ORIGINAL ARTICLE

CUMULATIVE SEMANTIC INHIBITION IN SPANISH VERB PRODUCTION

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▪ ABSTRACT: This paper reports an experiment designed to assess the occurrence of lexical interference in verb production in Spanish. Using the semantic competitors paradigm (HOWARD *et al*., 2006), we show that the higher the number of verbs of the same category produced, the longer it takes to retrieve another verb of the same category in a picture naming task. According to our data, the production of a related verb delays the naming of a new member of the category by 20 ms., which means that, as is the case with nouns, semantically related verbs compete for selection. These results support the statement that, regardless their differences with respect to semantic representation and organization, verb and noun selection are guided by the same principles. Methodologically, our findings confirm that the paradigm is highly sensitive to semantic proximity effects, in terms of either categories or features. In light of these findings, we discuss the reasons why previous studies exploring semantic relatedness effects in verb production, most of them using the picture-word interference paradigm, have led to inconclusive and sometimes contradictory results.

▪ KEYWORDS: Semantic inhibition. Spoken word production. Verbs. Picture naming. Lexical interference.

Introduction

The effects of semantic similarity on word production have been widely researched and are well documented in the literature. For example, it is well established that

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naming a picture presented simultaneously with a semantically related word (e.g. GLASER; DUNGELHOFF, 1984; SCHRIEFERS; MEYER; LEVELT, 1990) or naming a picture that is semantically related to a word produced in response to a definition some trials earlier (e.g. WHEELDON; MONSELL, 1994) is slower as compared to an unrelated condition. This kind of effects has often been used to discuss semantic organisation principles and lexical selection processes. Nevertheless, as robust and useful as they may have been in the study of noun production, semantic effects have not been equally fruitful in the field of verb production. As a matter of fact, semantic effects in verbs have proved to be rather evasive so far: the studies are scarce and the results are inconclusive.

One reason why semantic interference effects are harder to find with verbs might be that verbs and nouns seem to be represented differently in the brain (e.g. SHAPIRO; MOO; CARAMAZZA, 2006), which could lead to differences in the way they are accessed from the lexicon (e.g. HILLIS; TUFFIASH; CARAMAZZA, 2002). Although the nature of grammatical category-specific effects is still debated, most of those reported in the literature seem to arise at a post-lexical level (morpho-syntax) (see VIGLIOCCO; VINSON; DRUKS *et al*, 2010 for a review). If grammatical class is not necessary as an organisational principle of lexical knowledge, there is no reason to expect differences in the way nouns and verbs are accessed from the lexicon.

A more plausible reason could be that the semantic relationships between verbs are more complex than those between nouns (e.g. verbs form less well defined categories or share features to a lesser extent or in more general ways; e.g. PLAUT, 1995; VINSON; VIGLIOCCO, 2008; VINSON, 2009), making them harder to define because we do not have enough knowledge about the relevant criteria (e.g. SCHNUR; COSTA; CARAMAZZA, 2002; TABOSSI; COLLINA, 2002). In this case, the lack of an effect in some studies might simply be due to the fact that the paradigm used to test the occurrence of semantic interference in verbs might not have been sensitive enough to detect such effects because either representational complexity or descriptive difficulty. The aim of our study was to assess the presence of semantic interference in verb production by means of a paradigm that is known to be sensitive to a large spectrum of categorical or featural semantic relationships (e.g. ALARIO; MOSCOSO DEL PRADO MARTÍN, 2010), namely, the cumulative semantic interference paradigm (e.g. HOWARD *et al.*, 2006).

In the introduction we will first give a brief overview of the available evidence regarding semantic interference effects in verb production and discuss a potential problem arising in the use of picture-word interference effects as a proxy for lexical selection. Secondly, we will introduce the paradigm we relied on and the reasons why it is believed to index lexical selection. We will also present recent evidence showing that it is highly sensitive to effects of semantic interference. Finally, we will argue that, if nouns and verbs are accessed from the lexicon in similar ways, they should both elicit semantic interference effects in a sufficiently sensitive paradigm that taps into lexical selection.

Previous Research into Semantic Interference Effects in Verb Production

By far the most used paradigm to investigate the effects of semantic interference in verb production has been that of picture-word interference paradigm (e.g. GLASER; DUNGELHOFF, 1984; SCHRIEFERS; MEYER; LEVELT, 1990). Participants have to name pictures while ignoring a simultaneously presented written word. The picture-word interference effect refers to the finding that participants are slower in naming the picture when the word is semantically related to the target picture than when there is no such relationship. This effect has been interpreted as reflecting competition between different lexical candidates: we know that whenever a speaker wants to express a concept through speech, semantically related concepts also become active and spread some activation to their lexical representations. The mechanism responsible for selecting the intended word is thought to operate taking account of the level of activation of all potential candidates, and eventually selecting the word with the highest level of activation (e.g. DELL, 1986; LEVELT; ROELOFS; MEYER, 1999). Thus, if the activation level of competing candidates is boosted as in the picture-word interference paradigm, selection of the correct word is harder. While the picture-word interference effect is largely documented in noun production, in the case of verbs the results are less clear.

In a study using the picture-word interference paradigm, Roelofs (1993) obtained a robust semantic interference effect in bare verb naming in Dutch. Naming latencies for a verb were longer when the distracter was a semantically related verb than when it was an unrelated verb. In Roelofs's view, the competition between candidates is responsible for this effect, results suggesting that verb selection is guided by the same principles as the selection of nouns.

However, subsequent studies failed to obtain similar results and cast doubt on Roelofs's interpretation. In spite of their previous work replicating Roelofs's findings (TABOSSI; COLLINA, 1999), Tabossi and Collina (2002) failed to obtain interference effects in an experiment with Italian verbs. In other studies, semantic interference has been found only in some of the experimental conditions, and there does not seem to be systematicity with regard to what these conditions are. For instance, using an extension of the picture-word interference paradigm for sentence production in German, Schriefers, Teruel and Meinshausen (1998) found the semantic relatedness effect only for utterances with transitive verbs in initial position; no interference was observed for transitive verbs in final position or for intransitive verbs, regardless of their place in utterances. Additionally Schnur, Costa and Caramazza (2002) found a semantic interference effect for intransitive verbs only.

However, there are a few studies that confirm the occurrence of semantic effects under strictly controlled conditions (BELKE; MEYER; DAMIAN, 2005; VIGLIOCCO; LAUER *et al.*, 2002; VIGLIOCCO; VINSON; LEWIS *et al*., 2004). Vigliocco and Lauer *et al*. (2002), for example, tested the occurrence of interference effects in a cyclic naming task for both objects and actions, in blocks of semantically very similar, somewhat similar or dissimilar stimuli. They succeeded in finding semantic effects both for objects

and actions modulated by the semantic distance between the exemplars. Based on this graded nature, it was suggested that semantic effects could be better accounted for in terms of featural overlapping. Also, Collina and Tabossi (2007) obtained semantic interference between verbs under the classical picture-word interference paradigm using the Italian translations of the stimuli employed by Roelofs (1993). While these studies were able to discard some of the potential causes of the discrepant results (for instance response set; COLLINA; TABOSSI, 2007) and show the importance of the selection of materials (e.g. COLLINA; TABOSSI, 2007; VIGLIOCCO; LAUER *et al*., 2002), they did not settle the issue. Nonetheless, most researchers seem to concur with the conclusion reached by Schnur, Costa and Caramazza (2002), that the inconsistency in semantic interference effects in verb production can be attributed to a series of factors, the most important being the complex semantic organisation of verbs, where categories can be difficult to distinguish and categorization levels cannot be established easily.

Aside from the inconclusive results, the picture-word interference paradigm is currently being subject to criticism by researchers who have argued that it does not tap into lexical processing but instead reflects the speed with which a response can be excluded from an output buffer in the parser (e.g. JANSSEN *et al.*, 2008; MAHON *et al.*, 2007). The reasoning behind this criticism is that written words are processed in a faster and more automatic manner by the linguistic system than pictures are. Thus, in the picture-word interference paradigm, although subjects are instructed to ignore the written words, they cannot help processing them. Given that the response required by the task is the name of the picture, the processing of the written word has to be detained at some point in order for the speaker not to articulate the wrong word. The locus of this response exclusion has been situated near the end of the speech production process, in a response buffer that takes into account all the relevant criteria for the desired response to be produced. One of these criteria is modality and another is semantics. Thus, in the case of written distracter words that are semantically related to the target, the distracter is harder to exclude because while the modality is clearly incompatible with the response, some aspects of the semantics not.

In sum, the studies investigating semantic interference effects in verb production have led to inconclusive and sometimes contradictory results, which is most likely due to the complex semantic organization of verbs or to descriptive difficulties. In addition, the paradigm used in the majority of these studies –picture-word interference– might not be informative about lexical processing. The issue thus calls for a new, fine-grained approach.

Cumulative Semantic Interference in Picture Naming

Howard and colleagues (2006) introduced a new paradigm of semantic interference thought to reflect processes of lexical selection (e.g. COSTA; STRIJKERS *et al.*, 2009; HOWARD *et al*., 2006; but see NAVARRETE; MAHON; CARAMAZZA, 2010). In this

study, participants had to name pictures of objects belonging to 24 different semantic categories that were intermixed in the stream of pictures. The crucial manipulation was the ordinal position in which a given picture was presented within its category. The authors observed a cumulative and linear increase in RTs with each ordinal position, meaning that every time participants named a picture belonging to the same semantic category as a previously named picture (e.g. naming "lion" after having named "tiger") the response was a little bit slower (30 ms.). They argued that the cumulative semantic inhibitory effect is due to competition processes at the lexical level. When a picture is presented for naming, the semantic nodes corresponding to semantically related words also become active, although to a lesser degree, and spread activation to their lexical nodes (sharing of semantic activation). Those related lexical candidates that were named previously are given a head start in this process due to persisting activation (priming). Thus, assuming that the selection mechanism takes into account the level of activation of all active lexical candidates (selection by competition), the result is an increasingly slower process. Note that this effect cannot be accounted for in terms of response exclusion since a) only one stimulus is presented at a time; and b) the response exclusion hypothesis does not predict cumulative effects. This effect seems to be very sensitive to different strength in semantic relationships. The study of Howard *et al*. (2006) included, as mentioned above, 24 different semantic categories. As highlighted by Alario and Moscoso del Prado Martín (2010), there was considerable diversity in how these categories were defined, ranging from very general (e.g. furniture) to very specific (e.g. computer equipment, headgear). In an extended analysis of the data set of Howard and colleagues, Alario and Moscoso del Prado Martín found that there was systematic variability in the amount of inhibition between categories, but that all 24 categories included in the experiment contributed to the cumulative inhibition effect. So far, the paradigm has proven to be productive and sensitive enough to yield robust results in different domains of lexical processing research (see HARVEY; TRAUT; MIDDLETON, 2019) on aphasic word production; Oppenheim (2018) on newly acquired words; Runnqvist *et al*. (2012) on bilingual speech production, among others). Thus, this paradigm has the potential to solve the methodological difficulties (lack of sensitivity) and the theoretical problems (failure to reflect lexical processing) problems of previous research into semantic interference in verb production.

Is there Cumulative Semantic Interference in Verb Production?

In the context of the inconclusive and problematic results obtained in previous studies, the robustness of the evidence obtained for nouns with the cumulative semantic interference paradigm renders it interesting to explore the less well-known domain of verb production. This paper reports an experiment designed to test the occurrence of the effect obtained by Howard *et al*. (2006) for verb production in Spanish. A positive result would allow us to conclude that a) the absence of an effect in previous studies is

most likely related to the insufficient sensitivity of the experimental paradigm to effects in categories with more complex or less well defined structures; and b) the positive effect obtained in other studies using the picture-word interference paradigm can be replicated in a paradigm that is thought to tap into lexical selection and whose results cannot be explained in terms of response exclusion. This would mean that the selection process for verbs and nouns is similar.

Method

Participants

37 native Spanish speakers aged 21-40 (16 women, 21 men) drawn from students and staff of the School of Philosophy and Letters and the School of Science of the University of Buenos Aires volunteered as participants.

Materials

Seventy-one line drawings were selected (see Appendix 3 for samples). Twenty-five of the 71 belonged to 5 different categories: manner of motion, (animal) sound emission, (non agentive) substance emission, contact, and transfer,[1] with 5 items in each category (see Appendix 1 for the complete list). The fact that no further categories were taken into account was motivated by the scarcity of related items with a similar semantic behaviour. In addition, 40 fillers and 6 practice items were selected, bearing no semantic relations with the experimental verbs.

Design and Procedure

After the first 6 practice items, participants were presented with a sequence of 65 pictures for naming. Following the procedure of Howard *et al*. (2006), five exemplars from each of the categories under study were embedded within the sequence. Pictures belonging to the same category were separated by a lag of 2, 4, 6, or 8 intervening items; each interval was present once for every category. Hence, 23 items intervened between the first and last items in each category.

Thirty-seven different lists were created with the following constraints. Items intervening between members of a category might either be drawn from other

[1] Categories were chosen following Levin (1993) and Levin and Rappaport (1995). The inclusion of verbs within each category was done using the semantic classification of the ADESSE database (Base de datos de verbos, alternancias de diátesis y esquemas sintáctico-semánticos del español [ADESSE]. Available at http://adesse.uvigo.es). A subjective rating was also performed in which 24 participants rated the semantic relationship between the words in each category through a Likert scale ranging from 1 to 7. Only items with an average equal to or above 6 were included.

experimental categories or be fillers. The position of filler items and the order of the categories in the sequence of 65 items were randomly assigned, except that only fillers could occur in the first five positions of the sequence.

Lag order was pseudorandomised, and effort was taken to ensure that each of the 24 possible lag orders occurred a similar number of times across all lists. Likewise, different lag orders appeared in a given ordinal position (2 to 5) a similar number of times. Importantly, in order to avoid item-specific effects, we ensured that every experimental item appeared a similar number of times (between 7 and 8 times for all lists) in each ordinal position within its category.

Stimuli were black-and-white line drawings sized 300 x 300 pixels and presented centred on a 1024x768 pixel screen in 32 colours. The experiment was run in DMDX (FORSTER; FORSTER, 2003). Each picture was preceded by a visual cue (an asterisk) for 500 ms, followed by a blank screen for 250 ms. RTs were recorded by DMDX's voice key from the onset of the picture. The picture remained on the screen until detection of a response or for a maximum of 2000 ms. and was followed by a new blank screen for 500 ms. The DMDX-recorded RTs were checked for accuracy and timing (properly triggered voice key) using CheckVocal (PROTOPAPAS, 2007).

Subjects were instructed to name each picture as rapidly and accurately as possible, describing what the actor shown was doing. Thus, they had to produce a verb. There was no familiarization phase, nor feedback throughout the experimental session, after the practice set. During this training, feedback was given if required to achieve the expected answer. The experiment lasted approximately 12 minutes.

Data Analysis

Two types of responses were excluded from the analysis: naming errors and omissions. Semantically non related verbs and words from other lexical classes were considered naming errors. Latencies of more than 2000 ms. (responses initiated after the picture disappeared) were considered omissions. Acceptable alternatives (e.g. "entregar" instead of "dar;" see Appendix 1 for the full list of items and acceptable alternatives) were considered right answers and included in the analysis.

Data were analysed for the number of unrelated items between the occurrence of two items in a category (lag) and for its ordinal position within the category. Following the protocol of Howard *et al*. (2006), separate analyses were carried out treating subjects and categories as random factors, leading to F1 and F2 statistics.

Results

In analysing the data, naming errors (7.46%) and omissions (6.38%) were excluded. In total, excluded data accounted for 13.84% responses. Including acceptable alternatives, the analysis was performed over 797 data points. For each

removed data point, we corrected the position of the other items corresponding to the same category, so that the analysis was performed taking into account the actual position of each item within its category. Naming errors consisted mainly of lexical class substitutions ("a baby"; "a throw"; "hangover"), semantically non-related verbs ("have fun" for walk; sometimes due to visual errors: "clean" for bleed) or comments on the picture ("he's having a bad time"). Errors and omissions were uniformly distributed across categories.

The two effects we wanted to identify on response times were (a) that of the ordinal position within a category and (b) that of the lag between members of the same category.

The experiment's design minimised but did not eliminate the confound between the ordinal position of an item within a category and its serial position in the experiment. Due to the total number of stimuli and categories and given that the last category had to begin at least 23 positions before the end of the experiment, the highest positions tended to be concentrated at the end of the experimental lists. In order to neutralise any possible contribution of serial position, we decided to adjust subjects' RTs for any linear changes in RT (either speeding up or slowing down) over the course of the experiment. All analyses were conducted on both linearly-adjusted and non-adjusted RTs.

First of all, we quantified absolute position effects within the experiment, making a linear regression of RTs with respect to position. The resulting gradient was 0.48 (-0.7765, 1.7457), $F = 0.5689$, $p = .4509$. In order to separate both effects, RTs were adjusted in terms of serial position. This adjustment should therefore tend to reduce position effect within a category. Table 1 shows latencies for each ordinal position and lag, for both uncorrected and corrected data.

Table 1 – Naming Reaction Times, by Ordinal Position within the Category and Lag

A	Ordinal Position											
Lag	1		2		3		4		5		*Mean*	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
2			1091	44	1045	36	1111	56	1067	45	1076	22
4			1039	45	1092	52	1064	38	1078	41	1067	22
6			1045	56	1037	33	1077	44	1110	48	1066	22
8			1038	46	1101	55	1089	39	1189	52	1101	24
Mean	1021	21	1053	24	1068	22	1085	22	1104	23		

B	Ordinal Position											
Lag	1		2		3		4		5		*Mean*	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
2			1094	44	1047	36	1108	56	1063	45	1076	22
4			1041	45	1093	52	1063	38	1074	41	1066	22
6			1045	55	1036	33	1076	44	1107	48	1065	22
8			1039	46	1100	55	1087	39	1186	52	1100	24
Mean	1025	21	1055	24	1068	22	1083	22	1101	23		

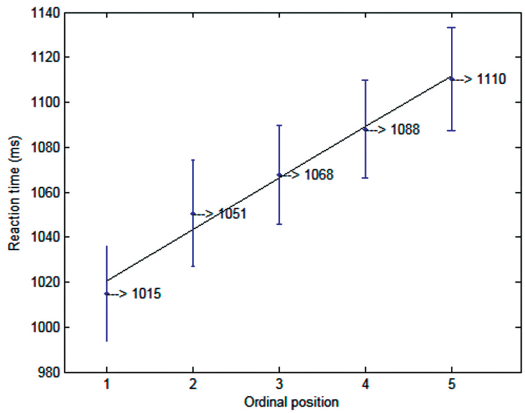
Note. Section A shows uncorrected RTs. Section B shows RTs corrected for linear changes over the experiment. *Mean* and *Standard deviation* are expressed in milliseconds.

Source: Authors' elaboration.

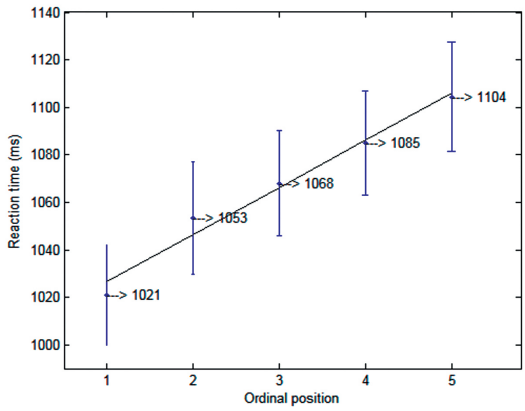
Analysing uncorrected and corrected RTs for linear changes, we studied lag and ordinal position effects on naming latencies. Table 1 shows how mean RTs increased monotonically as a function of ordinal position (column means) but were unaffected by lag (row means). This holds for both the uncorrected and the corrected data. As is clear from Figure 1 (A), the analysis of uncorrected data showed an effect of ordinal position, even if it was significant only in the by subjects analysis (by subjects, gradient = 25 (9.33,40.6), $F1(_{1,184}) = 9.9166$, $p = .0019$, $MSE = 23264.49$; by categories, gradient = 22.1 (-9.99,54.2), $F2(_{1,24}) = 2.0305$, $p = .1676$, $MSE = 12053.79$), which holds for corrected data as well (by subjects, gradient = 22 (6.34,37.7), $F1(_{1,184}) = 7.6796$, $p = .0062$, $MSE = 23354.38$; by categories, gradient = 19.2 (-13,51.3), $F2(_{1,24}) = 1.5220$, $p = .2298$, $MSE = 12056.95$), as is evident in Figure 1 (B). On the other hand, the analysis showed no significant lag effect (uncorrected data: by subjects, gradient = 5.69 (-6.38,17.8), $F1(_{1,147}) = 0.8674$, $p = .3532$, $MSE = 27612.25$; by categories, gradient = 3.61 (-19.7,26.9), $F2(_{1,19}) = 0.1056$, $p = .7490$, $MSE = 12313.02$; corrected data: by subjects, gradient = 5.38 (-6.69,17.4), $F1(_{1,147}) = 0.7757$, $p = .3799$, $MSE = 27599.13$; by categories, gradient = 3.31 (-20,26.6), $F2(_{1,19}) = 0.0888$, $p = .7691$, $MSE = 12328.11$).

Figure 1 – Figure A shows ordinal position effect on latency for uncorrected data for linear changes. Figure B shows ordinal position effect on latency for corrected data for linear changes. Error bars correspond to the standard error.

A.



B.



Source: Authors' elaboration.

In sum, our results replicate Howard *et al.*'s findings (2006) for nouns, showing that the higher the number of verbs of the same category produced previously, the longer it takes to retrieve another verb of the same category in a picture naming task, irrespective of the number of intervening unrelated items (lag).

Discussion

In this study we wanted to assess the presence of semantic interference in verb production. We hypothesized that previous inconsistencies in such effects could be explained in term of either a more complex semantic organization of verbs as compared to nouns or the difficulty in defining semantic categories of verbs accurately, complicating the detection of semantic interference. We conducted an experiment within a paradigm known to be sensitive to a large spectrum of categorical or featural semantic relationships: the cumulative semantic interference paradigm introduced by Howard and colleagues (2006). In this experiment, participants had to produce verbs conjugated in the third person present in response to pictures representing actions. Within the stream of pictures three variables were manipulated: a) semantic category membership; b) ordinal position of a given member within its category; and c) lag between ordinal positions.

Due to the numerous difficulties that verb studies had encountered in reproducing the effects verified in nouns, the design of our study favoured, in the selection of materials, the control of the variables that could be relevant. In addition to belonging to the same category, defined according to the ADESSE base, it was sought, based on a subjective assessment survey, that the selected stimuli had a maximum semantic proximity. Additionally, we controlled for the level of categorization, that is to say that none of the members of the category could be considered superordinate or subordinate with respect to another (COSTA; MAHON *et al*., 2003). In addition, the maximum distance between categories was sought, in order to avoid overlaps (that is, that an item of a category could be a competitor with respect to another of a different category). We also controlled for the syntactic behaviour. Although they are largely predictable from semantic properties, we independently verified that the verbs in a category showed equivalent selectional properties. These restrictions allowed to build a very limited set of materials. Replicating previous studies, we found that, within a given category, naming latencies increased 20 ms. with each ordinal position, and this effect was independent of the number of intervening trials (lag). The magnitude reported in the literature regarding nouns is around 30 ms. per item.

Our experiment is, so far, the first to verify cumulative effects of semantic competitors for verbs. It is, on the other hand, one of the firsts to confirm the validity of the effect in Spanish, regardless of category.[2] The fact that verbs are susceptible to interference from semantic competitors thus constitutes strong evidence that words in this class are selected under competition.

The occurrence of this cumulative interference effect due to the previous recovery of other semantically related words can only be explained under the assumption that three properties are essential to the speech production system (HOWARD *et al*., 2006).

[2] The effect of cumulative semantic inhibition for nouns in Spanish was proven by a study of our authorship. See Sevilla, Martínez-Cuitiño & Shalóm (2008). García Castro et al. (2008) also encountered priming effect of semantic competitors for nouns in Spanish and Catalan.

First, there is *coactivation* at the semantic level: the semantic nodes corresponding to words related to the target you are trying to produce are activated simultaneously, although to a lesser extent than the target. Secondly, there is *priming*: the activation of a produced item is sustained over time, even if other words are selected during that period. Finally, there is *competition* in the system: the activation of related candidates affects the subsequent selection of a target making it slower and, predictably, more prone to errors. In other words, the results of Howard *et al*. (2006), later confirmed by several works, including the one presented here, demonstrated that the semantic inhibition effect described by Wheeldon and Monsell (1994) is a consequence of competition. It is also a uniformly accepted conclusion from these studies that competence is the result of the facilitation (that is, the sustained activation) of representations of semantically related words that have been accessed before.

Thus, at the theoretical level, the most obvious implication of our results is that lexical selection processes for verbs and nouns seem to obey similar principles. Although this might not be that surprising, the main contribution of our study is that it clears the doubts cast by the inconclusive data from previous studies.

At the methodological level, the fact that we found an effect of semantic interference in an experiment including a quite diverse set of verbs provides additional evidence that the cumulative semantic interference paradigm is highly sensitive to relationships between semantic features or categories (e.g. ALARIO; MOSCOSO DEL PRADO MARTÍN, 2010). In light of these results, caution should be exercised when drawing conclusions from the null results stemming from other paradigms that are less sensitive to such relationships. This also holds true for those null results obtained in the context of positive results we mentioned in the introduction (e.g. effects for transitive or intransitive verbs only; SCHNUR; COSTA; CARAMAZZA, 2002; SCHRIEFERS; TERUEL; MEINSHAUSEN, 1998). As shown by Alario and Moscoso del Prado Martín (2010), it is the case that, depending on the definition of a category or the strength of the relationship between its members, there is systematic variability in the amount of semantic interference. Thus, it is possible that the effects of categories with a small amount of inhibition become invisible with a less sensitive manipulation. Given the difficulty in defining categories in the domain of verbs –be it descriptive or due to a complex representational structure–, this variability could account for the inconsistent results for semantic interference effects in verb production.

Although it appears that the cumulative semantic interference paradigm is more suitable than the picture-word interference paradigm to test effects of semantic relatedness, it is worth to note that both paradigms quite consistently elicit the same pattern of results. Thus, even though these effects could have two independent sources leading to a similar behaviour, it seems more parsimonious to assume that previous positive results from the picture word interference paradigm actually tell us something about lexical processing and not only about response exclusion.

Following Howard's *et al*. (2006), our study uses semantic inhibition as a proxy to understand lexical selection mechanisms, and it does not commit to a theory about

how conceptual and semantic knowledge about verbs is organized. In fact, although lexical access is similar, it may still be the case that lexico-semantic representations or the relationship between them is different for verbs and nouns. As we pointed out, although the effect of cumulative interference is addressed here as it indicates the selection under competition at the lexical level, in the interpretation of the results it is necessary to contemplate that the inhibition originates in the first instance in the co-activation of semantic related items in the conceptual level. In this sense, when weighing the results with respect to those of previous studies, carried out with nouns, the potential existence of differences in the conceptual knowledge of events and objects must be taken into account.

There are many reasons why nouns and verbs may differ regarding their lexico-semantic representation, two of them being the level of concreteness (verbs tend to be more abstract than nouns; e.g. VINSON; VIGLIOCCO, 2008) and the level of individuation (while most nouns are separable entities, verbs are usually not; e.g. SHAPIRO; MOO; CARAMAZZA, 2006). This could presumably lead to more diffuse categories or weaker links between features.

However, it is equally plausible that the semantic complexity of verbs is only descriptive in nature, which does not preclude representational differences. For example, it might be the case that verbs are related in terms of motor aspects whereas relations between nouns are mainly based on visual features (e.g. KHADER *et al.*, 2010). In this scenario, the complexity of both categories could be similar, but the relevant criteria for defining semantic relationships would be different. Future research should aim at elucidating whether the semantic complexity attributed to verbs is a real psychological phenomenon or a descriptive difficulty. A highly sensitive paradigm like the cumulative semantic interference paradigm could offer the necessary tools to test these hypotheses.

Conclusion

In this paper we have shown that semantic interference holds in verb production using the paradigm of competing candidates. The results become particularly relevant in a context where experimental evidence for lexical selection in this word class has not been consistent so far.

Methodologically, our findings confirm that the paradigm is highly sensitive to semantic proximity effects, in terms of either categories or features. In a broader sense, they shed light on previous results obtained with the picture-word interference paradigm, suggesting that, even if they are less clear, they still say something about lexical selection processes. Theoretically, our data support the statement that verb and noun selection are guided by the same principles. More generally, they contribute to prove the uniformity of processing principles across word classes. This does not mean, however, that lexical-semantic representations of verbs and nouns are not different and have the same semantic organisation. Further studies are needed to determine the nature

of the criteria governing semantic relationships between verbs that make the effect of interference between candidates more difficult to observe. Thus, cumulative inhibition seems to be a promising field for further exploration.

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- *RESUMEN: Este artículo presenta un experimento diseñado para evaluar la ocurrencia de interferencia léxica en la producción de verbos en español. Usando el paradigma de los competidores semánticos (Howard et al., 2006), mostramos que cuanto mayor es el número de verbos de la misma categoría producidos, más tiempo lleva recuperar otro verbo de la misma categoría en una tarea de denominación de imágenes. Según nuestros datos, la producción de un verbo relacionado retrasa la denominación de un nuevo miembro de la categoría en 20 ms, lo que significa que, como es el caso para los sustantivos, los verbos relacionados semánticamente compiten por la selección. Estos resultados respaldan la propuesta de que, independientemente de sus diferencias con respecto a la representación y organización semántica, la selección de verbos y sustantivos se rige por los mismos principios. Metodológicamente, nuestros hallazgos confirman que el paradigma es altamente sensible a los efectos de proximidad semántica, en términos de categorías o rasgos. A la luz de estos hallazgos, discutimos las razones por las cuales los estudios previos que exploraron los efectos de la relación semántica en la producción de verbos, la mayoría de ellos utilizando el paradigma de interferencia entre palabras y dibujos, han llevado a resultados no concluyentes y a veces contradictorios.*

- *PALABRAS CLAVE: Inhibición semántica. Producción de palabras habladas. Verbos. Denominación de imágenes. Interferencia léxica.*

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APPENDIX 1 – Target verbs by category (Acceptable alternatives) [English translations]

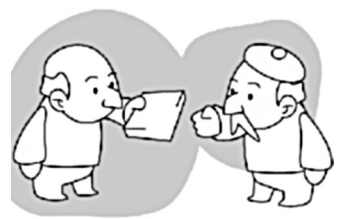
1. Manner of movement: saltar [jump]; correr [run]; caminar [walk]; marchar [march]; nadar [swim];
2. Animal sound emission: mugir [moo]; ladrar [bark]; maullar [meow]; relinchar [neigh] rugir [roar]
3. Non agentive substance emission: sangrar [bleed]; sudar (transpirar) [sweat]; llorar [cry]; babear [drool]; vomitar [vomit]
4. Contact: golpear (pegar) [hit]; empujar [push]; pellizcar [pinch]; masajear [massage]; acariciar [caresse]
5. Transfer: dar (entregar) [give]; pagar [pay]; regalar [give as a present]; robar [steal]; vender [sell]

APPENDIX 2 – Fillers and practice ítems (Acceptable alternatives) [English translations]

Pescar [fish]; plantar [plant]; abrir [open]; tirar [throw]; exprimir [squeeze]; jugar [play]; construir [build]; rastrillar [rake]; dibujar [draw]; trepar [climb]; coser [sew]; comer [eat]; arreglar [fix]; barrer [sweep]; planchar [iron]; cocinar [cook]; pintar [paint]; llevar [bring]; encender [light]; pelar [peel]; fumar [smoke]; regar [water]; tejer [knit]; atar [tie]; rezar [pray]; servir [serve]; escribir [write]; borrar [delete]; arrestar (apresar) [arrest]; subir [go up]; engordar [fatten]; florecer [flourish]; dormir [sleep]; caer [fall]; guiñar [blink]; beber [drink]; cavar [dig]; cortar [cut]; leer [read]; perseguir [chase]; reír [laugh]; aplaudir [clap]; soñar [dream]; plegar (doblar) [fold]; disparar [shoot]; saludar [greet].

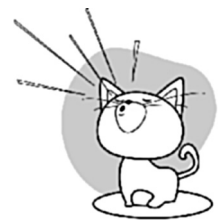
APPENDIX 3 - Picture samples

"Vomitar"



"Dar"

"Empujar"



"Maullar"

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