Verb Production and the Semantic Interference Effect

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In three experiments, we explored the semantic interference effect in verb production with the picture-word interference paradigm. Experiments 1 and 3 addressed whether there is an effect of semantically related distracters on gerundial verb production; In Experiment 2, we explored the effect in naming verbs in sentence production and the third person singular form. The semantic interference effect was found in two of the three experiments. However, the effect was inconsistent when transitive and intransitive verbs were analyzed separately. The results are discussed in the context of models of the semantic interference effect in lexical access.

1. Introduction

How do we select the lexical nodes that express the meaning we want to communicate? This crucial issue for understanding the processes involved in speech production occupies the attention of many researchers in the language production field (e.g., Caramazza & Costa, 2000; Dell, 1986; Levelt, Roelofs, & Meyer, 1999; Roelofs, 1992; Starreveld & La Heij, 1995, 1996). However, the focus has been almost entirely on the production of simple nouns. In this article, we study lexical access for words of another grammatical category - verbs - by exploring a contextual effect in the picture-word interference paradigm, the semantic interference effect.

The picture-word interference paradigm is one of the most widely used paradigms to study the mechanisms involved in lexical selection in speech production (for reviews see Glaser, 1992; MacLeod, 1991). In this paradigm, participants name a picture while ignoring the presentation of a distractor word. A robust effect in this paradigm is the semantic interference effect. This refers to the observation that naming latencies are slower when the picture and the distractor belong to the same semantic category (e.g., 'table'/'chair') than when they do not (e.g., 'table'/'hand')

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(Glaser & Glaser, 1989; Lupker, 1979; Schriefers, Meyer, & Levelt, 1990; Starreveld & La Heij, 1995). It is generally assumed that the semantic interference effect reveals competition among lexical nodes during the lexical selection stage (Levelt et al., 1999; Roelofs, 1992; Starreveld & La Heij, 1995). For example, when the speaker sees the picture 'table'[i], its concept (TABLE) is activated as well as other concepts that are semantically related, such as CHAIR. The activation of these concepts spreads and activates their corresponding lexical nodes. If the distractor is the word 'chair', it activates directly its lexical node "chair" which has been at this point also activated by the picture 'table'. In such a scenario, both lexical items ("chair" and "table") are highly activated. Lexical selection is delayed in this case on the assumption that the ease with which the target lexical node is selected depends on how much larger its level of activation is than that of other lexical nodes[ii]. Another robust effect is the phonological facilitation effect. Here, the selection of a phonological representation is speeded up when the picture and distractor are phonologically related (e.g., 'table'/'tape') than when they are not (e.g. 'table'/ 'hand'). This acceleration of speech is thought to be a result of the overlap of sound representations between the picture name and the written word (Schriefers et al., 1990).

The semantic interference effect has been used to investigate various issues regarding lexical access in speech production. For example, Schriefers et al. (1990) used the time-course of the semantic interference effect in relation to that of the phonological facilitation effect to argue that lexical access follows strictly serial processing. Meyer (1996) also used the semantic interference effect to explore the size of the grammatical planning units during the production of multiword utterances. Thus, it appears that the semantic interference effect in the picture-word interference paradigm can be a useful tool to constrain claims about lexical access. The question is whether this effect can also be used to study the lexical access of verbs.

There are two studies that address the issue of whether semantic interference effects exist in verb naming. Roelofs (1993) obtained a reliable semantic interference effect in bare verb naming in Dutch. Naming latencies for pictures depicting actions ('eating') were slower when the distractor word was a semantically related verb ('drinking') that when it was unrelated ('jumping'). Roelofs argued that the similarity between the results obtained with noun and verb naming suggests that the principles guiding the selection of those two word types are the same.

This view is complicated by more recent results. Schriefers, Teruel, and Meinshausen (1998) made use of the semantic interference effect for verbs to study the processes involved in the production of sentences. They also addressed the extent to which the semantic interference effect arises for both transitive and intransitive verbs[iii]. In their study, participants were asked to produce utterances in German in which the verb was either transitive or intransitive. They also manipulated the utterance format such that the verb was located either in the first position of the utterance (e.g. Verb-Subject (VS) for intransitive verbs or Verb-Subject-Object (VSO) for transitive verbs) or in later positions (e.g., Subject-Verb (SV) for intransitive verbs or Subject-Object-Verb (SOV) for transitive verbs). They found that the transitivity of the verb affected the magnitude of the semantic interference effect. Semantic interference for transitive verbs was observed only when they occupied the first position in the utterance, and no semantic interference effects were seen for intransitive verbs regardless of where the verb occurred in the sentence.

Schriefers et al. offer two explanations for the lack of effect seen for three of the four utterance formats used in their study. They argue that when the verb is not the first element of the utterance (SV or SOV utterances), it is not obligatory to have access to the lexical node corresponding to the verb before the articulation of the sentence starts. Therefore, any interference with the selection of the verb's lexical node will be invisible in naming latencies. However, this account cannot explain the lack of semantic interference observed when intransitive verbs were located in the first position of the utterance (VS). The authors argue that this lack of an effect is due to a specific property of German, the non-canonical order of the VS utterances. According to them, since the VS word order is the non-canonical order in German, participants may have automatically planned the canonical order (SV) and then re-structured the sentence to conform to the required VS order[iv]. They further speculate that when intransitive verbs are in the first position of the utterance this restructuring process may mask the effect of semantically related distractors in naming latencies.

Whatever the merits of these explanations, it is possible that the source of the differential effects of semantically related distractors in transitive and intransitive verb naming may be caused by factors unrelated to word order. Because Schriefers et al. tested the semantic interference effect for verbs only in the context of sentence production, it is unknown whether a reliable semantic interference effect can be obtained when they are tested outside the context of the utterance formats used in their experiments. Thus, before using the picture-word paradigm to study finer-grained assumptions about the processes involved in the lexical access of verbs, it is important to explore the reliability of the phenomenon in experimental conditions similar to those used for noun lexical access. Thus, the main goal of this article is to assess the robustness of the semantic interference effect for verb naming under various utterance formats.

This paper presents three experiments designed to explore this issue in English. Measures were taken to establish the reliability of the semantic interference effect in verb production. First, we tested a large number of picture-word pairs. Second, we asked several groups of participants to name the pictures in a single verb-naming task and in a sentence-naming task.

To anticipate our results, a semantic interference effect was observed in two of three experiments. However, intransitive verbs were more consistent in showing the semantic interference effect in comparison to transitive verbs.

2. An Overview of the Experiments

We report three experiments in which the semantic interference effect was explored in verb naming. In all the experiments, the target pictures were paired with a semantically related and unrelated verb. The distractors paired with a given picture had the same transitivity value as that of the depicted action[v]. Additionally, all the distractor words were presented in the gerundial form (ing). The categorical relationship between the pictures and the semantically related verbs was assessed by native English speakers who chose the best match for the picture-distractor pair out of several alternatives. The most agreed upon pair was selected for use in the experiments. Different groups of five raters judged the stimuli for each experiment, which resulted in different semantically related picture-word pairs across experiments. Regarding the type of utterances produced, we varied them in several ways. Table 1 summarizes some of the properties of the three experiments. As described in Table 1, participants named the target pictures using: a) the gerundial form of the action depicted (walking; cutting etc.) - Experiments 1 and 3; b) short sentences (he/she walks; he/she cuts the paper etc.) - Experiment 2 (Group 1); and c) the third person form of the singular (walks; cuts etc.) - Experiment 2 (Group 2). Unless otherwise noted, all experiments were conducted as described in Experiment 1.

Table 1. A summary of properties for each experiment (Exp): number of participants (#Part), number of pictures (# Pics), response (response), and format of response (Format Response).

Experiment	#Part.	#Pics.	Response	Format Response
Exp.1	16	22	Verb Alone	Gerundial (running)
Exp.2(Group 1)	19	28	Sentence	3rd Person (He runs)
Exp.2(Group 2)	19	28	Verb Alone	3rd Person (runs)
Exp.3	20	36	Verb Alone	Gerundial (running)

3. Experiment 1

Semantic interference effect in bare verb naming

<u>Method</u>

<u>Participants</u>. Sixteen Harvard University undergraduate students were paid for their participation. All were native English speakers.

<u>Materials</u>. Twenty-two black and white photographs depicting actions

were used as target stimuli (a modified set based on the materials used in (Fiez & Tranel, 1997) (see Appendix A for the list of stimuli). Eleven of the pictures depicted an actor performing an intransitive action (e.g., running), and 11 depicted an actor performing an action on an object (a transitive action, e.g., cutting). Each picture was presented with two distractor words: (a) semantically related verb (e.g., walking for running); and (b) semantically unrelated verb (e.g., laughing for running). As shown in Table 2, the semantically related and unrelated distractors were matched for frequency and word length such that words from both conditions were as similar as possible on these lexical characteristics (all Fs < 1) (This was the case across all 3 experiments, as demonstrated in Table 2). We manipulated the target-distractor semantic relatedness in two separate sets of items. This allowed us to investigate the effect of semantic relatedness with a relatively large number of observations (88 per participant) as well as to assess the replicability of any effect of semantic relatedness across word sets. Two sets of distractors were used for a total of 4 picture repetitions.

Table 2. A summary of the average frequency (frequency) and letter length (# Letters) for the semantically related and unrelated distractors for each experiment.

Experiment	Frequency		# Letters	
	Related	Unrelated	Related	Unrelated
Exp.1	89	92	7.7	7.4
Exp.2(Group 1)	102	99	7.7	7.1
Exp.2(Group 2)	102	99	7.7	7.1
Exp.3	74	74	7.6	7.6

Four pictures were included as warm-up trials at the beginning of each block. The distractors were shown in 28-point boldface capital letters in Geneva font and were superimposed on the pictures. Pictures were centered at fixation, and word position varied randomly in the region around fixation to prevent participants from systematically fixating the portion of the picture not containing the distractor. However, for an individual picture, the position of all its distractors was the same.

The experimental stimuli were presented in different blocks, where the trials were randomized such that (a) the same picture did not occur twice in the same block; and (b) the same distractor condition occurred no more than 3 times in a row. The block presentation was counterbalanced between subjects according to a Latin-square design.

Before the experiment proper, participants had 3 practice series. In the first series participants were presented with all the pictures with a row of X's printed inside each picture, to train the subject to use the correct name for each picture. In the second and third practice series they were presented with all the pictures with practice distractors printed inside every picture. These practice distractors were not used during the experiment.

Apparatus. The pictures were presented on a Macintosh using the PsychLab program (Bub and Gym, University of Victoria, British Columbia, Canada). Response times (RTs) were measured to the nearest millisecond by means of a voice key (KOSS headset/ CMU voicebox) from onset of the picture until the voice key was triggered.

Procedure. Participants were tested individually in a darkened testing room. They were instructed to name pictures as quickly and as accurately as possible. When participants made mistakes during the practice session, they were asked to name the picture correctly. Each trial proceeded as follows: A fixation point (+) was shown for 700 ms, with a 300 ms ISI, followed by presentation of the stimulus. Interstimulus-interval was 2000 ms. The experimenter remained in the testing room in order to record incorrect responses and when voice key malfunctions occurred. A session lasted approximately 25 minutes.

Analyses. Three types of responses were classified as errors: (a) production of the wrong name; (b) verbal disfluencies (stuttering, utterance repairs, etc.); and (c) voice key malfunctions. Responses slower than 300 ms and 2 SDs from a subject's condition mean were also eliminated. All missing data points were replaced by a subject's condition mean. Separate analyses were carried out with subjects and items as dependent variables, yielding F1 and F2 statistics, respectively. Two variables were analyzed: "type of verb" (transitive vs. intransitive) and "type of distractor" (semantically related vs. unrelated). The two variables were considered within-subject variables for the F1. For the F2 statistics, the first variable was considered as a between-item variable and the second as within-item. We also analyzed transitive and intransitive pictures separately to assess the reliability of the semantic interference effect for the two types of verbs.

Results

Table 3 presents a summary of the response time means and error rates broken down by type of distractor (semantically related and unrelated). Similar error rates were obtained for the semantically related (10.4%) and unrelated conditions (8.2%) indicating that the RT results do not reflect a speed-accuracy trade-off [$F1\ (1,15) = 1.38$, $MSE = .1598$, $p = .26$; $F2 < 1$]. Also, error rates did not depend on type of verb [$F1\ (1,15) = 2.71$, $MSE = .3132$, $p = .12$; $F2\ (1,20) = 1.21$, $MSE = .3132$, $p = .28$] or the interaction between type of distractor and type of verb [$F1\ (1,15) = 1.04$, $MSE = .1200$, $p = .32$; $F2 < 1$].

Table 3. Summary of the results by experiment, broken down by type of verb and type of distractor. Error rates are in parentheses. Significant differences in response times of $p < .05$ indicated by an *.

Experiment	Type of Distractors						
	Transitive			Intransitive			Total
	Related	Unrelated	Effect	Related	Unrelated	Effect	
Exp.1	764* (8.0)	737 (7.7)	-27	753* (12.8)	730 (8.8)	-23	-25
Exp.2 (Grp1)	692 (15.0)	691 (11.3)	-1	695* (12.0)	657 (6.8)	-38	-19
Exp.2 (Grp2)	730 (8.3)	720 (8.6)	-10	738* (12.8)	697 (10.2)	-41	-26
Exp.3	727 (4.8)	714 (5.2)	-13	708 (5.1)	717 (5.2)	+9	-2

The main effect of the variable type of distractor was significant, [$F1$ (1, 15) = 19.82, MSE = 216892, $p < .01$; $F2$ (1, 20) = 16.84, MSE = 216892, $p < .01$], revealing that naming latencies were significantly longer when the pictures were presented with a semantically related distractor than with an unrelated distractor. The main effect of the variable type of verb was not significant [$F1$ (1, 15) = 2.47, MSE = 27022, $p > .10$; $F2 < 1$]. Finally, the interaction between the variables type of distractor and type of verb was not significant either [$F1$ and $F2 < 1$].

We analyzed transitive and intransitive pictures separately in order to be sure that the semantic interference effect was robust for both types of verbs (following Schriefers et al., 1998). When analyzed separately, transitive pictures showed a 27 ms semantic interference effect both by subject [$F1$ (1, 15) = 5.68, MSE = 131040, $p < .05$] and by item [$F2$ (1,10) = 11.88, MSE = 131040, $p < .01$)] Intransitive pictures showed a significant semantic interference effect of 23 ms, both by subject [$F1$ (1,15) = 4.55, MSE = 87987, $p < .05$] and by item [$F2$ (1, 10) = 5.97, MSE = 87987, $p < .05$].

When each set of items is analyzed separately the semantic interference effect is marginally significant for the first set of distractors [$F1$ (1,15) = 3.40, MSE = 52303, $p = .085$; $F2$ (1, 20) = 3.89, MSE = 52303, $p = .062$] and clearly significant for the second set [$F1$ (1,15) = 19.35, MSE = 184835, $p < .001$; $F2$ (1,20) = 13.58, MSE = 184835, $p < .01$].

Discussion

Semantically related distractors increased picture-naming latencies in comparison to unrelated distractors, for both transitive and intransitive verbs. This suggests that semantically related verbs produce similar effects as semantically related nouns.

Given the assumption that the semantic interference effect arises as a consequence of the larger lexical competition produced by a semantically related distractor in comparison to an unrelated distractor during lexical selection, we can conclude that verb selection is a competitive process. In the following experiment, we will try to extend this observation in a more "natural" task in which participants are asked to produce sentences. The question then is whether a delay in the selection of the verb lexical node translates into a delay in the production of the whole utterance.

There are results that have addressed the extent to which semantic interference can be obtained when multi word utterances are produced. These studies have reported important differences between nouns and verbs. For example, semantic interference effects were found when the distractor word was semantically related to the second noun in coordinate noun phrases (e.g., the arrow and the bag) (Meyer, 1996), suggesting that a delay in the selection of a noun located in quite late positions in the utterance slows down naming latencies. The scenario is quite different for verbs. Schriefers and colleagues (1998) obtained a semantic interference effect only when the verb (transitive) was placed in the first position in the utterance and no semantic interference effects when the verb occurred later in the utterance.

Experiment 2 is designed to examine whether a delay in the selection of verbs located in non-initial positions slows speech onset. At issue is whether the results will fall in line with previous work in noun phrase production (e.g., Meyer, 1996) or in sentence production (e.g., Schriefers et al., 1998).

4. Experiment 2

Sentence production and bare verb naming

The main goal of this experiment is to explore the semantic interference effect for verbs in a sentence context. Two major differences between Experiments 1 and 2 were the use of different materials and the fact that participants were asked to produce the 3rd person present tense. A first group of participants (Group 1) was asked to name pictures using full sentences (e.g., "she pets the cat", or "she jumps"), while ignoring semantically related and unrelated verb distractors. We also included a control group (Group 2) in which participants were asked to name the same pictures using the 3 rd person singular form of the verb (e.g., "pets", "jumps"). Although our primary interest was in the results of Group 1 (sentence production), the results of Group 2 help us test the sensitivity of the experimental design.

Method

Participants. Thirty-six participants from the same population as in Experiment 1 took part in the experiment. Half of them were assigned to Group 1 and the other half to Group 2. None had participated in Experiment 1.

Materials. Twenty-eight line drawings depicting actions were used as target stimuli for Experiment 2 (a modified set based on the materials used in (Masterson & Druks, 1998) (see Appendix B for the list of stimuli). Fourteen of these pictures depicted an actor performing an intransitive action, and 14 depicted an actor performing an action on an object (a transitive action). Half of the actors depicted were male, and half were female. Each line drawing was used in 3 distractor conditions, for a total of 3 repetitions. The distractor conditions included: (a) semantically related verbs (28 items); (b) semantically unrelated verbs (28 items); and (c) a baseline condition (a string of 6 X's printed inside each picture).

Procedure. Participants in Group 1 were asked to name the pictures using simple sentences (e.g., He laughs) and participants in Group 2 were asked to use the 3 rd person singular form of the action name (e.g. laughs). All other aspects of the experiment were the same as Experiment 1.

Analysis. We analyzed naming latencies and error rates for both groups together. For the F1 analysis, we considered "utterance type" (sentence vs. single verb) as a between-subjects variable, and "type of verb" (transitive vs. intransitive) and "type of distractor" (semantically related vs. unrelated) as two within-subjects variables. For the F2 analysis, we considered "type of verb" a between item variable, and "utterance type" and "type of distractor" as within items variables.

Results

Mean response times and error rates as a function of type of distractor, type of verb and utterance type, are presented in Table 3. Semantically related distractors led to more errors than unrelated distractors [12% and 9.2% respectively; $F1\ (1, 36) = 5.34$, MSE = $p < .05$; $F2\ (1, 26) = 6.97$, $p < .05$]. Error rates did not depend on utterance type [$F1 < 1$; $F2\ (1, 26) = 1.52$ $p > .20$)] or type of verb ($F1$ and $F2 < 1$). Only one significant interaction was observed in the error rates analyses [type of verb and utterance type, $F1$ (1,36) = 7.68, MSE = .6090, $p < .01$; $F2$ (1,26) = 10.04, MSE = .6090, $p < .01$]. All the other interactions were not significant (all p's > .1).

Semantically related distractors led to longer naming latencies than unrelated distractors [F1 (1, 36) = 28.92, MSE = 187867, p < .001; F2 (1, 26) = 50.40, MSE = 13843, p < .001]. The main effects of utterance type, and type of verb were only marginally significant [utterance type: F1 (1, 36) = 2.39, MSE = 54117, p > .10; F2 (1, 26) = 145.18, MSE = 398757, p < .001; type of verb: F1 (1, 36) = 8.04, MSE = 5221, p < .001; F2 (1, 26) = 1.38, MSE = 3847, p >. 20]. This suggests that verbs named in isolation or as part of a sentence did not differ in how quickly they were named. It also suggests that transitive and intransitive pictures were named equally fast[vi].

Importantly, the interaction between type of distractor and type of verb was significant [F1 (1, 36) = 17.38, MSE = 11290, p < .001; F2 (1, 26) = 30.29, MSE = 8319, p < .001], revealing that the difference in the semantic interference effect observed for transitive (5 ms) and intransitive (40 ms) verbs was significant. Planned comparisons showed that the semantic interference effect for transitive pictures was not significant [F1 < 1; F2 (1, 13) = 2.14, MSE = 350, p > .10] while for intransitive pictures it was significant [F1 (1, 36) = 45.10, MSE = 29602, p < .001; F2 (1, 13) = 56.48, MSE = 21812, p < .001]. No other interactions were significant (all Fs < 1).

Discussion

The results of this experiment partially replicate those observed in Experiment 1: verb distractors semantically related to the named action increased response times in comparison to unrelated distractors. This effect was observed both when verbs were performed in isolation and when they were produced as part of sentences. However, a closer look at the data reveals that the semantic interference effect is only present when participants named intransitive verbs. The difference between semantically related and unrelated distractors for transitive verbs was not significant in either naming condition (sentences or isolated).

Caution must be exercised when interpreting the failure to observe a semantic interference effect for transitive verbs. Not only does this pattern of results contrast sharply with Experiment 1, but it also contrasts with the results observed by Schriefers et al. (1998). Thus, before drawing any conclusions from the lack of semantic interference effect for transitive verbs, it is reasonable to attempt to replicate the semantic interference effect observed in Experiment 1.

5. Experiment 3

Semantic interference effect in bare verb naming

The aim of this experiment is to replicate the semantic interference effect observed in Experiment 1. As in Experiment 1, participants were asked to name the pictures in gerundial form. This allows us to test whether the lack of an effect for transitive pictures in Experiment 2 is due to the different response formats between experiments. Furthermore, the verbs used in this experiment were different from those used in Experiments 1 and 2, allowing us to test the reliability of the semantic interference effect for both transitive and intransitive verbs. Finally, in this Experiment unlike in Experiment 1, the same verbs served as semantically related and unrelated distractors (see below), reducing the possibility of obtaining a semantic interference effect due to extraneous properties of the items used in the two conditions.

Method

Participants. Twenty participants from the same population as in the previous experiments participated here. None had participated in previous experiments.

Materials. Thirty-six line drawings were used as target stimuli (see Appendix C for the list of stimuli). Eighteen of the target pictures depicted an actor performing an intransitive action (e.g., running), and 18 depicted an actor performing an action on an object (a transitive action, e.g., cutting). Semantically related and unrelated distractors were identical in order to control for unintentional pairing effects between different sets of semantically related and unrelated distractors[vii]. All other aspects of the experiment were the same as Experiment 1.

Results and discussion

Error rates for each condition were statistically similar (5.0 % for the semantically related condition and 5.2 % for the unrelated condition; $F1$ and $F2 < 1$). There were no differences in error rates for type of verb, or for the interaction between type of verb and type of distractor ($F1$ and $F2 < 1$). Means per condition and error rates are reported in Table 3.

No significant effects were obtained in this experiment. Semantically related distractors led to comparable naming latencies as unrelated distractors ($F1$ and $F2 < 1$). Transitive pictures were named at the same rate as intransitive pictures [$F1\ (1, 19) = 3.25$, $MSE = 1231$, $p < .01$; $F2 < 1$]. The interaction between type of verb and type of distractor condition was not significant [$F1\ (1, 19) = 5.99$, $MSE = 2270$, $p < .05$; $F2\ (1, 34) = 2.29$, $MSE = 2042.941$, $p > .10$]. When responses to transitive and intransitive verbs were analyzed separately, there was no effect of the semantically related distractors in comparison to the unrelated distractors (For transitive picture naming: $F1\ (1, 19) = 3.58$, $MSE = 1464$, $p < .10$; $F2\ (1, 17) = 1.56$, $MSE = 1317.759$, $p = < .30$; For intransitive picture naming $F1\ (1, 19) = 2.34$, $MSE = 847.62$, $p < .20$; $F2 < 1$).

The results of this experiment contrast sharply with those of Experiment 1. In Experiment 1, naming latencies were slower for semantically related distractors than for unrelated distractors, whereas no differences were observed here. However, the results confirm the absence of a semantic interference effect for transitive verbs as observed in Experiment 2.

6. General Discussion

The goal of this study was to explore the semantic interference effect in the picture word interference paradigm as a tool to further study the processes involved in the production of verbs. We have reported three experiments in which participants were asked to produce verbs while ignoring the presentation of a semantically related or unrelated distractor verb. In Experiments 1 and 2 participants named the pictures more slowly when they were accompanied by a semantically related distractor than by an unrelated distractor (see Table 3). In contrast, in Experiment 3 naming latencies were independent of the type of distractor. Further inspection of the results of Experiment 2 revealed that the difference between semantically related and unrelated distractors was only reliable for intransitive verbs.

In the Introduction, we discussed some of the studies that have explored the semantic interference effect in verb production, and we argued that this effect seems to be less reliable than that observed in noun production. For example, Schriefers et al. (1998) observed a semantic interference effect only for verbs in the first position of the utterance and only when they were transitive: no semantic interference was obtained for intransitive verbs even when they were located in the first position in the utterance. Although Schriefers et al. explained the lack of semantic interference effect for intransitive verbs in terms of specific properties of German, recent experiments conducted in Spanish (Santesteban, 2000) and in Italian (Collina & Tabossi, personal communication), raise doubts about the reliability of the semantic interference effect for verbs, regardless of language specific properties. The studies conducted in Spanish and Italian failed to observe any systematic semantic interference. Given these contrasting results, before drawing any conclusion about the processes by which verbs are selected, it is important to clarify the contexts in which a semantic interference effect for verbs is obtained.

In the following, we entertain some possible explanations for the inconsistency of the semantic interference effect with verbs. Because the semantic interference effect relies on the semantic (categorical) relationship between the word produced and the distractor, the lack of semantic interference for verbs may be due to the way verbs are organized semantically. The semantic interference effect seen in object naming is restricted to those cases in which the distractor word and the picture are categorically related, that is, when two words belong to the same semantic category. For example, semantic interference is seen when naming a picture of a 'cat' and the distractor is 'dog'. If the response and distractor are merely associates (e.g. 'mouse'/ 'cheese') no semantic interference is seen (Alario, Segui, & Ferrand, 2000; Lupker, 1979). However a semantic relationship between two words does not guarantee semantic interference effects. For example, the production of 'animal' to the picture 'cat' when the distractor word is 'dog' (a subordinate member of the response word 'animal') is facilitated rather than inhibited by the distractor word (Glaser & Glaser, 1989). It seems that in order to observe semantic interference, not only do distractor words and responses need to belong to the same semantic category, but they also need to belong to the same level of categorization. Finding words that are related to each other both in terms of category and level within category is a simpler task for nouns than for verbs. For example, table and chair clearly belong to the same category (furniture) and are at the same level within the category. Did the materials we chose across the three experiments follow this relationship?

The way verbs are conceptually related to one another is not entirely clear (Miller & Fellbaum, 1991). Consider the verbs walk, run, and jog. Is jog a subordinate member of the category run, where walk belongs to a different category? Or are run and jog co-ordinate members (such a table and chair) of the same category as walk? This example illustrates that the selection of the right distractors for verbs is very difficult. Materials may be satisfying some conditions (response and distractor part of the same category) and failing other criteria (response and distractor not at the same level of categorization). Therefore, it is possible that the inconsistency of the semantic interference effect is due to the complex semantic organization of verbs where semantic categories are difficult to distinguish[viii].

The difficulty in choosing appropriate semantic distractors should affect both transitive and intransitive verbs, and this is the pattern that has been seen across studies. However, we speculate that the consistently smaller semantic interference effect seen here for transitive verbs may be due to a separate but related difficulty in choosing appropriate semantic relationships for transitive verbs. It is possible that the determination of semantic relationships for intransitive and transitive verbs is based on different properties. That is, two intransitive verbs are semantically related by virtue of the action they refer to, in the same way that two nouns are semantically related by virtue of the category they belong to. In comparison, for transitive verbs the semantic relationship can be based on the action or the object that is being acted upon. For example, for the transitive verb shuffle (cards), we could choose a verb that is semantically related to the object deal (cards) or related to the action whisk. The question is then whether these two types of relationships lead to the same interference pattern. A lack of effect or even facilitation in one case could potentially mask a semantic interference effect overall for transitive verbs. Although the semantic organization and level of categorization are factors that affect the semantic interference effect for all verbs, transitive verbs may be more susceptible.

This scenario is even more complicated when we consider recent results that suggest that the choice of the unrelated distractor may also be particularly important in creating semantic interference. Costa, Mahon, Savova, & Caramazza (in press) have identified another variable that affects the magnitude of the interference produced by a distractor that is independent of semantic relatedness. In that study, Costa et al. observed that the overall interference produced by a distractor word depends among other things, on whether the distractor word and the response share the same level of categorization. When participants are required to name pictures using basic-level names (e.g., dog), unrelated basic-level distractors (e.g., truck) interfere more than unrelated category-level distractors (e.g., vehicle). The complementary pattern of results is observed when participants are required to name the pictures using category-level names (e.g., animal). Thus, it appears that the level of categorization of a distractor word in relation to that of the response word modulates the magnitude of the interference created by the distractor. This variable is relatively easy to control in the case of nouns, because the different levels of categorization are quite distinct (e.g., dog and truck are at the same level of categorization while dog and vehicle are not). However as discussed above, when considering the semantic representation of verbs it is more complicated to establish the different levels of categorization. It appears that the semantic organization of verbs in terms of levels of categorization is less transparent. This raises the question of whether the paired distractors presented with a given picture share the same level of categorization. If they do not share the same level of categorization, varying levels of interference or even facilitation might be produced from picture to picture.

In short, the semantic interference effect seems to be a complex phenomenon where several variables may contribute to its detection. Therefore, a better understanding of how verbs are semantically related is needed in order to evaluate the cause of the transient semantic interference effect.

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APPENDIX A: Stimuli for Experiment 1. Naming verbs alone: Gerundial verbs.

PICTURE	Distractors set 1	
Transitive Verbs	Semantically Related	Semantically Unrelated
CARRYING	dragging	flipping
CUTTING	tearing	mixing
FLEXING	stretching	climbing
KICKING	hitting	selling
KISSING	hugging	pinching
PUNCHING	slapping	tilting
READING	writing	keeping
ROLLING	throwing	feeding
ROWING	sailing	leaping
SHUFFLING	dealing	riding
SQUEEZING	crushing	popping
Intransitive Verbs		
FISHING	hunting	packing
KNEELING	sitting	reaching
KNOCKING	pounding	blushing
LEANING	standing	trying
LISTENING	peeking	skating
POINTING	clapping	erupting
SMILING	laughing	flying
SNEEZING	coughing	crumbling
WALKING	running	living
WHISPERING	yelling	digging
WINKING	squinting	scrawling

APPENDIX A continued.

PICTURE	Distractors Set 2	
Transitive Verbs	Semantically Related	Semantically Unrelated
CARRYING	holding	turning
CUTTING	slashing	whirling
FLEXING	clenching	blurring
KICKING	smashing	weaving
KISSING	nuzzling	weighing
PUNCHING	scratching	shaving
READING	teaching	catching
ROLLING	bouncing	biting
ROWING	driving	watching
SHUFFLING	whisking	ironing
SQUEEZING	wringing	combing
Intransitive Verbs		
FISHING	golfing	barking
KNEELING	squatting	snowing
KNOCKING	banging	diving
LEANING	slumping	gleaming
LISTENING	staring	sleeping
POINTING	waving	ringing
SMILING	frowning	floating
SNEEZING	yawning	galloping
WALKING	jogging	juggling
WHISPERING	singing	fighting
WINKING	glaring	dripping

APPENDIX B: Stimuli for Experiment 2 (Group 1): Simple sentences, and (Group 2): Naming Verbs Alone, 3rd personal singular verbs.

	Transitive Verbs	Semantically Related	Semantically Unrelated
HE	CARRIES (a pumpkin)	throwing	ending
HE	DRAWS (a racket)	copying	yanking
SHE	DROPS (a glass)	lifting	washing
HE	IRONS (a shirt)	cleaning	tearing
SHE	KICKS (a drum)	hitting	eating
SHE	KISSING (a horse)	nuzzling	stashing
SHE	LIGHTS (a candle)	burning	pushing
HE	OPENS (a door)	shutting	mixing
HE	PEELS (an orange)	chopping	flipping
SHE	PETS (a cat)	hugging	banging
SHE	READING (a book)	writing	turning
HE	SMELLING (a flower)	touching	drinking
SHE	TICKLES (a dog)	scratching	guarding
HE	WATERS (a plant)	spraying	drowning
	Intransitive Verbs		
SHE	CRAWLS	running	reaching
SHE	CRIES	smiling	riding
SHE	DANCES	stumbling	melting
SHE	KNEELS	sitting	playing
HE	LAUGHS	screaming	flowing
HE	LEANS	standing	moving
HE	MARCHES	skipping	tilting
SHE	POINTS	clapping	erupting
HE	SINGS	whistling	blushing

SHE	SKATES	sledding	slouching
HE	SLEEPS	resting	flying
HE	SWINGS	climbing	nodding
SHE	WALKS	jogging	pouting
HE	YAWNS	burping	squeaking

APPENDIX C: Stimuli for Experiment 3. Naming verbs alone: Gerundial verbs.

PICTURE	Distractors	
Transitive Verbs	Semantically Related	Semantically Unrelated
CARRYING	dragging	scratching
CATCHING	tossing	shutting
DRIVING	piloting	pruning
DROPPING	lifting	washing
IRONING	washing	lifting
KICKING	punching	piloting
KISSING	nuzzling	stabbing
OPENING	shutting	tossing
PAINTING	sculpting	nuzzling
PEELING	chopping	hugging
PETTING	hugging	chopping
PLANTING	pruning	punching
PUSHING	holding	writing
READING	writing	holding
SEWING	weaving	tasting
SHOOTING	stabbing	sculpting
SMELLING	tasting	weaving
TICKLING	scratching	dragging

APPENDIX C continued.

PICTURE	Distractors	
Intransitive Verbs	Semantically Related	Semantically Unrelated
CRAWLING	skipping	floating
CRYING	smiling	dreaming
DIVING	floating	waving
FISHING	hunting	smiling
KNEELING	sitting	running
KNOCKING	ringing	begging
LAUGHING	screaming	sliding
MARCHING	jogging	burping
POINTING	waving	skipping
PRAYING	begging	ringing
SINGING	whistling	wading
SKATING	sledding	squinting
SLEEPING	dreaming	hunting
SWIMMING	wading	whistling
SWINGING	sliding	screaming
WALKING	running	sitting
WINKING	squinting	jogging
YAWNING	burping	sledding

Foot notes

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[i] Throughout this article, single quotation marks will be used to denote pictures and distractors, double quotation marks for lexical representations, and capitalization for conceptual representations.

[ii] According to this explanation, the mechanism that produces the semantic interference effect is slightly more complicated, since the distractor word also sends activation to the lexical node corresponding to the picture's name ("table").

[iii] In Roelofs' experiments the transitivity of the verb was not a controlled factor. For discussion of the role of verb transitivity in lexical selection see Schriefers et al. (1998).

[iv] In the experiment, participants were required to produce S(O)V and VS(O) utterances intermixed.

[v] The transitivity of a distractor word was determined by its most frequent dictionary definition.

[vi] For this and subsequent experiments, the baseline condition was significantly faster than the combined semantically related and unrelated conditions. This analysis will not be separately reported.

[vii] Using unrelated distractors that differ from related distractors has merits. Each semantically related and unrelated pair can be maximally different semantically, and optimally matched for other criteria (letter length, syllable, etc.). As explained, however, using identical related and unrelated distractors also has advantages.

It has been argued that semantic categories for verbs are more difficult to establish in comparison to nouns due to the shallow nature of verbs' semantic hierarchy (e.g., many potential categories with few members) (Miller & Fellbaum, 1991) and the added contribution of verbs' syntactic properties in defining categories (Levin, 1993) among other reasons.