

Lexical Ambiguity in Nouns: Frequency Dominance and Declensional Classes

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Abstract

The existence of differences in lexical processing between ambiguous and unambiguous words is still controversial. Many factors seem to play a role in determining different ambiguity effects in word recognition, such as ambiguity type, experimental paradigm, frequency dominance, etc. The aim of this study is to investigate the role played by frequency dominance and declensional class in recognizing Italian homonymous nouns, namely, forms with multiple unrelated meanings. We report the results of two visual lexical decision experiments, in which these factors are manipulated. An ambiguity disadvantage effect is found for words belonging to two different declensional classes (Exp. 2, e.g., *conte*), while an absence of processing differences is reported for ambiguous words within the same declensional class (Exp. 1, e.g., *credenza*). Moreover, an interaction between condition and frequency is found: the inhibitory effects are stronger for ambiguous nouns with two frequency-balanced meanings than for ambiguous nouns with a strongly dominant meaning. The results are compatible with the idea that several factors should be taken into account in order to disentangle competing accounts of lexical ambiguity processing. We discuss these results in terms of how variables such as frequency dominance and declensional class affect the activation of lexical representations and play a role in determining different ambiguity effects in lexical access.

Keywords: lexical ambiguity; homonymy; frequency; declensional classes; word recognition.

Introduction

The semantic ambiguity of lexical forms is pervasive in natural languages: many words have multiple unrelated meanings (homonymous words, e.g., the Italian word *eroina*, which designates both a type of drug, *heroin*, and a magnificent woman, *heroine*), as well as distinct, but semantically related senses (polysemous words, e.g., *impresa*, which refers both to an economic enterprise, *company*, and an heroic action, *deeds*). Despite the weight of this phenomenon, how human beings store and access these meanings is still an open question.

The goal of this study was to further investigate how lexically ambiguous words are represented in the mental lexicon; specifically, we aimed at understanding if these forms differ from unambiguous words in lexical processing, when no disambiguating contextual material is provided. Previous research, whether arguing for or against the existence of an ambiguity advantage effect in word recognition (faster RTs on ambiguous words than unambiguous ones) did not obtained consistent results (facilitatory effects: Borowsky, & Masson, 1996; Hino & Lupker, 1996; Hino, Pexman, & Lupker, 2006; Jastrzembki, 1981; Millis & Button, 1989; Rubenstein,

Garfield, & Millikan, 1970; null effects: Clark, 1973; Forster, & Bednall, 1976; Gernsbacher, 1984; disadvantage effects: Beretta, Fiorentino, & Poeppel, 2005; Rodd, Gaskell, & Marslen-Wilson, 2002). One reason of such empirical discrepancies might be that several variables (e.g., ambiguity type, experimental paradigm, frequency effects, etc.) have not been always considered. In the experiments reported here, the control of all of these factors hopefully provides a new perspective to re-evaluate ambiguity effects in word recognition tasks. First of all, ambiguous words used in our study are exclusively homonyms, in order to avoid confusion in the type of lexical ambiguity under investigation. A number of recent studies, indeed, provided evidence for differences in processing between unrelated meanings of homonymous words and related senses of polysemous words (e.g., Azuma, & Van Orden, 1997; Klepousniotou, 2002; Klepousniotou, & Baum, 2007; Klein, & Murphy, 2001, 2002; Rodd et al., 2002). Moreover, all experimental forms adopted in our study are only semantically ambiguous words, namely, words with two meanings belonging to the same grammatical class. A previous study on lexical ambiguity processing reported evidence for processing differences between ambiguous words between noun and verb (e.g., *costa*, with a nominal meaning, *coast*, and a verbal meaning, *it costs*) and ambiguous words within the same word class (e.g., *campione*, with two nominal meanings, *champion* and *sample*) (Mancuso, & Laudanna, 2013).

Finally, the goal of this study is to present evidence for a modulation of the effect of lexical ambiguity depending on these two variables:

- the meaning frequency dominance, that is whether there are processing differences between balanced ambiguous words (two meanings which have equal probabilities of occurrence, e.g., *sirena*, meaning both *mermaid* and *alarm*; and unbalanced ambiguous words (having a more frequent meaning, e.g., *campione*, meaning both *champion*, dominant meaning, and *sample*, subordinate meaning).

- the declensional class of these forms, namely, whether there are processing differences between ambiguous forms belonging to the same declensional class (e.g., *credenza*, meaning both *faith* and *cupboard*) and ambiguous forms belonging to two different declensional classes (e.g., *teste*, which means both *heads*, meaning of the word ending in *-a*, and *witness*, meaning of the word ending in *-e*).

Evidence from eye-movement studies showed that meaning frequencies play a role in processing ambiguous words. Fixation times are often longer when context supports the subordinate meaning of an unbalanced ambiguous word compared to all the other conditions.

Furthermore, when the context is neutral, readers take longer on a balanced ambiguous word than on an unbalanced ambiguous word or an unambiguous control word (Binder, 2003; Duffy, Morris, & Rayner, 1988; Rayner, Pacht, & Duffy, 1994). Even in single word recognition tasks, some studies reported different ambiguity effects depending on the meaning frequency dominance of the stimuli (Rubenstein et al., 1970; Klepousnioutou, Pike, Steinhauer, & Gracco, 2012). As to declensional class information, only a restrict number of studies investigated the role played by this variable in the lexical organization and processing, reporting effects both in recognition and in production tasks (Bordag, & Pechmann, 2009; De Martino, & Laudanna, 2011).

The existence in Italian language of a set of ambiguous nouns with an alternation between two declensional classes gives us the opportunity to explore further this property and verify its role in the lexical access of nouns. To our knowledge, no previous study has considered the combined effect of frequency dominance and declensional class on processing of ambiguous forms. The prediction is to find different ambiguity effects for ambiguous items within the same declensional class and for ambiguous items with an alternation between two declensional classes, as well as different effects depending on frequency dominance (balanced vs. unbalanced words). The rationale behind this prediction is that in the course of lexical access word forms have to be attributed to one grammatical class and to a specific declensional paradigm; thus, words who may belong to two or more classes posit a stronger problem of formal ambiguity.

Method

Materials

Fifty-six Italian homonymous nouns having two unrelated meanings were selected and split in four subsets by modulating frequency dominance and declensional class.

Thirty six nouns belonging to the same declensional class were used in Experiment 1:

- 18 with two balanced nominal meanings, N=N (e.g., *credenza*, cupboard/belief);
- 18 with two unbalanced nominal meanings, N>N (e.g., *campione*, champion/sample).

Twenty nouns belonging to two different declensional classes (nouns ending in *-e/i* and nouns ending in *-a/e* or in *-o/i*) were used in Experiment 2:

- 10 with two balanced nominal meanings, N=N (e.g., *teste*, heads/witness);
- 10 with two unbalanced nominal meanings, N>N (e.g., *sete*, thirst/silks).

All frequencies were calculated on the basis of a written corpus of almost 4.000.000 occurrences (CoLFIS, Bertinetto et al., 2005). Since ambiguous forms belong to the same grammatical class, a consultation of sentence contexts in the corpora was required in order to disambiguate the

occurrences and calculate how many times an ambiguous word occurs either in a meaning or in another one. For the unbalanced words, the dominant meaning has a mean frequency of occurrence of 87% (range: 65–98%) and the subordinate meaning has a mean frequency of 13% (range: 2–35%). For the balanced words, the dominant meaning has a mean frequency of occurrence of 55% (range: 45–59%) and the subordinate meaning has a mean frequency of 45% (range: 31–55%). Critical stimuli were also submitted to speakers in an off-line semantic association task, in order to be sure that all meanings of ambiguous items were known by speakers (Gernsbacher, 1984). Forty Italian mother-tongue students – which did not take part in the experiments – were asked to say as many meanings as they think of for each word, without a time limit. Only the ambiguous words for which at least the 80% of subjects have listed both the meanings were used in the study. Each subset of critical stimuli was compared to a subset of unambiguous nouns¹. All experimental and control materials were matched for frequency of occurrence², syllable, letter and phoneme length, orthographic neighborhood size, imageability and familiarity. Sixty real words and one hundred thirty-two pseudowords were included in the list as fillers³.

Procedure

A simple visual lexical decision task was used as experimental paradigm. Reaction times (ms) and rate accuracy constituted the dependent variables.

Participants

One hundred twenty native speakers of Italian with an average age of 25 years (range 18–35) participated in the study (Exp. 1: 46 subjects; Exp. 2: 74 subjects).

Results

The data were submitted to a 2-way repeated measures analysis of variance (ANOVA) for subjects and a between effects ANOVA for items, with Condition as a factor having 2 levels (i.e., experimental vs. control) and Frequency as a factor having 2 levels (i.e., balanced vs unbalanced), for both accuracy and reaction times (RTs).

In Experiment 1, the Condition effect on reaction times and error rates is not significant. A significant Frequency effect on RTs is observed (only for subjects) [$F_{1, 46} = 7.8, p < 0.001$], as well as on error rates (only for subjects) [$F_{1, 46} = 7.9, p < 0.001$]. The interaction Condition x Frequency is not significant. Post-hoc comparisons reveal that experimental N > N forms are recognized significantly

¹ Specifically, the experimental forms used in the Experiment 1 were matched with unambiguous nouns ending in *-a* or in *-o*, while the items used in the Experiment 2 were matched with unambiguous nouns ending in *-e*.

² In the case of ambiguous forms, the sum of relative frequencies of both meanings was considered.

³ In the Experiment 2, only one hundred pseudowords were included in the list as fillers.

faster than experimental N = N forms ($p < 0.001$), although less accurately ($p < 0.01$).

In Experiment 2, the Condition effect is significant for participants [RTs: $F_{1,74} = 13.04$, $p < 0.001$; Errors: $F_{1,74} = 4.21$, $p < 0.05$]. A significant Frequency effect for participants is also observed [RTs: $F_{1,74} = 5.28$, $p < 0.05$; Errors: $F_{1,74} = 5.57$, $p < 0.05$], as well as an interaction Condition \times Frequency (only for subjects) [RTs: $F_{1,74} = 15.04$, $p < 0.001$; Errors: $F_{1,74} = 6.30$, $p < 0.01$]. Post-hoc comparisons reveal that experimental N=N forms are recognized significantly slower and less accurately than their unambiguous control words ($p < 0.001$).

In the table below, mean RTs and error rates of two experiments are reported.

	Contr.		Exp.		Effect	
	rt	%err	rt	%err	rt	%err
Exp. 1						
N>N	517	4.1	509	4.3	-8	+0.2
N=N	523	4.9	527	2.3	+4	-2.6
	520	4.5	518	3.3	-2	-1.2
Exp. 2						
N>N	534	3.8	530	3.4	-4	-0.4
N=N	526	3.6	550	7.2	+24	+3.6
	530	3.7	540	5.3	+10	+1.6

Table 1: RTs and error rates in Exp. 1 & 2

Discussion

The results seem to corroborate the hypothesis of a role played by declensional class in determining different ambiguity effects in visual word recognition.

When ambiguous forms belong to the same declensional class (Experiment 1), their processing does not differ from unambiguous forms. In the case of nouns belonging to two different declensional classes (Experiment 2), an ambiguity disadvantage effect is reported. As to the meaning dominance frequency, a significant interaction between condition and frequency is reported only in Experiment 2: balanced ambiguous nouns are recognized significantly slower and less accurately than unambiguous controls.

The results are in line with a previous study, where an inhibitory effect was reported only when the ambiguity involves the syntactic level (different parts of speech, e.g., noun and verb such as *abito*, meaning *dress* and *I live*) and when meaning frequencies are balanced (Mancuso, & Laudanna, 2013).

All homonymous words are supposed to have two distinct semantic representations, each corresponding to the specific meaning they can assume. When speakers encounter an ambiguous word in isolation, it can happen that they activate only one of its meanings and ignore the other one. Multiple meanings of homonymous words do not share any semantic representation and do not cooperate with each other during lexical processing. At this level of ambiguity, frequency dominance does not seem to affect the processing of ambiguous words.

In the case of homonymous words belonging to two different declensional classes - or grammatical classes, as in Mancuso and Laudanna (2013) - a further level of ambiguity can be postulated. These forms are supposed to have two distinct representations also at the input orthographic lexicon level, each corresponding to the specific morpho-syntactic features that ambiguous words can assume (e.g., the grammatical class, the declensional paradigm, etc.). The ambiguity disadvantage effect reported on these forms can be situated at this level. Multiple morpho-syntactic representations are expected to compete with each other during lexical access; moreover, the competition process is expected to be stronger when ambiguous items are frequency-balanced. Further investigations are needed in order to corroborate the hypothesis of a role played by declensional class and frequency dominance in lexical ambiguity processing. The results reported in this study are based, indeed, on a restrict item set, since in Italian there are not many words with an alternation between two declensional classes. Further experiments might be carried out in another language, in order to verify whether current results might be replicated.

In conclusion, the findings seem to show how it is crucial to assume a new methodological perspective in order to investigate the ambiguity effects in word recognition. Only by taking a broader view of the possible factors affecting lexical processing of ambiguous forms we will be able to direct our efforts in order to better understand the lexical ambiguity processing and its relation to other aspects of language comprehension.

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References

- Azuma, T., & Van Orden, G. C. (1997). Why SAFE is better than FAST: The relatedness of a word's meanings affects lexical decision times. *Journal of Memory and Language*, 36, 484-504.
- Beretta, A., Fiorentino, R., & Poeppel, D. (2005). The effects of homonymy and polysemy on lexical access: An MEG study. *Cognitive Brain Research*, 24, 57-65.
- Binder, K. S. (2003). The influence of local and global context: An eye movement and lexical ambiguity investigation. *Memory and Cognition*, 31, 690-702.
- Bordag, D., & Pechmann, T. H. (2009). Externality, internality, and (in)dispensability of grammatical features in speech production: Evidence from Czech declension and conjugation. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 35, 446-465.
- Borowsky, R., & Masson, M. E. J. (1996). Semantic ambiguity effects in word identification. *Journal of*

- Experimental Psychology: Learning, Memory, and Cognition*, 22, 63-85.
- Clark, H. H. (1973). The language as fixed-effect fallacy: A critique of language statistics in psychological research. *Journal of Verbal Learning and Verbal Behavior*, 12, 335-359.
- De Martino M., & Laudanna, A. (2011). The role of the declensional class in recognition of Italian written nouns. *Proceedings of the XVII Conference of the European Society for Cognitive Psychology* (p.159). San Sebastian-Donostia.
- Duffy, S. A., Morris, R. K., & Rayner, K. (1988). Lexical ambiguity and fixation times in reading. *Journal of Memory and Language*, 27, 429-446.
- Forster, K. I., & Bednall, E. S. (1976). Terminating and exhaustive search in lexical access. *Memory and Cognition*, 4, 53-61.
- Gernsbacher, M. A. (1984). Resolving 20 years of inconsistent interactions between lexical familiarity and orthography, concreteness, and polysemy. *Journal of Experimental Psychology: General*, 113, 256-281.
- Hino, Y., & Lupker, S. J. (1996). Effects of polysemy in lexical decision and naming: An alternative to lexical access accounts. *Journal of Experimental Psychology: Human Perception and Performance*, 22, 1331-1356.
- Hino, Y., Pexman, P. M., & Lupker, S. J. (2006). Ambiguity and relatedness effects in semantic tasks: are they due to semantic coding? *Journal of Memory and Language*, 55, 247-273.
- Klein, D. E., & Murphy, G. L. (2001). The representation of polysemous words. *Journal of Memory and Language*, 45, 259-282.
- Klein, D. E., & Murphy, G. L. (2002). Paper has been my ruin: Conceptual relations of polysemous senses. *Journal of Memory and Language*, 47, 548-570.
- Klepousniotou, E. (2002). The processing of lexical ambiguous words: Homonymy and polysemy in the mental lexicon. *Brain and Language*, 81, 205-223.
- Klepousniotou, E., & Baum, S. R. (2007). Disambiguating the ambiguity advantage effect in word recognition: An advantage for polysemous but not homonymous words. *Journal of Neurolinguistics*, 20, 1-24.
- Klepousniotou, E., Pike, G. B., Steinhauer, K., & Gracco, V. (2012). Not all ambiguous words are created equal: An EEG investigation of homonymy and polysemy. *Brain and Language*, 123, 11-21.
- Mancuso, A., & Laudanna, A. (2013). Revisiting the ambiguity effect in word recognition: part of speech and meaning dominance effects. *Proceedings of Architectures and Mechanisms for Language Processing* (p. 171). Marseille.
- Millis, M. L., & Button, S. B. (1989). The effect of polysemy on lexical decision time: Now you see it, now you don't. *Memory and Cognition*, 17, 141-147.
- Rayner, K., Pacht, J. M., & Duffy, S. A. (1994). Effects of prior encounter and global discourse bias on the processing of lexically ambiguous words: Evidence from eye fixations. *Journal of Memory and Language*, 33, 527-544.
- Rodd, J. M., Gaskell, M. G., & Marslen-Wilson, W. D. (2002). Making sense of semantic ambiguity: Semantic competition in lexical access. *Journal of Memory and Language*, 46, 245-266.
- Rubenstein, H., Garfield, L., & Millikan, J. A. (1970). Homographic entries in the internal lexicon. *Journal of Verbal Learning and Verbal Behavior*, 9, 487-494.