The mental representation of compound nouns: evidence from neuro- and psycholinguistic studies

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Compounds are morphologically complex words (e.g., swordfish) formed by the concatenation of two or more independent lexemes, called constituents (e.g., sword and fish). There is a general debate as to whether constituent representations are accessed during compound processing, and which compound properties would influence this parsing procedure. Indeed, cross-linguistic results of experiments employing priming paradigms indicate a separate representation of compound constituents (e.g., Libben et al., 2003; Zwitserlood, 1994; Jarema et al., 1999). However, several results in cognitive neuropsychology, as well as a number of theoretical considerations, suggest that also properties associated to a whole-word representation of the compound have to be represented (e.g., Mondini et al., 2002). Moreover, it is far from clear as to whether the head-modifier roles of constituents are represented in the mental lexicon: in fact, in most compounds it is possible to identify a head constituent, that shares its lexical and semantic properties with the whole compound (e.g., fish in swordfish), but since most studies are run on Germanic languages, in which the head is always the rightmost element (Williams, 1981), this issue has been mostly overlooked in psycholinguistic literature. Romance languages, which are characterized by both head-initial and head-final compounds, could be an ideal benchmark to test the headedness effect. This thesis investigates the mental representation of compound nouns in a series of six studies exploiting the properties of compounding in Italian, and adopting methodologies from both psycholinguistics and cognitive neuropsychology, with the aim of proposing a unified explanation for the whole-word and structure effects observed in compound processing. Most of the Chapters of this thesis have been published as individual studies on peer-reviewed international journals and presented at several international conferences.

In a first study, effects related to the compound structure were investigated in the context of neglect dyslexia (Chapter 1). The aim of the study was to test the effect of compound headedness, as well as find converging evidence in favour of a whole word representation of compound words. Since patients affected by neglect dyslexia are known to be sensitive to lexical properties of the read stimuli (Arduino et al., 2008), we used it as an experimental model to investigate word access. Seven participants affected by neglect dyslexia were asked to read a set of compound words, that could be either left-headed (pescespada) or right-headed (astronave). Moreover, a set of pseudocompounds was also presented, created by substituting the leftmost element of the compounds with a orthographically similar word (e.g., pestespada, antronave). Results indicate that head-initial compounds elicit less neglect errors than head-final compounds: the leftmost element is easier to retrieve when it is head of the word. Moreover, existing compounds are read more accurately than pseudocompounds, whose leftmost elements are often omitted or substituted. I interpret these results in a multiple-layer architecture, with separate access to constituents at peripheral levels and a top-down facilitation from the central, whole-word representation of the compound.

The effect of headedness was further investigated in a priming study on normal participants (Chapter 2). The issue was addressed adopting a constituent priming paradigm with a lexical decision task. Head-initial and head-final compounds were employed as experimental stimuli and the position of the primed constituent was manipulated. In other words, four possible primes were prepared for each target compound: the first constituent (pesce-pescespada), the second constituent (spada-pescespada), a control word for the first constituent (peste-pescepada) and a control word for the second constituent (sposa-pescespada). A priming effect was found, indicating that related primes facilitates compound access in comparison to control primes, and thus confirming the automatic access to constituent representations. Moreover, in head-final compounds data reveal a larger priming effect for the head than for the modifier constituent. These results suggest that different kinds of compounds have different representations in the mental lexicon: only head-final compounds are represented with an internal head-modifier hierarchy (Williams, 1981), in line with their distributional properties in Italian morphology (Schwarze, 2005).

Converging evidence with the results of the priming study was further sought through the analysis of compound naming errors in patients suffering from aphasia (Chapter 3). A picture-naming task of compound nouns with either head-initial (pescespada) or head-final (autostrada) forms was administered to a large sample (91) of Italian aphasic patients. Their accuracy in retrieving either constituents was analyzed with a mixed-effects logistic regression. The interaction between headedness and constituent position emerged as significant: the modifier was more difficult to retrieve than the head, but the effect was much more pronounced for head-final compounds. The pattern of results is highly consistent with the data from the priming experiment on healthy subjects, indicating the hierarchical representation of head-final compounds. The converging results, obtained with a different item set, different subject type, and different experimental paradigm, speak for the reliability of the effect, and the different task employed (tapping into output processing levels) provides convincing evidence that compound headedness is represented at central processing levels.
The organization of this central and modality-independent representation was then investigated in a single case study on a deep dyslexic patient (Chapter 4), focusing on the interplay between constituent and compound grammatical properties. I extensively assessed the case of GR, whose reading impairment mainly affected verbs and morphologically complex words. In a first experiment, Verb-Noun (VN) compound nouns (e.g., lavapiatti) were employed as stimuli, and were contrasted with the compound constituents (e.g., lava, piatti) presented in isolation. GR made errors on the verb constituent more frequently than on the noun, and the accuracy distribution was similar to the one observed for the constituents presented in isolation. In a second experiment the VN compounds were embedded into sentence frame, in order to favour whole-word access, and were compared to paired verb phrases (e.g., Maria lava piatti). The results were not replicated in this second experiment: when embedded in sentences, VN compounds were read significantly better than verb-phrases and no grammatical-class effect emerged. Overall, results suggest a complex representation of compound nouns. The disproportionate impairment, which emerged in reading the verb component of isolated VN compounds, indicates that the grammatical properties of constituents are being retrieved. However, results suggest a whole-word representation when compounds are embedded in sentences; since the sentence context affects the access to compounds through syntactic constraints, the whole-word representation is arguably at a grammatical level as well. Results are accounted for by positing a multiple-lemma representation for complex words (Levett et al., 1999), with a highly dynamic interplay between the constituent and the compound nodes.

The semantic processing of compound words was finally investigated in a study on frequency effects in lexical decision of either head-initial or head-final compound words (Chapter 5). I tested the modulation of both headedness and semantic transparency (i.e., how well a compound meaning can be derived from the meaning of its constituents). Interactions between constituent frequencies, headedness and semantic transparency emerged as significant predictors of response times. Constituent frequency effects were mostly observed for transparent compounds, whereas in opaque compounds the contribution of the constituents was limited. However, frequency effects had opposite directions depending on compound headedness: constituent-frequency effects were facilitatory for head-final compounds, and inhibitory for head-initial compounds. Results indicate that the head-modifier roles are crucial in semantic processing, and that the constituent contribution in accessing compound can be efficiently explained in the framework of a parallel-route model (Kuperman et al., 2009) involving a conceptual combination procedure (Gagné & Spalding, 2007). Moreover, the effects confirm the preference for the head-final structure in Italian compounding: when the head-final assumption is not satisfied, in fact, head-modifier roles should be reassigned in a time consuming process.

The results on lexical decision were replicated in an eye-tracking study on compound reading (Chapter 6), in order to shed light on the time-course of the observed effects. Compound words were embedded into sentences, and presented to participants in a reading task. Fixation times on the compounds were measured, and the effects of constituent frequencies, as well as the modulation by semantic transparency and headedness, were tested. The interaction between constituent frequency and semantic transparency emerged as early as the first fixation on the compound, indicating a very early involvement of the semantic properties in compound processing. However, the modulation of headedness emerged only when analyzing late processing measures (i.e., gaze duration, total fixation time), confirming that the information on head-modifier roles is accessed only at late processing stages, and providing crucial evidence for the definition of the time-course of the conceptual combination procedure (Gagné & Spalding, 2007).

The six studies presented in the dissertation provides a number of results about the processing of Italian compound words indicating that the variables associated to the whole compound (i.e., compound headedness, whole-word frequency and semantic transparency) play a crucial role in word processing, and that the lexical and grammatical properties of constituents are also accessed. I proposed that these effects can be accounted for by positing (i) a compound node at the lemma level, i.e., a representational unit binding constituents together into a single lexical unit, along with specifying how these constituents must be combined, and (ii) a parallel procedure dedicated to the conceptual combination of constituent meanings. In the conclusion of the dissertation, I therefore proposed a hybrid model of compound processing, comprising both multiple processing stages and parallel processing routes. In particular, the model described merges the distinction between lemma and lexeme levels described by Levett et al. (1999) with the multiple route framework proposed by Kuperman et al. (2009), on the basis of the theoretical principle of maximization of opportunity (Libben, 2007). Obviously, the model still needs to be tested, and many details have to be better defined. However, the proposed hybrid architecture is indeed promising, and I think that even the present formulation is able to parsimoniously explain the many effects reported in the experimental part of the dissertation.
Reference list