Semantic priming effects in Italian verbs recognition: the role of grammatical classes and semantic categories

Azzurra Mancuso
University of Salerno
Via Giovanni Paolo II, 132
Fisciano, SA, 84084, Italy
amancuso@unisa.it

Maria De Martino
University of Salerno
Via Giovanni Paolo II, 132
Fisciano, SA, 84084, Italy
mdemartino@unisa.it

Alessandro Laudanna
University of Salerno
Via Giovanni Paolo II, 132
Fisciano, SA, 84084, Italy
alaudanna@unisa.it

Abstract

English. The hypothesis that grammatical class information is represented in the mental lexicon and that it is activated during lexical access has generated a wide literature about the differences between nouns and verbs. However, the available evidences are discordant.
In this study we tried to disentangle grammatical class effects from semantic categories effects during visual word recognition by exploiting the semantic priming paradigm.
Semantically related prime-target pair were arranged. They could share (verb-verb) or not (noun-verb) grammatical class information. A third condition was included where noun primes and verb targets had both an action as a referent (*delitti/uccide*, crimes/he-she kills).
Only prime/target pairs sharing grammatical class information showed significant semantic priming effects.
Results are compatible with the hypothesis that grammatical class is an organizational criterion in the mental lexicon and it is activated during lexical access.

Italiano. *L'ipotesi secondo cui l'informazione di classe grammaticale sia rappresentata nel lessico mentale e attivata durante l'accesso lessicale ha dato origine a un'ampia letteratura sulle differenze tra nomi e verbi. La base empirica è, tuttavia, ancora incerta.*
In questo studio abbiamo usato il paradigma del priming semantico per distinguere il ruolo della classe grammaticale da quello della categoria semantica di appartenenza delle parole in un compito di riconoscimento visivo.
Sono state impiegate coppie prime-target semanticamente collegate che condividevano (verbo-verbo) o meno (nome-verbo) la classe grammaticale. In una terza condizione abbiamo usato prime-nome e target -verbo che avevano entrambi un referente appartenente alla categoria semantica delle azioni (delitti/uccide).
L'effetto di priming semantico è risultato significativo solo per le coppie prime-target che condividevano l'informazione di classe grammaticale.
I dati sono compatibili con l'idea che la classe grammaticale sia un criterio organizzativo nel lessico mentale e che sia attivata durante l'accesso lessicale.

1 Introduction

Psychological and neural evidence revealed that the distinction between parts of speech, mainly nouns and verbs, occurring in all languages (Sapir, 1921) affects speaker's performance: grammatical class is preserved in speech errors (Garrett, 1982) and nouns and verbs can be selectively disrupted in aphasic populations (Collina, Marangolo, and Tabossi, 2001; Miceli, Silveri, Villa, and Caramazza, 1984; Miceli, Silveri, Nocentini, and Caramazza, 1988).
An influential hypothesis states that the grammatical class is an organizing principle in the mental lexicon (Caramazza and Hillis, 1991) but the picture of empirical data is actually multifaceted and often inconsistent (for a review, see Vigliocco, Vinson, Druks, Barber, and Cappa, 2011).
For the sake of conciseness, here we focus on two examples of alternative interpretations about the role of grammatical class in lexical representation and processing of words.
A first position, mostly grounded on word production data (Pechmann, Garrett, and Zerbst, 2004; Pechmann and Zerbst, 2002; Vigliocco, Vinson, and Siri, 2005), is that grammatical class information, although lexically represented, is

only retrieved under specific circumstances, namely in sentence or phrasal contexts (Levelt, Roelofs, and Meyer, 1999; Garrett, 1982). However, grammatical class effects are significantly reported in word production even in tasks not requiring syntactic integration (Mahon, Costa, Peterson, Vargas, and Caramazza, 2007; De Simone and Collina, 2016). A stronger lexicalist view is held in the field of recognition and comprehension processes and conceives grammatical class as a feature of words that is automatically retrieved during lexical access. Comparisons between noun/verb homographs (*condannato* N (the convict) vs. *condannato* V (past participle, convicted), Postiglione and Laudanna, 2016) and homonymic nominal and verbal forms (*saliva* N, spittle vs. *saliva* V, he/she went up, Mancuso and Laudanna, 2013) revealed the possibility that separate, grammatical class-specific representations are present in the lexicon. Also in this case, different patterns of data have been described (Vigliocco, Vinson, Arciuli and Barber, 2008).

A possible reason for such a divergence relies on the fact that grammatical class effects are often not clearly distinguishable from the influence of confounding variables, i.e. the imageability of words, the number of inflectional alternatives for nominal and verbal stems, the argumental structure of nouns and verbs and so on. A challenging issue is that noun/verb distinction is not lexical in nature but relies on an object/action distinction (Vigliocco et al., 2005).

Here we aim at verifying whether lexical access to input orthographic representations of Italian verbs can be affected by the pre-activation of grammatical class information. The semantic priming paradigm was exploited and the expected facilitation effect on target verbs elicited by semantically related primes was compared across prime/target pairs sharing or not grammatical class information, i.e., noun/verb pairs vs. verb/verb pairs. In order to disentangle the possible confound between grammatical class (nouns vs. verbs) and semantic categories which nouns and verbs belong to (objects vs. actions), two different types of noun-verb pairs were used: object nouns denoting objects (*candela*, candle) vs. nouns denoting actions (*sberla*, slap).

We reasoned as follows: if grammatical class informs input orthographic representations of words, its pre-activation through primes should speed up targets recognition even in a lexical decision task where any process of syntactic integration is not involved. On the contrary, semantic priming effects are expected to equally affect prime/target pairs regardless their grammatical relation. No interaction between grammatical class and semantic relation is expected because the two variables are supposed to affect lexical selection with distinct modalities (Yudes, Domínguez, Cuetos, and de Vega, 2016).

2 Experiment

2.1 Method

Participants: Seventy-six undergraduate students (36 females) from University of Salerno voluntarily took part in the experiment. They were all native speakers of Italian, free of speech-language and hearing disorders and they all had normal or corrected-to-normal vision. Their age ranged from 18 to 31 years (AV: 22 years). They served for a session lasting about 30 minutes. Each pair of participants constituted one data point in the statistical analyses.

Materials: Sixty Italian unambiguous verbs were selected as targets and subdivided into 3 lists on the basis of the type of prime word adopted:

1. Object Noun/Verb Condition, ON/V: 20 targets were preceded by semantically related object nouns (*bottega*/*acquista*, atelier/he-she buys);
2. Action Noun/Verb Condition, AN/V: 20 targets were preceded by semantically related action nouns (*furto*/*ruba*, theft/he-she steals);
3. Verb/Verb Condition, V/V: 20 targets were preceded by semantically related verbs (*colpiva*/*spara*, he-she struck/he-she fires).

The semantic distance between prime and target was calculated on the basis of an off-line rating (on a 7-points Likert scale), previously submitted to 54 participants (who did not take part into the experiment) and balanced among conditions.

Each experimental list was matched with a control list:

1. Object Noun/Verb Control Condition, ON/V_C: 20 targets were preceded by unrelated object nouns (*polmone/acquista*, lung/he-she buys);
2. Action Noun/Verb Control Condition, AN/V_C: 20 targets were preceded by unrelated action nouns (*dormita/ruba*, the sleep/he-she steals);
3. Verb/Verb Control Condition, V/V_C: 20 targets were preceded by unrelated verbs (*variava/spara*, he modified /he-she fires).

Targets of the three lists were matched for the following variables:

- cumulative written frequency of the verb paradigm;
- written form frequency;
- length calculated in number of letters;
- lexical decision latencies and percentage errors[1].

The mean values for the controlled parameters of targets are shown in Table 1.

	Paradigm Frequency	Form Frequency	Length	LD latencies	LD %errors
ON/V	236	27	6.8	551ms	4%
AN/V	248	23	6.4	545ms	6%
V/V	238	28	6.5	553ms	5%

Table 1. Summary of targets characteristics

Primes of the both experimental and control lists were matched for:

- written form frequency;
- length calculated in number of letters.

The mean values for the controlled parameters of primes are shown in Table 2. Values for frequency were taken from the CoLFIS database (Bertinetto, Burani, Laudanna, Marconi, Ratti, Rolando & Thornton, 2005).

	Form frequency (related prime)	Length (related prime)	Form frequency (unrelated prime)	Length (unrelated prime)	Prime/target Semantic distance
ON/V	20	6.1	17	6.2	5.5
AN/V	16	7	17	7	5.3
V/V	16	7.4	11	7.7	5.2

Table 2. Summary of primes characteristics

Procedure: The participants were tested individually; an experimental session consisted of two parts: a practice and an experimental phase.
A semantic priming lexical decision task was used as experimental paradigm. Participants were asked to be as fast and accurate as possible. They had to press on two buttons: the button corresponding to their dominant hand for the decision 'word', the other for the decision 'non-word'.
Stimuli appeared in lower case letters (12-point size) in the center of the computer screen. Each experimental trial was composed by: fixation point (200 ms), blank (300 ms), prime (200 ms), blank (50 ms), target (1 sec). If the participant did not respond within 1000 ms, the feedback *"Fuori tempo"* (out of time) was given and the trial was recorded as an error. Following the participant's response (or non-response), the next trial was presented after a delay of 1 sec.
Reaction times (ms) and accuracy constituted the dependent variables.

*Equipment***:** Response box, connected to a PC running the E-Prime software 2.0 (Psychology Software Tools, Inc., Pittsburgh, PA).

2.2 Results

A repeated measures ANOVA was performed on the averaged correct response latencies and on errors with the Condition (two levels (i.e., semantically related vs. unrelated) and the Experimental List (3 levels, ON/V, AN/V and V/V) as variables. Separate analyses were carried out for participants and items, yielding F1 and F2 statistics, respectively.

Data from two items (*bombarda* (he/she bombs) and *contagia* (he/she infects) were excluded from the analyses because they elicited a number of errors exceeding the sample's mean more than 2.5 standard deviations.

Data on reaction times (reported in Table 3) revealed significant main effects of Condition [$F1(1,75)=21.3$, $p<.01$; $F2(1, 55)=5,73$, $p<.05$] and Experimental List [$F1(2,150)=21.6$, $p<.01$; $F2(2, 55)=1.2$, $p<.1$].

No significant interaction between the two variables was observed.

Interestingly, planned comparisons revealed that the observed semantic priming effect is mainly elicited by prime/target pairs sharing grammatical class information: V/V Condition ($p<.05$). On the contrary, both conditions where primes do not share grammatical class information with the targets (i.e., AN/V and ON/V) exhibit a weak semantic priming not reaching statistical significance.

[1]Prior to the study, a simple visual lexical decision experiment was administered to 35 participants (who did not take part into the priming experiment), in order to verify whether targets of the three conditions were exactly balanced with each other.

Condition	ON/V	AN/V	V/V	Overall
Related	554 (-5)	545 (-12)	562 (-18)**	554 (-11)
Unrelated	559	557	580	565

Table 3. Correct lexical decision response latencies as a function of the Condition and Experimental List

On accuracy data (reported in Table 4) only a significant effect of the Experimental List was detected [$F1(2,250) = 10.53$, $p < .01$; $F2(2, 55) = 3.98$, $p < .02$].

Condition	ON/V	AN/V	V/V	Overall
Related	1.8%	1.5%	2.6%	2%
Unrelated	1.6%	1.6%	3.2%	2.1%

Table 4. Lexical decision percentage of errors as a function of Condition and Experimental List

3 Conclusion

Our purpose here was to clarify whether grammatical class works as an organizational criterion of word representations within the mental lexicon. In particular, we aimed at demonstrating that words from different grammatical classes tend to be processed differently by speakers not only because of their differences in terms of semantic categories they belong to (actions vs. objects) or of semantic features (imageability) but also because their lexical representations specify their role as different parts of speech.

From an empirical point of view, our purpose was to verify:

- whether grammatical class information is automatically activated when orthographic representations of Italian verbs are accessed;
- whether grammatical class effects can be detected in tasks that do not explicitly require syntactic integration processes, that is during the processing of isolated words;
- whether grammatical class effects are an epiphenomenon of the semantic categories to which nouns and verbs belong to or if they are truly grammatical in nature.

We addressed the issue by exploiting the semantic priming effect, a robust and well-known effect in word recognition consisting in the advantage in lexical decision tasks exhibited by target words when preceded by semantically related primes and compared to an unrelated baseline.

Our experimental design was suitable to investigate the problem for two main reasons:

- it allows to pre-activate a definite linguistic feature, i.e. grammatical class (nouns vs. verbs) information and/or a semantic category (actions vs. objects), and to observe whether such a property can affect word processing;
- it rules out the intervention of any confound due to syntactic integration process because it focuses on lexical access to single word representations.

With that aim, we manipulated the congruency of grammatical class in different kinds of prime/target pairs. The rationale of the experiment was the following: if grammatical class informs lexical representation of words, its preactivation through the prime should modulate the expected effects of semantic priming.

In order to specifically disentangle the role of grammatical class from the influence of semantic category of referents of nouns and verbs, we observed the effect in different conditions: grammatically congruent prime/target pairs, prime/target pairs from incongruent grammatical classes but both belonging to the semantic category of actions, and prime/target pairs from incongruent grammatical classes and different semantic categories (objects for nouns and actions for verbs).

Our results showed that semantic priming is effective only for prime/target pairs sharing grammatical class information; much weaker effects were detected for noun/verb pairs, regardless of the semantic category of the referents.

This pattern of data seems to indicate that grammatical class informs lexical representations in the orthographic input lexicon since its preactivation through the prime modulates the expected facilitation induced by semantically related primes. In other words, grammatical class is likely to be automatically activated during lexical access to written representation of Italian verbs and, in addition, it is effective during processing of verbal forms presented outside a sentence context. This effect seems to have a truly grammatical basis as it is not elicited by grammatically incongruent prime/target pairs. Moreover, in our experiment the congruency of grammatical class between prime and target does not interact with the semantic similarity between prime and target:

this suggests that the two sources of information affect the word recognition process with distinct modalities.

This pattern of data, although preliminary, adds new challenging details to the debate about lexical representation of grammatical class information and provides evidence in favor of the lexicalist models that conceive grammatical class as an intrinsic property of the lexical representation consulted during lexical access which is necessarily and automatically accessed at least during written word recognition processes.

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