category as the picture is sufficient for a semantically related distractor to produce interference compared

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[2] We distinguish among three levels of categorisation of concepts: category-, basic-, and subordinate-level. These levels correspond to the so-called vertical dimension used by Rosch, Mervis, Gray, Johnson, and Boyes-Braere (1976). There are a number of variables that differentiate these levels. For example, they differ in their level of inclusiveness, with category-level concepts being the most inclusive and subordinate concepts the least inclusive. Furthermore, the elements at each level also differ in their similarity. At the category-level, the concepts are very different (e.g., animal vs. vehicle), at the basic-level concepts they share many more properties (e.g., cat vs. dog), and at the subordinate-level they share even more properties (e.g., spaniel vs. poodle).

with unrelated distractors. Thus, one crucial generalisation that has emerged from research with the picture-word interference paradigm can be stated as follows: semantic coordinate distractors interfere in picture naming.

There is another potentially important empirical generalisation regarding the semantic relationship between target and distractor that can be drawn from research with the picture-word interference paradigm. In several studies it has been observed that when pictures are named at the category-level (e.g., respond ‘animal’ to a picture of a ‘‘dog’’), semantically related distractors (e.g., *mouse*) produce *facilitation* instead of interference (Glaser & Düngelhoff, 1984; Roelofs, 1992). This reversal of the polarity of the effect—from interference in the case of basic-level naming to facilitation in the case of category-level naming—further supports the important role played by category-level information in the picture-word naming paradigm. More specifically, it appears that the factor level of categorisation determines both whether or not a semantically related distractor word will affect how easily a picture’s name can be accessed as well as the polarity of the effect.

In this article we explore the possibility that a common factor or general principle underlies the contrasting effects of semantically related distractors in basic- and category-level naming. The fact that the polarity of the effect produced by semantically related distractors in the picture-word interference paradigm depends on the categorical relationship between distractor and target responses invites the inference that semantic categorisation plays a fundamental role in this paradigm. It could be argued that level of categorisation may be one of the dimensions at play when deciding which part of the stimulus (the distractor word or the picture’s name) needs to be produced and which needs to be ignored. More precisely, the assumption is that level of categorisation information is used to determine which semantic representations are considered for lexicalisation. Accordingly, when a semantically related distractor (*mouse* is presented at the same level of categorisation as that at which the response must be given (‘dog’), the level of categorisation dimension provides no useful information for individuating the response from the distractor, and therefore the distractor remains a competitor for selection, resulting in the observed semantic interference effect. In contrast, when the two stimuli belong to different levels of categorisation (response: ‘animal’; distractor: *mouse*), it is possible for the system to differentiate between the two semantic representations, very early on, strictly on the basis of their level of categorisation value, preventing semantic interference between target and distractor. Nevertheless, the semantic representation of the response ‘animal’ would receive activation from two sources, the picture (‘‘dog’’) and the distractor word (*mouse*) making its retrieval easier than in the unrelated condition, and therefore leading to the semantic facilitation effect observed in category-level naming.

How can we test the account described above? One possibility is to assess the effect of level of categorisation by itself, independently of any semantic relationship between distractors and responses. If the amount of interference created by a distractor word depends, to some extent, on whether the system can use the level of categorisation dimension to identify the target semantic representation, then naming latencies should be faster in those conditions in which that dimension discriminates between distractors and responses. In other words, distractors presented at the same level of categorisation as that of the response should interfere more than those presented at a different level of categorisation, irrespective of their semantic relationship. We tested this prediction by exploring the interference produced by unrelated distractors presented at different levels of categorisation in different naming conditions: category- (e.g., 'animal') and basic-level naming (e.g., 'dog'). If distractors interfere more when they share their level of categorisation with the responses than when they do not, we would expect the following complementary pattern of results: category-level distractors (e.g., *vehicle*) should interfere more than basic-level distractors (e.g., *car*) in category-level naming (e.g., ''animal''), and basic-level distractors should interfere more than category-level distractors in basic-level naming (e.g., 'dog'). In other words, we expect to obtain an interaction between the level of categorisation of the response and the level of categorisation of the distractor word.

Before testing these predictions, it is important to address one existing explanation for the contrasting effects of semantically related distractors in basic- and category-level naming. In contrast to the hypothesis presented above, Roelofs (1992, 1993; see also Levelt, Roelofs, & Meyer, 1999) has argued that the differential effects of semantically related distractors do not reflect intrinsic differences between the levels of categorisation at which pictures have to be named relative to that at which distractors are presented. Instead, the proposal is that these contrasting effects are caused by differences in the experimental designs used in category- and basic-level naming experiments, and more specifically, in the number of response set items (the number of words that the participant has to produce during the experiment), and in the number of times these words are repeated, included in the experiments. Roelofs noted that in category-level naming experiments the number of response items is usually very small (between three and nine items) relative to the number of response items used in basic-level naming experiments (Glaser & Glaser, 1989; Glaser & Düngelhoff, 1984). Furthermore, in the category-level naming experiments, target responses are typically repeated many more times than the target items in the basic-level naming experiments. In other words, it is possible that the level of category effects are artifacts of systematic methodological differences between experiments.[3] This possibility is tested in Experiment 1 in which the performance of participants in category-level naming task is analysed with a design identical in the relevant respects to that used in an experiment (Caramazza & Costa, 2001) in which semantic interference was observed in a basic-level naming task (see below). If the differential effects of semantically related distractors in basic- and category-level naming previously reported in the literature are merely the consequence of differences in experimental design between the two naming tasks, we would expect to obtain a semantic interference effect in this experiment. However, if the contrasting results in the category- and basic-level naming tasks are due to the level of categorisation of the target relative to the distractor, we would expect a semantic facilitation effect in this experiment.

To sum up, we present four experiments designed to explore the basis of the differential effects of semantically related distractors in basic- and category-level naming. In Experiment 1, we try to rule out the possibility that the contrasting effects of semantically related distractors are due to methodological artifacts across experiments. In Experiments 2–4, we directly explore whether the level of categorisation variable is at the basis of the contrasting effects of semantically related distractors.

EXPERIMENT 1. SEMANTIC EFFECTS IN CATEGORY- AND BASIC-LEVEL NAMING: AN EXPERIMENTAL ARTIFACT?

In this experiment we investigated the effect of semantically related distractors in category-level naming. As discussed in the Introduction, it is possible that the differential effects of semantically related distractors are merely the result of the different designs used in the experiments in which category- and basic-level naming has been investigated. Roelofs (1992, 2001) has argued that under the same experimental circumstances, semantically related distractors should always lead to the same result (either facilitation or interference). In this experiment, we used an identical design in the relevant respects to that used by Caramazza and

[3] Roelofs (1992, 2001) has argued that when the number of responses in a picture-word interference experiment is large enough that the response items cannot be kept in short-term memory (and the number of repetition is not very large), semantically related distractors should always produce semantic interference. This is because a response-set cannot be established and, therefore, any distractor word, irrespective of its level of category, should enter into competition with the target word (but for further discussion see also Caramazza and Costa, 2000, 2001; Roelofs, 2001; Starreveld & La Heij, 1999).

Costa (2001), in which semantic interference was observed with a basic-level naming task. However, unlike in that experiment, we asked participants in the present experiment to name pictures at the category-level.

Several crucial features of the design employed in our previous study were kept constant in this experiment. First, the number of responses was the same: 11 basic-level terms in Caramazza and Costa (2001) and 11 category-level terms in the present experiment. Second, the distractor words were never responses in either experiment. Third, the number of times a response word was produced was the same in the two experiments: six times. By keeping these variables constant between our previous experiment and the present experiment, we are able to compare the effect of semantically related basic-level distractors in basic-level and category-level naming under comparable experimental circumstances. Thus, we can test whether the differential effects of semantically related distractors in category- and basic-level naming are the result of differences in the experimental designs commonly used in the two tasks. If that hypothesis were to be correct, then we should observe the same pattern of results in basic- and category-level naming. And since semantic interference was observed in the basic-level naming experiment reported by Caramazza and Costa (2001), semantic interference would also be expected in the category-level naming experiment reported here. However, if the polarity of the effect of semantically related distractors depends on the level of categorisation of the response relative to that of the distractor, we would expect the opposite effect—viz., facilitation.[4]

Method

Participants. Sixteen native English speakers, students at Harvard University, took part in the experiment. Participants were paid for their participation.

Materials. Twenty-two pictures from 11 semantic categories (two pictures per semantic category) were included in the experiment

[4] While the number of responses and the number of times that a response had to be given were identical to those in Caramazza and Costa's study (2001), the number of pictures was larger (22 vs. 11) and the number of times that a picture appeared was smaller (three vs. six) in the present experiment. According to the explanation given by Roelofs (2001) for the contrasting effects of semantically related distractors in basic- and category-level naming, these two differences between the experiments should not affect the polarity of the effects of semantically related distractors. This is because in the theoretical framework he has proposed what matters is the number of responses rather than the number of pictures, and in that respect the two experiments are identical.

(Appendix A).[5] Thus, the number of possible responses in the experiment was 11 (11 category names), as in the experiment by Caramazza and Costa (2001) in which 11 basic-level names were used. All category names consisted of a single non-compound word. Each picture (e.g., ''dress'') appeared with two distractor words: a semantically related word (e.g., *sock*), and an unrelated word (e.g., *tulip*). Pictures were also presented along with a filler condition (a string of XXXs). Thus, the 11 response words were each produced six times during the experimental phase. This is the same number of repetitions that was used in Caramazza and Costa's study.

Each distractor appeared in the semantically related and unrelated conditions (e.g., the distractor *sock* was paired once with the picture ''dress''—response 'clothing', and once with the picture ''daffodil''—response 'flower'). The paired distractors were always phonologically dissimilar to the responses, while similar in frequency and length (see Appendix A). Distractors appeared in capital letters (Helvetica, bold, 40 point) around the fixation point (with a maximum variation of 1 cm) to prevent subjects from systematically ignoring them on the basis of location. However, for each given picture, all distractors appeared at the same place. Stimuli were presented in six blocks of 11 trials each with short breaks in between blocks. In each block all the conditions and semantic categories were presented a similar number of times (three or four). Stimuli were randomised within the blocks with two restrictions: (1) responses on consecutive trials were phonologically dissimilar; and (2) there was a maximum of two consecutive trials of the same condition. The order of block presentation was randomised between participants.

Procedure. Participants were tested individually in a dimly lit, sound-attenuated room. Testing was administered via PsyScope 1.2.2 (Cohen, MacWhinney, & Flatt, 1993) under the supervision of an experimenter who kept a record of the participant's errors. Participants were presented with written instructions supplemented, if necessary, by oral clarification. They were explicitly instructed to name the category name of each picture as quickly and accurately as possible. The instructions contained an example and a definition of category naming, along the lines of: ''The category name of a picture is the broader, more general term by which the picture can be described. For example, the category name of ''dress'' is 'clothing'.''

Following the instructions, participants took part in a practice session during which they were familiarised with the structure of the experiment

[5] Note that the number of category names that one can use as target responses is not very large, since the number of semantic categories is a small set.

and saw all the pictures. In this training session, the pictures were paired with unrelated distractors (unrelated words), none of which appeared in the experimental session, or with a string of XXXs (about one-third of the practice trials, mirroring the ratio in the experimental session). If participants produced a different response from the one expected by the experimenter, they were required to use the appropriate one. In the majority of cases, subjects produced the expected response. A trial consisted of the following events: First, a question mark appears in the centre of the screen. The participant pressed the space bar to view the stimulus. A fixation point (+) appeared for 200 ms in the centre of the screen, followed by the stimulus. A response-triggered voice key terminated the stimulus. There was a fixed 200 ms interval before the participant could initiate the next trial by pressing the space bar. The experimental session lasted approximately 20 min.

Analyses. Three types of responses were scored as errors: (a) production of names that differed from those designated by the experimenter; (b) verbal disfluencies (stuttering, utterance repairs, production of nonverbal sounds that triggered the voice key); (c) recording failures. Erroneous responses and outliers (i.e., responses exceeding 2s or three standard deviations from the participant's mean) were excluded from the analyses of response latencies. According to these criteria, 5.6% of the data points were discarded. The error percentages and mean naming latencies are presented in Table 1. Naming latencies and error rates were submitted to two *t*-test comparisons (by subjects and by items), yielding t_1 and t_2 statistics, respectively. In these analyses, one within-subjects variable (semantic relatedness) with two values (semantically related vs. unrelated) was analysed.

Results and discussion

The main effect of semantic relatedness was significant, $t_1(15) = 3.647$; $p < .01$, $t_2(21) = 3.096$, $p < .01$, revealing that naming latencies were significantly faster (56 ms) when the distractor word was semantically related to the picture than when it was unrelated. No significant differences were observed in the error analyses.

The results of this experiment show that when category-level naming (e.g., 'animal') is required, semantically related basic-level distractors (e.g., *mouse*) produce *facilitation* rather than interference. Crucially, these results contrast sharply with the 31 ms semantic *interference* effect observed when basic-level naming was required in an experiment with an identical number of response items (11) and response repetitions (6) (Caramazza & Costa, 2001). Thus, we can conclude that the contrasting

TABLE 1
Naming latencies (mean), error rates (E%) and standard deviations (SD) as a function of type of distractor in Experiment 1 (category-level naming)

Distractor type	*Mean*	*SD*	*E%*
Semantically related	870	116	6.5
Semantically unrelated	926	89	4.8
Semantic effects	−56		
Related-unrelated			

effects of semantic facilitation and interference observed in category- and basic-level naming, respectively, are not methodological artifacts but most likely reflect the influence of category-level information in lexical access in the picture-word interference paradigm. It is interesting to note that a similar conclusion was reached by Vitkovitch and Tyrrell (1999) on the basis of their results which showed that in a subordinate naming task ('poodle') semantically related subordinate distractors (*spaniel*) produced interference whereas semantically related basic-level distractors (*dog*) produced facilitation.

EXPERIMENT 2. CATEGORY-LEVEL NAMING: A TEST OF THE LEVEL OF CATEGORISATION HYPOTHESIS

In the Introduction we proposed that the factor level of categorisation may play an important role in explaining the semantic distractor effects observed in basic- and category-level naming tasks. The fact that semantic interference is only obtained when distractors and responses are at the same level of categorisation invites the following inference: distractors at the same level of categorisation as the response may interfere more than distractors at different levels of categorisation, even when no semantic relationship exists between distractors and target responses. In Experiment 2, we tested this prediction by exploring the degree of interference produced by *unrelated* distractors presented at different levels of categorisation in a category-level naming task. If the interference produced by a distractor word depends to some extent on whether it is at the same level of categorisation as the response, then, in category-level naming, unrelated category-level distractors should interfere more than unrelated basic-level distractors.

In this experiment participants were asked to name a set of pictures using category-level names (e.g., 'animal') while ignoring unrelated basic-level (e.g., *car*) or unrelated category-level distractors (e.g., *vehicle*).

Method

Participants. Thirty-two participants from the same population as in the previous experiment were paid for their participation. None had participated in the previous experiment.

Materials. Eighteen pictures representing elements of six different semantic categories (animals, buildings, furniture, tools, vegetables, and weapons) were included in the experiment (three pictures per category). All the category names consisted of a single non-compound word (Appendix B). Each picture was paired with two semantically unrelated distractor words: a category-level and a basic-level distractor. The category-level distractors were chosen according to the following criteria: (1) they had to be non-compound words; and (2) they designated categories which contained a basic-level member similar in frequency and length (in number of letters) to the category name, which could be used as a basic-level distractor. The two sets of distractors were matched for frequency and letter length (see Appendix B). For example, the picture ''hammer'', which was to be named as 'tool', was paired with *clothing* (unrelated category-level), and *jacket* (unrelated basic-level). Each picture also appeared with three additional unrelated filler distractors. Each distractor word appeared three times associated with three different pictures. The other features of the experiment were similar to those of Experiment 1.

Results and Discussion

Following the criteria used in Experiment 1, 5.7% of the data points were excluded from the analyses (Table 2). No differences were observed in the error analyses (all *t*s < 1).

Naming latencies were slower when the distractor was a category-level name than when it was a basic-level name, $t_1(31) = 3.03$, $p < .01$, $t_2(17) = 2.17$, $p < .05$.

The observation that basic-level distractors interfere less than category-level distractors in category-level naming, is consistent with the notion that distractor words presented at the same level of categorisation as that at which the response has to be given produce more interference than distractors presented at a different level of categorisation.

However, this difference may also be due to the fact that category-level distractors (e.g., *vehicle*) cause more overall interference than basic-level distractors (e.g., *car*). For example, one could argue that a category-level distractor activates all the representations of the basic-level elements that belong to its category (the distractor word *vehicle* activates all the basic-level terms that are vehicles—car, train, canoe, etc.), leading *always* (and

TABLE 2
Naming latencies (mean), error rates (E%) and standard deviations (SD) as a function of type of distractor in Experiment 2 (category-level naming)

Distractor type	*Mean*	*SD*	*E%*
Category-level	729	91	5.6
Basic-level	710	79	5.9
Level of categorisation effects (Category-level—basic-level)	19		

regardless of the level of categorisation at which the response has to be given) to more difficulties in the selection of the appropriate response representation. Thus, before we can conclude that the reported results support the hypothesis that the amount of interference produced a distractor word depends on whether it is presented at the same level of categorisation as that at which the response has to be given, we need to exclude this latter explanation. We do this by reversing the relationship between the level of categorisation of the response and that of the distractor.

EXPERIMENT 3. BASIC-LEVEL NAMING: REVERSING THE LEVEL OF CATEGORISATION EFFECT

In this experiment participants were asked to name the pictures with basic-level names (e.g., 'dog') while ignoring either a category-level distractor word (e.g., *vehicle*) or a basic-level distractor word (e.g., *car*). This is a crucial experiment that allows us to adjudicate between the two explanations raised in the discussion of Experiment 2. If category-level distractors were, in general, to interfere more than basic-level distractors, independent of the level of categorisation at which the response has to be given, we should replicate the pattern of results observed in Experiment 2. That is, naming latencies should be slower when the distractors are category-level names (e.g., *vehicle*) than when they are basic-level names (e.g., *car*). However, if distractor words that share the level of categorisation with the response word interfere more than those that do not, we should observe slower naming latencies with basic-level distractors (e.g., *car*) than with category-level distractors (e.g., *vehicle*), since the response word is given at the basic-level (e.g., 'dog').

Method

Participants. Thirty-two participants from the same population as Experiment 1 were paid for their participation. None had participated in the previous experiments.

Materials. Twenty pictures of objects belonging to 10 semantic categories (two pictures per semantic category) were paired with the following distractors: (1) an unrelated category-level distractor (e.g., *vehicle*); and (2) an unrelated basic-level distractor (e.g., *car*). They were also presented along with a filler unrelated distractor. The category-name and the basic-level name distractors were matched for frequency and letter length (see Appendix C). Each distractor appeared twice, each time with a different picture.

Stimuli were presented in three blocks (20 trials each) with short breaks between blocks. Each picture appeared once per block. The number of trials of a given condition was kept similar within a block (six or seven). Stimuli were randomised within the blocks with the same restrictions as in previous experiments. The order of block presentation was randomised between subjects. The procedure and all other aspects of the design were the same as in Experiment 2.

Results and discussion

Following the same criteria as in Experiment 1, 4.7% of the data points were discarded from the analyses, along with the data points of one participant because of his high percentage of errors (10%). No significant differences were observed in the error analyses (see Table 3; all ts < 1).

Naming latencies were faster when the distractor was a category-level name than when it was a basic-level name, $t_1(30) = 2.41$, $p < .02$, $t_2(19) = 2.09$, $p < .05$.

This result complements that of Experiment 2 where in category-level naming (e.g., 'animal') category-level distractors (e.g., *vehicle*) interfered more than basic-level distractors (e.g., *car*). The fact that category-level distractors interfered more than basic-level distractors in Experiment 2 and that the opposite pattern was observed in Experiment 3 rules out an explanation of these effects in terms of differences in the intrinsic properties of the distractor words. Rather, such a pattern of results suggests that the amount of interference produced by a distractor depends, to some extent, on its level of categorisation *relative to* that of the response.

TABLE 3
Naming latencies (mean), error rates (E%) and standard deviations (SD) as a function of type of distractor in Experiment 3 (basic-level naming)

Distractor type	*Mean*	*SD*	*E%*
Category-level	715	54	4.8
Basic-level	733	60	4.7
Level of categorisation effects (Category-level—basic-level)	−18		

However, caution should be exercised in drawing conclusions from a comparison of Experiments 2 and 3. This is because the experiments differed not only in terms of the level of categorisation at which the response had to be given but also on other variables, such as the number of categories used in the two experiments, and the number of pictures per semantic category included in each experiment. Although it is unlikely that these differences between experiments are responsible for the differential interference produced by basic- and category-level distractors in the two naming tasks, in Experiment 4 we further test the effects of the level of categorisation in a more controlled experiment.

EXPERIMENT 4. CATEGORY-LEVEL AND BASIC-LEVEL NAMING: COMBINING THE LEVEL OF CATEGORISATION EFFECTS

In this experiment participants were divided into two groups. Group 1 participants were asked to name a set of pictures using category-level names (e.g., 'animal'); Group 2 participants were asked to name the same set of pictures using basic-level names (e.g., 'dog'). Both groups of participants had to perform the naming task while ignoring unrelated basic-level (e.g., *car*) or unrelated category-level distractors (e.g., *vehicle*). Crucially, the only difference between the two groups of participants was the level of categorisation at which the response had to be given, thus allowing us to directly compare the interference produced by a given distractor word as a function of its level of categorisation relative to that of the target response. If distractors interfere more when they are of the same level of categorisation as the responses than when they are not, we would expect the following complementary pattern of results in Experiment 4: For the group of participants who name the pictures using category names (Group 1, e.g., 'animal'), category-level distractors (e.g. *vehicle*) should interfere more than basic-level distractors (e.g., *car*), and for the group of participants who name the pictures using basic-level names (Group 2, e.g., 'dog'), basic-level distractors should interfere more than category-level distractors. In other words, an interaction between Group of participants and Type of distractor would support the notion that the level of categorisation at which the response has to be given relative to that at which the distractor word is presented modulates the magnitude/polarity of the distractor's effect.

Method

Participants. Sixty-four participants from the same population as in the previous experiment were paid for their participation. None had participated in the previous experiment. Participants were randomly assigned to either Group 1 (category-level naming) or Group 2 (basic-level naming).

Materials. Eighteen pictures representing items from six different semantic categories (animals, buildings, furniture, tools, vegetables, and weapons) were included in the experiment (three pictures per category). All category names consisted of a single non-compound word (Appendix D). Each picture was paired with two semantically unrelated distractor words: a category-level and a basic-level distractor. For example, the picture ‘‘hammer’’, which was to be named as ‘tool’ by Group 1 participants and as ‘hammer’ by Group 2 participants, was paired with *clothing* (unrelated category-level) and *jacket* (unrelated basic-level). The category-level distractors were chosen according to the following criteria: (1) they had to be non-compound words; and (2) they designated categories which contained a basic-level member similar in frequency and length (in number of letters) to the category name. All distractor words denoted or belonged to different semantic categories than those of the pictures. The two sets of distractors, category- and basic-level, were matched for frequency and letter length (see Appendix D). Each distractor word appeared with three different pictures. The materials were presented in two blocks of 18 pictures each, with each picture appearing once in each block. Stimuli were randomised within each block, with the following restrictions: (a) responses (either category- or basic-level) were neither phonologically nor semantically related to one another or to distractor words across consecutive trials; and (b) no more than two trials contained distractors at the same level of categorisation. This randomisation procedure was carried out twice for each block, and the resulting stimulus orders for each randomisation were reversed, resulting in four different possible stimulus orders for a given block. Block order followed a Latin Squares design, resulting in eight different orders of stimulus presentation. Subjects were randomly assigned to one of these eight orders. Finally, it is important to stress that the experimental design, even to the detail of the order of stimulus presentation, was identical for Group 1 and Group 2 participants.

Procedure. Participants in Group 1 were instructed to name the pictures using category-level names as in Experiment 1, whilst participants in Group 2 were asked to name the pictures using basic-level names. Before the experiment proper participants were presented with all the pictures and were asked to name them using category-level names (Group 1) or basic-level names (Group 2). In this training phase the pictures were presented along with pure verb distractor words that were semantically unrelated to the pictures. Each experimental block began with a warm-up trial in which a patch of red was presented and subjects either named the stimulus as ''colour'' (Group 1) or as ''red'' (Group 2). The distractor words for warm-up trials were adverbs. The experiment lasted about 10 min. A trial consisted of the following events: First a question mark appeared in the centre of the screen until the participant pressed the space bar. A fixation point (+) appeared for 700 ms, followed by the stimulus. Stimulus presentation was terminated by a response-triggered voice key. There was a fixed 1000 ms interval before participants could initiate the next trial by pressing the space bar. The other features of the procedure were the same as in Experiment 1.

Results and discussion

Following the criteria used in Experiment 1, 9.7% of the data points for Group 1 and 9.2% for Group 2 were excluded from the analyses (see Table 4). We also excluded from both Groups 1 and 2 the naming latencies for three pictures that were paired with the distractor words 'shape' and 'square'. This was because many participants spontaneously produced the responses ''shape'' or ''square'' instead of ''colour'' or ''red'' to the warm-up trial. Thus, in order to avoid the possibility of an overlap between the response set and the distractor set, we eliminated those trials in which the distractor words *shape* and *square* appeared. Naming latencies and error rates were submitted to separate analyses of variance with one between-subjects independent variable ''Group'' (Group 1: category naming; Group 2: basic naming), and one within-subjects variable ''Type of distractor'' (basic-level vs. category-level). No differences were observed in the error analyses (all Fs < 1).

In the analysis of naming latencies, the main effect of the variable ''Group'' was significant, $F_1(1, 63) = 9.17$, $MSE = 22697.3$, $p < .01$, $F_2(1, 14) = 11.62$, $MSE = 5281.3$, $p < .01$, revealing that naming latencies were slower for Group 1 than for Group 2. The main effect of the variable ''Type of distractor'' was not significant (both Fs < 1). However, the interaction between these two factors was significant, $F_1(1, 63) = 12.12$, $MSE = 675.2$, $p < .01$, $F_2(1, 14) = 6.52$, $MSE = 556.7$, $p < .03$, revealing that the magnitude of the interference produced by a given distractor word depended on its level of categorisation in relation to that at which the response had to be given. A further analysis of this interaction revealed that for Group 1 (category-level naming), category-level distractors interfered more than basic-level distractors, although this effect only reached significant values in the analysis by subjects, $t_1(31) = 2.15$, $p < .04$, $t_2(14) = 1.33$, $p < .20$, while for Group 2 (basic-level naming) the opposite pattern was observed: basic-level distractors interfered more than category-level distractors, $t_1(31) = 2.75, p < .01, t_2(14) = 3.01, p < .01$.

TABLE 4
Naming latencies (mean), error rates (E%) and standard deviations (SD) as a function of type of distractor and group of participants in Experiment 4

	Group of participants					
	Group 1 (category-level)			*Group 2 (basic-level)*		
Distractor type	*Mean*	*SD*	*E%*	*Mean*	*SD*	*E%*
Category-level	738	47	9.6	659	49	8.3
Basic-level	725	41	10.0	676	47	10.0
Level of categorisation effects (Category-level—basic-level)	13			−17		

A closer look at the behaviour of distractor words in the two groups of participants revealed that for Group 1, 11 out of 15 items were named slower in the context of category-level distractors than in the context of basic-level distractors, while for Group 2, 11 out of 15 items were named slower in the context of basic-level distractors than in the context of category-level distractors.

The most important result observed in this experiment is the interaction between the level of categorisation at which the response has to be given and the level of categorisation of the distractor word. This interaction suggests that the amount of interference produced by a distractor depends, to some extent, on its level of categorisation *relative* to that of the response.

GENERAL DISCUSSION

Two main results have been reported in this article. First, the facilitation effect observed in category-level naming with semantically related basic-level distractors appears not to be an artifact of the task requirements, since it arises in an experimental task identical in the relevant respects to one in which semantic interference is obtained when basic-level responses and basic-level distractors are used. Second, there is an independent effect of the level of categorisation of the distractor in relation to that of the response, both in category and in basic-level naming. Semantically unrelated distractors that are of the same level of categorisation as the response interfere more than unrelated distractors at a different level of categorisation (see Figure 1). This novel effect indicates that the interference produced by a distractor depends not only on its semantic relatedness with the response but also on the level of categorisation of both stimuli. Indeed, these two variables both contribute to the amount of interference, as shown by the fact that the semantic interference effect is restricted to those cases in which distractors and responses belong to the same level of categorisation.

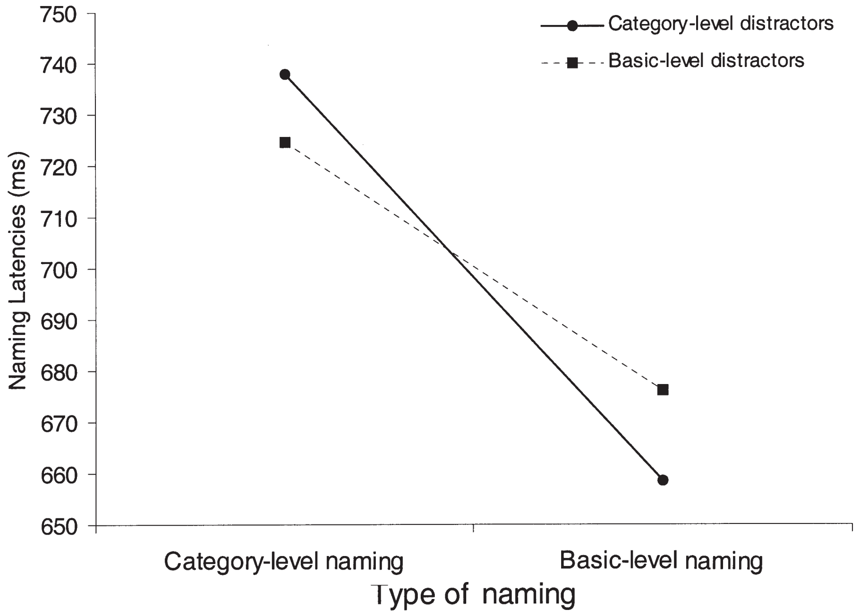

Figure 1. Naming latencies for the two groups of participants included in Experiment 4, broken down by type of distractor.

In Experiment 1 we evaluated whether a methodological explanation can account for the differential effects of semantically related distractors—facilitation in the case of category-level naming and interference in the case of basic-level naming. It had been noted that the different effects obtained for category- vs. basic-level naming in the picture-word interference paradigm could be due to the differences in the number of responses and/or number of repetitions of these responses in the two types of tasks (Roelofs, 1992, 2001). In this view, if we were to match category- and basic-level naming tasks on number of responses and number of repetitions of responses, semantically related distractors should always produce equivalent effects, regardless of the variable "level of categorisation". However, the results of Experiment 1 disconfirm this hypothesis: category-level naming led to semantic facilitation in a task involving the identical number and repetitions of target items for which semantic interference had previously been obtained with a basic-level naming task (Caramazza & Costa, 2001). Thus, it appears that we have to seek an explanation of the contrasting effects of semantically related distractors in category- and basic-level naming tasks, not in terms of methodological differences between tasks, but rather in terms of the nature of the relationship between targets and distractors in the two tasks (see Vitkovitch & Tyrrell, 1999, for a similar argument).

In Experiments 2, 3 and 4 we explored whether there is an independent effect of the level of categorisation of the distractors in relation to that of the responses, in both category-level and basic-level naming. We found that distractors that have the same level of categorisation as the response word interfere more than distractors that have a different level of categorisation than the response.

There are, then, two facts that call for explanation: (1) the effect of the level of categorisation of the distractor in relation to that of the response; and (2) the contrasting effects of semantically related distractors when category-level vs. basic-level naming is required—that is, facilitation v. interference, respectively. Note that both facts implicate the variable level of categorisation, as a central factor, since whether semantically related distractors produce interference or facilitation depends on whether the responses and distractors have the same level of categorisation.

In the Introduction we suggested the possibility that the level of categorisation and the semantic relatedness effects observed in the picture-word interference paradigm have a common cause. Specifically, we argued that one component of the reaction time variance in this paradigm reflects the ease with which the cognitive system can identify which semantic representation (that of the target picture or that of the distractor word) needs to be lexicalised for naming. The results of Experiment 2, 3 and 4 provide important clues on how this process might work. The results show that in basic-level naming, basic-level distractors interfered more than category-level distractors, while the opposite result was obtained in category-level naming. These results suggest that level of categorisation information plays a fundamental role in the process that determines which semantic representation is to be lexicalised in a naming task. More specifically, we propose that in the picture-word interference paradigm the demands of the task serve to define the lexicalisation criteria (e.g., produce basic-level names of produce category-level names) which are used to select the relevant semantic information. In other words, if the task requires the production of, for example, category-level names, the semantic representations of basic-level items will not be considered for lexicalisation; instead, only category-level representations are considered for lexicalisation. Along the same lines, when participants are asked to produce basic-level responses, the selection mechanism considers basic- but not category-level semantic representations as possible candidates for lexicalisation.

How does this explanation account for the results observed when the responses and distractors are semantically related but belong to different levels of categorisation? Consider for example, the semantic facilitation observed when distractors are presented at the basic-level (e.g., *mouse* and *car*) and the response must be given at the superordinate level (e.g., 'animal'). In this case, the semantic representations of both distractors fail to satisfy the level of categorisation condition for lexicalisation and therefore can be excluded from further consideration on the basis of that information alone.[6] As a consequence, both distractors can be discarded early on as possible responses. However, the distractors differ in their interaction with the target semantic representation. While the semantic representation of the related distractor (e.g., *mouse*) activates that of the response word 'animal', the semantic representation of the unrelated distractor (e.g., *car*) does not. If anything the unrelated distractor word *car* activates the semantic representation ''vehicle'', which, because it satisfies the level of categorisation condition, could compete for lexicalisation with the response ''animal''. Therefore, the selection of the target's semantic representation (e.g., ''animal'') would be easier when presented with semantically related (e.g., *mouse*) than with unrelated distractors (e.g., *car*).

This explanation could also account for Vitkovitch and Tyrrel's observation that subordinate naming (e.g., 'spaniel') is facilitated, rather than hampered, by the representation of the correct basic-level distractor (e.g., *dog*) in comparison with another unrelated basic-level distractor (e.g., *car*). In this case, the distractor word *dog* but not the distractor word *car* activates the semantic representation of the target ''spaniel''. However, the semantic representations of *dog* and *car* are not considered for lexicalisation because they do not satisfy the level of categorisation condition and therefore can be excluded from further consideration for lexicalisation. The net result is that the semantic representation of ''spaniel'' is relatively more activated in the context of the distractor *dog* than in the context of the distractor *car* and therefore can be lexicalised faster.[7]

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[6] A possible way in which this mechanism may be implemented is by raising the activation level of the semantic representations belonging to the level of categorisation at which the response has to be given. In such a way, the competition produced by a distractor word belonging to a different level of categorisation would be smaller than that produced by a distractor word belonging to the same level of categorisation.

[7] We have assumed that naming involves selection of the appropriate semantic representation for lexicalisation. This assumption appears to endorse the late selection view of selective attention. The fact that there are semantic effects in Stroop-like tasks is consistent with this view. Our position is simply that selection may occur at multiple levels and that even when selection occurs this does not imply that the non-selected representation ceases to affect processing. Instead, we think that the most plausible assumption is that non-selected representations send activation to the representations with which they are connected, albeit in much smaller amounts than the selected representations.

The account we have proposed for the level of categorisation effects in the picture-word interference paradigm locates the causes of the effects at the level of semantic processing, and more specifically at the level of selection of semantic representations for lexicalisation. The question remains whether the classic semantic interference effect in basic-level naming (and subordinate naming) can also be located at the level of semantic processing instead of lexical selection as is typically done (Caramazza & Costa, 2000, 2001; Roelofs, 1992; Schriefers, et al., 1990; Starreveld & La Heij, 1995). The proposal here is that categorical *membership* (e.g., than a dog is an animal) may be used to discriminate between the semantic representations activated by the complex stimulus composed of a picture and a distractor word in the process of deciding which semantic representation to lexicalise. On this account, the semantic interference effect in basic-level naming (or at least a part of it) reflects whether or not the lexicalisation mechanism can use the categorical membership of the semantic representations of the distractor and the picture to distinguish between them. When the picture and the distractor belong to the same semantic category (e.g., ''dog'', *mouse*), and basic-level naming is required (e.g., 'dog'), information about their categorical membership (e.g., animal) cannot be used to distinguish between the two semantic representations. Therefore, the cognitive system needs to use finer-grained information to decide which semantic representation (the target ''dog'' or the distractor *cat*) to select for further processing. This extra processing will, presumably, slow down the lexicalisation of the target semantic representation and eventually the production of the target word. In contrast, when the two stimuli belong to different semantic categories (e.g., ''dog'', *car*), the membership in different categories (e.g., animal vs. vehicle) can be used to more easily determine which semantic representation needs to be lexicalised.

The explanations we have proposed for the semantic relatedness and the level of category effects in the picture-word interference paradigm differ in detail but share a common assumption about the locus of the effect in the naming process. The assumption that is shared by the explanations proposed here is that the effects reflect processes at the level of selection of semantic representations for lexicalisation. The explanations differ in that in one case—the effects of level of categorisation of targets and distractors—it is the information about the level of categorisation of a semantic representation (e.g., basic-level) that determines the polarity and magnitude of the effects of the distractors. In the other case—the effect of semantic interference in same-level distractors and target responses—it is category membership (e.g., the fact that a dog and cat are members of the same category, animal) that determines the polarity of the effect.

Before concluding, it is worth noting that there are other factors that may affect the extent to which semantically related distractors produce interference in the picture-word interference paradigm. For example, when a categorically related distractor is presented well before the target picture (e.g., 400–600 ms), the semantic interference effect disappears and semantic facilitation or priming may even appear (Alario, 2001; Carr, McCauley, Sperber, & Parmelee, 1982; Glaser & Düngelhoff, 1984; La Heij, Dirkx, & Kramer, 1990). The existence of priming between categorically related items is not necessarily in contradiction with our explanation of the semantic interference effect. Priming may arise as a consequence of spreading activation from the distractor's semantic representation to the target semantic representation. The reason the semantic representation of the distractor word does not interfere with the selection of the target semantic representation in this condition is because participants presumably would have had enough *time* to discard the semantic representation of the distractor word as a possible candidate for lexicalisation. Thus, the priming effect reveals the benefits that accrue to the target response from spreading activation without the potential interference from currently active competitors.[8]

In short, then, the account given here makes the following main assumptions: (a) one component of the reaction time variance in the picture-word interference paradigm reflects the ease with which the cognitive system can differentiate the semantic representation that needs to be lexicalised from those that need to be ignored; (b) the ease with which this operation occurs depends, among other factors, on two variables: the level of categorisation of the target relative to that of the distractor and the categorical relationship between target and distractor; (c) semantic interference arises when neither of these two variables can be

[8] There is one interesting result in the literature that may be problematic for our account of the semantic interference effect. La Heij, Hooglander, Kerling, & Van der Velden (1996) observed that translation times (translate the English word ''dog'' into the Dutch word ''hond'') were faster when the prompt words were presented in the context of a semantically related picture (e.g., *cat*) than in the context of a semantically unrelated picture (e.g., *car*). The paradigm is superficially identical to the picture-word interference paradigm—in both cases subjects are required to produce a word in the context of a distractor. However, an interpretation of the result reported by La Heij et al. (1996) along the lines of the arguments we have developed here is difficult because of the nature of the task employed by those researchers. Although translation is supposed to be conceptually mediated, it is also possible that the translation is achieved through links between lexical nodes. This does not mean that translation is achieved only one way or the other, but rather that both strategies may be automatically engaged during such a process. If that were to be the case, it would not be easy to estimate how a difficulty in the selection of the proper semantic representation would affect naming latencies, given that the system would have already activated the proper target lexical node through the word to word links.

used to differentiate the semantic representation of the response from that of the distractor; and (d) semantic facilitation arises when level of categorisation information excludes semantically related distractors from consideration for lexicalisation while the related distractors activate the target responses.

We have offered a unitary account of several phenomena in the picture-word interference paradigm. This account places the locus of the observed effects at the level of semantic processing (for related proposals see Glaser & Glaser, 1989; Luo, 1999; Rosinski, 1977; Rosinski, Golinkoff, & Kukish, 1975), and more precisely at how easy it is to select the semantic information that has to be lexicalised. Does this mean that the semantic effects in the picture-word interference paradigm have little to do with the processes involved in lexical access? At this point it is premature to reach this conclusion. This is because there is nothing in our results that prevents an explanation in terms of lexical competition. Thus, it is possible that although the semantic contextual effects (semantic interference and facilitation) and the level of categorisation effect originate at the semantic level, they could actually be revealing the ease with which the lexical node corresponding to the target word is retrieved. In other words, the semantic dimensions we have discussed (categorical membership and level of categorisation) may be modulating the level of activation of the lexical nodes corresponding to the target and the distractor. The results of this study do not exclude this possibility. Nonetheless, our results reveal the need to reconsider the locus of the semantic interference effect in the picture-word interference paradigm. The semantic interference effect may not be telling us anything about the process involved in the selection of the target lexical node (lexical selection), but instead could be revealing aspects of the semantic processes involved in word production or lexicalisation.

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APPENDIX A

Materials employed in Experiment 1

Responses	*Pictures*	*Distractors*	
		Semantically related	*Unrelated*
Flower	Daisy	Rose	Shirt
	Daffodil	Tulip	Sock
Vegetable	Pepper	Carrot	Hammer
	Onion	Tomato	Dresser
Vehicle	Car	Truck	Desk
	Plane	Bus	Pink
Clothing	Skirt	Shirt	Rose
	Dress	Sock	Tulip
Tool	Axe	Hammer	Carrot
	Saw	Wrench	Cherry
Weapon	Gun	Sword	Green
	Bomb	Rifle	Circle
Fruit	Apple	Pear	Spoon
	Strawberry	Cherry	Wrench
Furniture	Bed	Dresser	Tomato
	Table	Desk	Truck
Utensil	Spatula	Spoon	Pear
	Ladle	Fork	Cone
Colour	Red	Green	Sword
	Blue	Pink	Bus
Shape	Cube	Circle	Rifle
	Square	Cone	Fork

APPENDIX B

Materials employed in Experiment 2

Responses	*Pictures*	*Distractors**	
		Category-level	*Basic-level*
Weapon	Cannon	Vehicle	Truck
	Bow	Shape	Square
	Spear	Colour	Red
Animal	Cat	Vehicle	Truck
	Camel	Shape	Square
	Mouse	Colour	Red
Building	House	Clothing	Jacket
	Church	Utensil	Spatula
	Tower	Fruit	Apple
Tool	Hammer	Clothing	Jacket
	Saw	Utensil	Spatula
	Pliers	Fruit	Apple
Vegetable	Carrot	Clothing	Jacket
	Pepper	Utensil	Spatula
	Corn	Fruit	Apple
Furniture	Table	Vehicle	Truck
	Couch	Shape	Square
	Cupboard	Colour	Red

*The two sets of distractors were matched for frequency and letter length (75 vs. 71 respectively, $F < 1$; and 6.2, 5.3, $p > 0.07$).

APPENDIX C

Materials employed in Experiment 3

Responses	*Pictures*	*Distractors**	
		Category-level	*Basic-level*
Dog	Dog	Utensil	Violet
Cat	Cat	Utensil	Violet
Tomato	Tomato	Clothing	Catapult
Eggplant	Eggplant	Clothing	Catapult
Coat	Coat	Vegetable	Strawberry
Hat	Hat	Vegetable	Strawberry
Hammer	Hammer	Furniture	Aeroplane
Rake	Rake	Furniture	Aeroplane
Cannon	Cannon	Fruit	Shovel
Gun	Gun	Fruit	Shovel
Table	Table	Flower	Potato
Stool	Stool	Flower	Potato
Rose	Rose	Vehicle	Kettle
Tulip	Tulip	Vehicle	Kettle
Car	Car	Weapon	Horse
Bicycle	Bicycle	Weapon	Horse
Spoon	Spoon	Animal	Dress
Fork	Fork	Animal	Dress
Apple	Apple	Tool	Chair
Pear	Pear	Tool	Chair

* Category- and basic-level distractors were matched for frequency (61 and 43 respectively; $F < 1$) and letter length (6.7 and 6.7 respectively, $F < 1$).

APPENDIX D

Materials employed in Experiment 4

Responses	*Pictures*	*Distractors**	
		Category-level	*Basic-level*
Weapon	Cannon	Toy	Doll
	Gun	Fruit	Apple
	Spear	Vehicle	Truck
Animal	Cat	Vehicle	Truck
	Camel	Shape	Square
	Mouse	Toy	Doll
Building	House	Fruit	Apple
	Church	Toy	Doll
	Tower	Utensil	Spatula
Tool	Hammer	Shape	Square
	Saw	Clothing	Jacket
	Pliers	Fruit	Apple
Vegetable	Carrot	Utensil	Spatula
	Onion	Clothing	Jacket
	Corn	Shape	Square
Furniture	Table	Clothing	Jacket
	Bed	Utensil	Spatula
	Chair	Vehicle	Truck

* Category- and basic-level distractors were matched for frequency (46 and 46 respectively; $F < 1$) and letter length (5.8 and 5.5 respectively, $F < 1$).