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Semantic access to constituents of compounds and pseudocompounds: Evidence from dichoptic presentation

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Abstract

The early moments of compound and pseudocompound visual word recognition were investigated by probing their "constituent" concepts (e.g., *BED* in *bedroom* and *FAN* in *fanfare*). This was achieved by concomitantly presenting target words in one visual field (left or right, projected to the right or left hemisphere, respectively) and a picture representing the referent of either the first or second "constituent" in the opposing visual field. The stimuli were presented for 133 ms followed by a backward mask and participants judged whether the word and picture were related to each other. The experimental manipulations consisted of target word type (compound or pseudocompound), word complexity (whole word or "constituent"), probed constituent position (first or second "constituent"), and word projection (left or right hemisphere). Our results suggest that the "constituents" of compounds and pseudocompounds are conceptually accessed. We discuss the implications of our findings for the nature of the visual word recognition system.

Keywords: visual word recognition; compounds; pseudocompounds; conceptual representation; word-picture relatedness task

Introduction

The lexical system is taken to be one of the key examples of the productivity and compositionality of mental representations (see, e.g., Fodor & Pylyshyn, 1988, 2015). The lexicon is productive because with a finite number of simple elements—such as morphemes—we can construct indefinitely many complex words by combining morphemes following morphological rules. By the same token, the meaning of complex words is in principle composed of the meaning of the constituents and how they are structured together. For instance, the compositional meaning of *blueberry* conveys minimally that the meaning of "a berry that is blue". However, the lexicon also contains items which, on the surface, could also be formed by composing free morphemes. For instance, although *carpet* is not a morphologically complex word, it can superficially be broken down into *car* and *pet* or interpreted as a whole. Importantly, the compositional meaning of the "constituents" (e.g., "the pet of the car") conflicts with the meaning of the whole word (e.g., "floor covering"). A fundamental issue for research on the nature of the visual word recognition system is whether we access the meaning of "constituents" embedded in complex (*blueberry*) and seemingly complex (*carpet*) words. If so, how are "constituents" identified from orthographic input?

At least since the pioneering work by Taft and Forster (1975), many studies have shown that the visual word recognition system breaks down morphological constituents prior to identifying a whole word in the mental lexicon—a process that precedes accessing the constituents' meanings (e.g., Longtin et al., 2003; Rastle et al., 2004; Beyersmann et al., 2016). That is, the visual word recognition system appears to be hard-wired to detect morpho-orthographic regularities in letter strings, while being initially blind to the semantics of identified segments (for a review, see Amenta & Crepaldi, 2012).

However, there is no consensus with regards to the nature of visual word recognition. Models generally differ with regards to the role attributed to morphological processing and, as a result, in their predictions of the meaning that is accessed (see Beyersmann et al., 2012). (1) First, proponents of a prelexical morpho-orthographic parsing stage predict that the meaning of "constituents" are accessed (Taft & Forster, 1975; Crepaldi et al., 2010). On this account, *blueberry* and *carpet* are initially interpreted according to their morpho-orthographic (pseudo)constituents. In contrast, (2) a model accounting for a postlexical morpho-semantic segmentation stage predicts that only the constituents of morphologically complex words are accessed (Giraudo & Grainger, 2001, 2003). According to this view, *blueberry* is interpreted by the composition of constituents' meanings, but *carpet* is identified as a whole word and only its whole word meaning is accessed. (3) Dual-route models postulate both pre- and postlexical morphological processes operating in parallel, whereby the compositional meaning of *blueberry* and both meanings of *carpet* are accessed (Diependaele et al., 2009; Libben & de Almeida, 2002). (4) Models of cascading processes propose that several interacting factors mediate word recognition and semantic processing, which includes accessing the meaning of lexical units embedded in words (Kuperman, 2013; Davis et al., 2019). As such, the orthographic input co-activates semantic information for the whole word and any letter string that may represent a word. For instance, *blueberry* would activate the meanings *blueberry*, *blue*, *berry*, *err*, and *be*. To reiterate, all models predict that the compositional meaning of *blueberry* should

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be accessed. By contrast, the predictions of the different models diverge when considering the processing of *carpet*.

The present study addresses the nature of word recognition –and in particular the mapping between morphemes and their conceptual representations by contrasting compounds and pseudocompounds employing a novel, dichoptic presentation paradigm. Compounds—i.e., complex words composed of two or more free morphemes—constitute an important test case for the study of visual word recognition and, by extension, morphological processing. Notably, compounds are the most productive word class, since their formation is not constrained by the selectional restrictions of its constituents (Libben, 2006, 2014). That is, indefinitely many novel compounds can be produced by novel two-word combinations—*Facebook* and *Airbus* are contemporary examples. In English, the morpho-semantic relation between the constituents is generally predictable, whereby the leftmost constituent is the modifier, and the rightmost constituent is the compound head (Dressler, 2006). The head determines not only the syntactic properties of the compound but also its semantic category (e.g., *bedroom* is a type of *room*, but *roommate* is a type of "mate"). The interpretation of compounds can, thus, rely on the composition of the modifier and the head. However, semantically opaque constituents (e.g., *bird* in *jailbird*) and exocentric compounds (e.g., *redhead*) are exceptions which highlight the range of phenomena bearing on morpho-semantic representation, of which semantically transparent compounds are the default case (see Schafer, 2018; and ten Hacken, 2018).

Pseudocompounds are an important test case for the nature of morpho-semantic processes because they are monomorphemic words that superficially embed letter strings that may stand for free morphemes (e.g., *carpet*, *fanfare*, *shamrock*). Thus, the question is that at any stage of processing they behave like compounds, that is if they are broken down into their constituents or whether they behave like monomorphemic words.

The semantic priming technique has been employed to probe whether "constituents" are semantically accessed. The technique involves presenting compounds or pseudocompounds (e.g., *bedroom*, *carpet*) and a semantic associate of their "constituent" (e.g., *pillow*, *drive*). Thus far, evidence for constituent access for true compounds has been inconsistent. Zwitserlood (1994), Sandra (1990), and Melvie et al. (2022) found mixed results for constituent access of compounds, which was, in some cases, mediated by the constituent's semantic transparency and the prime-target relationship—that is, compounds primed the semantic associate to a lesser degree than the inverse order of semantic associate and compound. However, in all three studies, there was no support for the access of "constituents" embedded in pseudocompounds. Crucially, all studies have relied on lexical priming, but our novel method probes the conceptual access to "constituents" without relying on lexical relations.

In the present study, we investigated the mechanisms underlying morpho-semantic processing by employing a masked word-picture paradigm with a relatedness judgment task. The main manipulation involved the dichoptic presentation of a compound or pseudocompound word target and a picture probing one of their "constituents". Participants had to judge whether the word-picture pair were related to each other (see Figure 1). Our design was motivated by the hypothesis that linguistic and visual processes would initially yield independent outputs, with the products of their initial computations accessing their conceptual representations (Fodor, 1983; de Almeida et al., 2019).[1] This implies that the same concept is tokened when recognizing the word *bed* and the picture of a bed. If the visual word recognition system identifies embedded words and accesses the meaning of "constituents", the relatedness judgements between compound and pseudocompound words and their corresponding "constituent" pictures should not differ. More explicitly, we hypothesized that, under the view of a prelexical morpho-orthographic parsing stage—which is also posited by dual-route models—participants should interpret the embedded words in pseudocompounds the same way as those in compound words, even though pseudocompounds are not morpho-semantically complex. Thus, the meaning of *fan* should be accessed when recognizing the word *fanfare*. By contrast, the postlexical morpho-semantic segmentation model would predict that participants would judge a pseudocompound word and the picture of one of its "constituent's" referent as unrelated. Under the models proposing cascading processes, we should expect the access of pseudocompound "constituents", but to a lesser degree than compound constituents. The expected decrement for

Figure 1: An illustration of the main manipulations with compounds and pseudocompounds target words and the picture probing the first (left column) or second (right column) "constituent".

[1] Notice that, as suggested by Forster (1985), methods that are taken to "interrogate" the internal computations as well as the outputs of visual and linguistic systems often rely on decisions obtained at a higher/central processor. This is typically the case of methods such as the picture-word interference task (e.g., Lupker, 1979; Sailor & Brooks, 2014), lexical decision, picture-word matching, etc. Crucially, the method we employ in the present study aims at tapping the output of object and word recognition systems while offsetting the effects of high-level decision with short and dichoptic stimuli exposure. See Method for details.

pseudocompounds should be due to the inhibition of the "constituent" concept following its competition with the whole word concept.

A key factor in the investigation of compound processing is the modifier-head relation. Considering that the compound head (e.g., *belt* in *seatbelt*) constrains the semantic category of the whole compound, relatedness responses may favor the second constituent of compounds (and pseudocompounds assuming "constituent" access). The semantic transparency of the compound head has been found to play a key role in compound recognition. That is, word recognition is facilitated when the compound head is transparent (e.g., *bluebird*) as compared to opaque (e.g., *jailbird*; Davis et al., 2019; Libben et al., 2003). However, some studies suggest that embedded constituents aligned at the edge of words are activated independent of position (Beyersmann et al., 2018; Grainger & Beyersmann, 2017). In the current experiment, we included pictures that represented either the first or second "constituent" of the target word to examine the role of constituent position during semantic processing.

Taken together, we aimed to investigate the nature of the visual word recognition system by probing the conceptual processing of compound and pseudocompound "constituents". We predicted that, if compounds and pseudocompounds are decomposed prior to lexical identification, then relatedness judgements should not differ between both word types. Additionally, considering the importance of the compound head position in determining the semantic category of the whole word, we expected an advantage for pictures representing the second "constituent" over those representing the first "constituent" regardless of word type.

Method

Participants

Forty-five participants (F = 38), between the ages of 19 and 50 (*M* = 24.29, *SD* = 5.73), were recruited from Concordia University's participant pool and were compensated with course credit. All participants were native English speakers (i.e., learned English before the age of 5 and used it as a dominant language), and had normal or corrected-to-normal vision.

Materials and Design

Experimental materials consisted of 24 compounds (*bedroom*) and 24 pseudocompounds (*fanfare*). Each target word was paired with a picture probing one of its "constituents" (*BED* and *FAN*, respectively; target pictures are written in uppercase hereafter). The number of target pictures probing the compounds and pseudocompounds' first (C1) and second (C2) "constituents" were evenly distributed. Compound and pseudocompound words were matched in logged word frequency per million (derived from COCA; Davies, 2009) and length. The "constituents" probed by the picture and the unprobed "constituents" were also matched in logged word frequency per million and length (see Table 1). We used the K-means clustering procedure to match target words (Guasch et al., 2017). There were 48 related (e.g., *bus -BUS*) and 96 unrelated (e.g., *cup-COMPASS*) filler word-picture pairs. Among the unrelated fillers, 12 compound and 12 pseudocompound words were paired with unrelated pictures.

We also presented the single "constituents" of compounds and pseudocompounds (*bed*, *rock*) as targets with their corresponding pictures. This was done to obtain a baseline RT and accuracy for the relation between pictures and the "constituents" embedded in compounds and pseudocompounds. To control for the size and position of the "constituents" in relation to their full-word counterparts, we included hashmarks replacing the unprobed constituent from the whole word target (e.g., the corresponding constituent target word for *bedroom* was *bed####* and for *shamrock* it was *####rock*). A proportionate number of related and unrelated filler target words included hashmarks either to its left or right, ranging from 3 to 5 characters long. The target pictures were selected from the BOSS database (Brodeur et al., 2010, 2014).

The experiment was a 2 x 2 x 2 x 2 factorial design, yielding 16 conditions. The variables were whole word type (compounds and pseudocompounds), word complexity (whole word and constituent), probed constituent position (first and second "constituent" probed by the picture) and

Table 1. Lexical Characteristics of the Compound and Pseudocompound Target Words

	Compounds				**Pseudocompounds**			
	Picture probing C1		Picture probing C2		Picture probing C1		Picture probing C2	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Target frequency	0.42	0.44	0.42	0.33	0.42	0.29	0.42	0.47
Target length	7.08	0.67	7.42	0.51	7.00	0.95	7.17	0.72
Probed constituent frequency	1.38	0.55	1.37	0.43	1.30	0.50	1.36	0.48
Probed constituent length	3.42	0.67	3.75	0.62	3.25	0.45	3.75	0.62
Unprobed constituent frequency	1.77	0.66	1.83	0.44	1.68	0.75	1.78	0.87
Unprobed constituent length	3.67	0.49	3.67	0.49	3.75	0.97	3.42	0.51

word hemispheric projection (left and right hemisphere; LH and RH hereafter). The experimental word-picture pairs were counterbalanced across 4 lists such that each pair from a minimal pair appeared once per list. Participants completed two blocks of trials with each block representing a list.

Procedure

The experiment was programmed using PsychoPy2 (Pierce, et al., 2019) on a 21" iMac computer running OS 10.13 (resolution 1920 x 1080, refresh rate 60 Hz). The target words were colored in black and displayed on a white background. The letters appeared in uppercase in monospaced Courier font. Participants were seated 53 cm from the center of the computer screen, in a dimly lit room. A forehead and chin rest stabilized participants' heads to ensure they were gazing at the center of the computer screen.

Participants were instructed to press the "L" key if the word and picture were related to each other or the "A" key if they were not related to each other, as fast and as accurately as possible. Trials had the following sequence: (1) a prompt instructing the participants to press the 'spacebar' to initiate the trial, (2) the presentation of a fixation cross for 1500 msec, (3) the concomitant presentation of a word and a picture for 133 msec, (4) a backward mask presented for 200 msec to eliminate visual aftereffects, and (5) a blank screen until a response was given or after 3000 msec elapsed from stimuli onset. If a response was not given within 3000 msec of stimuli onset, the trial was coded as incorrect. The words were presented either to the left or right of the fixation cross (i.e., RH and LH projections respectively) with the picture appearing in the opposite visual field. Pictures and words subtended about 2 degrees of visual arc from the fixation cross. The entire experiment included 10 practice trials and two blocks of 192 trials each. The full session lasted approximately 25 minutes.

Results

Prior to data analysis, participants' overall accuracy was screened to ensure they performed better than chance (i.e., above 50% accuracy). For the purposes of the analyses, "yes" responses (i.e., judgements of relatedness between word and picture) were considered a correct response in the experimental trials of pseudocompound target words. Although the correct response for a pair such as *fanfare-FAN* should be "no", a "yes" response signals the degree to which the "constituent" was accessed during the processing of the pseudocompound. All participants performed above chance, with mean accuracies ranging from 60% to 91% (M = 78.80, SD = 0.06). No trials were removed due to anticipations (i.e., below 200 ms). In addition, RTs 2.5 standard deviations beyond the participants' respective means were considered outliers (Van Selst & Jolicoeur, 1994) and were replaced with the cutoff value (0.03% of all responses; Osborne & Overbay, 2004).

The accuracy and RT analyses were performed with linear mixed effects (LME) models (Baayen et al., 2008) using the *lme4* package (Bates et al., 2015) in R (R Dev. Core Team, 2021). For all analyses, whole word type (compounds and pseudocompounds), word complexity (whole word or constituent), probed constituent position (first and second "constituent" probed by the picture), and word hemispheric projection (LH and RH) were entered as fixed effects, as well as their four-way interaction. All models used the *BOBYQA* optimizer (Winter, 2019). The fully fitted model for accuracy included by-participant varying slopes for word complexity, as justified by the likelihood tests. For the RT analyses, the fully fitted model included by-participant varying slopes for word complexity and probed constituent position, as justified by the likelihood tests. The p-values were derived for all analyses of model fit, main effects and interactions using the Likelihood Ratio Test, by comparing the full model against a reduced model excluding the relevant terms using the *mixed* function from the *afex* package (Winter, 2013, 2019; Singmann et al., 2018). The *emmeans* package with Bonferroni's correction was used to perform planned comparisons (Lenth, 2022). Following the inspection of residual plots, RTs were log-transformed to meet the assumptions of homoscedasticity and normality of residuals (Osborne, 2002; but see Lo & Andrews, 2015). All reports of standardized effect sizes used the pooled standard deviation between two groups. The *ggplot2* package was used to create the figures (Wickham et al., 2016).

Accuracy

The full model was compared to a null model consisting of only random predictors and was found to provide a statistically significant better fit to the data, $\chi^2(15) = 160.00$, $p < .001$, $R^2 = 0.36$, 95% CI [0.00, 0.45]. The main effects of whole word type ($\chi^2(1) = 34.52$, $p < 0.001$), word complexity ($\chi^2(1) = 54.79$, $p < 0.001$), probed constituent position ($\chi^2(1) = 14.44$, $p < 0.001$), and word hemispheric projection ($\chi^2(1) = 6.68$, $p = 0.01$) were all statistically significant. Additionally, the interactions between whole word type and word complexity ($\chi^2(1) = 8.26$, $p = 0.004$), probed constituent position and word hemispheric projection ($\chi^2(1) = 48.42$, $p < 0.001$), as well as word complexity, probed constituent position and hemispheric projection ($\chi^2(1) = 10.07$, $p = 0.002$) were statistically significant.

Planned comparisons revealed that responses to "constituents" embedded in compounds were more accurate than in pseudocompounds. Namely, the odds of correctly responding to compounds (e.g., *bedroom-BED*) were 38% ($p < 0.001$) higher than the odds for the corresponding constituent words (e.g., *bed####-BED*). In the case of pseudocompounds, the odds of correctly responding to the full words (e.g., *fanfare-FAN*) were 15% ($p < 0.001$) higher than the odds for the corresponding "constituent" words (e.g., *fan####-FAN*). Compounds also elicited more accurate responses than pseudocompounds (OR = 4.35, $p < 0.001$). Thus, "constituent" access may be more difficult when embedded in pseudocompounds as compared to compounds.

Surprisingly, responses were more accurate when the pictures probed the first "constituent" in comparison to the second "constituent" (see Figure 2). That is, the odds ratios between the whole compound and its constituent were 0.44 ($p = 0.01$) when the pictures probed the first constituent and 0.33 ($p < 0.001$) when the pictures probed the second constituent. Similarly, when the pictures probed the first "constituent", the odds ratios between the whole pseudocompound and its "constituent" were 0.19 ($p < 0.001$), and 0.12 ($p < 0.001$) when the second "constituent" was probed. Crucially, responses were more accurate when the picture probed the first "constituent" over the second "constituent" in both compound (OR = 2.24, $p = 0.008$) and pseudocompound target words (OR = 2.23, $p = 0.007$). Contrary to the expected compound head advantage, the findings demonstrate that the semantic access of the first "constituent" is facilitated in comparison to the second "constituent" for both compound and pseudocompound words. In other words, responses were more accurate when probing *bed* in *bedroom* (and *fan* in *fanfare*) than for *belt* in *seatbelt* (and *sham* in *shamrock*). Notably, the decomposition of words seems to operate from left-to-right, not based on a "head-hunting" procedure.

Additionally, as expected, responses were more accurate when the target word was presented in the right visual field (projected to the LH) in comparison to when they were presented in the left visual field (projected to the RH; OR = 1.23, $p = 0.009$). These results are in line with the left hemisphere dominance of language processing (e.g., Hunter & Brysbaert, 2008) as well as the anatomical locus of the visual word form area (Cohen et al., 2000).

Response Times

Only correct responses were included in the model. The full model provided a statistically significant better fit to the data than a null model consisting of only random effects, $\chi^2(15) = 86.00$, $p < .001$, $R^2 = 0.29$, 95% CI [0.00, 0.37]. The main effects of whole word type ($\chi^2(1) = 7.05$, $p = 0.008$), word complexity ($\chi^2(1) = 30.39$, $p < 0.001$), and probed constituent position ($\chi^2(1) = 5.39$, $p = 0.02$) were all statistically significant. Additionally, the two-way interaction between probed constituent position and word projection ($\chi^2(1) = 22.58$, $p < 0.001$), as well as the three-way interaction between word complexity, probed constituent position and word hemispheric projection ($\chi^2(1) = 6.82$, p = 0.009) were statistically significant.

Consistent with the results for accuracy, planned comparisons revealed word complexity effects for compounds ($d = -0.63$, $p < 0.001$) and pseudocompounds ($d = -0.72$, $p < 0.001$), whereby responses to constituents (e.g., *####belt-BELT*) were faster than full words (e.g., *seatbelt-BELT*). Responses were also faster for compounds compared to pseudocompounds ($d = -0.27$, $p = 0.03$) which suggests that semantic access of "constituents" is facilitated when embedded in compounds as compared to pseudocompounds.

Additionally, word complexity effects were found when the pictures probed the first and second "constituents" of compounds ($d = -0.59$, $p < 0.001$; $d = -0.49$, $p = 0.003$, respectively) and pseudocompounds ($d = -0.53$, $p = 0.002$; $d = -0.68$, $p = 0.003$, respectively) in comparison with their "constituents". However, there was no advantage for the first "constituent" over the second "constituent" for compounds ($d = -0.17$, $p = 0.25$) and pseudocompounds ($d = -0.25$, $p = 0.11$).

Discussion

In the present study, we investigated whether the "constituents" of compounds and pseudocompounds are conceptually accessed. Participants judged the semantic relatedness between simultaneously presented compound or pseudocompound words and pictures representing referents of their "constituents". The comparison between compounds and pseudocompounds allowed us to examine the nature of the visual word recognition system. Several models and their predictions were tested. Namely, models positing a prelexical morpho-orthographic decomposition stage would predict that the compound and pseudocompound "constituents" are identified and conceptually accessed (e.g., Taft & Forster, 1975, 1976; Diependaele et al., 2009). Under this view, relatedness judgements should not differ between compounds and pseudocompounds. In contrast, the model postulating a postlexical morpho-semantic decomposition stage would predict that only compound constituents are represented during visual word recognition (Giraudo & Grainger, 2001, 2003). If word recognition involves a cascade of processes (Davis et al., 2019), then all sublexical "constituents" embedded in compounds and pseudocompounds are expected to be activated. In the case of pseudocompounds, the whole word meaning competes and ultimately inhibits the meaning of all activated "constituents".

Our main finding was that "constituents" embedded in pseudocompounds seem to be accessed, but to a lesser degree than constituents embedded in compounds—with longer and less accurate relatedness judgements. Notably, the "relatedness" judgement task we employed produced errors close to 50% in the case of pseudocompounds' first

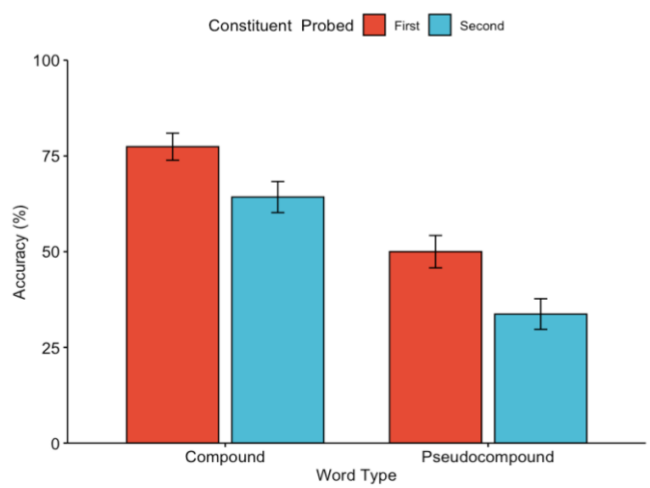

Figure 2: Mean accuracy for relatedness judgements as a function of probed constituent position for compounds (*bedroom-BED*/*seatbelt-BELT*) and pseudocompounds (*fanfare-FAN*/*shamrock-ROCK*). Data for both visual fields and hemispheric projections are plotted together. Error bars represent 95% CI of group means.

"constituent" and 30% when probing their second "constituent" (if we assume that the correct response is "no" between a pseudocompound word and the object depicting the pseudoconstituent). That is, 50% of the time *fanfare* is taken to be related to the object referent *FAN*. If there was no effect of morpho-orthographic parsing of the pseudocompound "constituents", we would expect judgments of relation between *fanfare* and *FAN* to be closer to zero rather than at chance.

Additionally, counter to our predictions of either a compound head advantage (Libben et al., 2003) or edge-aligned "constituent" access (Beyersmann et al., 2018), we found an advantage for the first "constituent" (i.e., "modifier position") across both word types. That is, pictures probing the first "constituent" (or modifier position) yielded more accurate relatedness judgements than pictures probing the second "constituent" in both compounds and pseudocompounds. There are two possible reasons for the first "constituent" advantage. One assumes that parsing proceeds in a left-to-right fashion and identifies the first potential constituent. Another reason might be that "constituent" meanings are quickly integrated following the modifier-head relation (Taft, 2004; Solomyak & Marantz, 2010; Gunther & Marelli, 2019). In particular, the compositional meaning is derived from the predication of the head by the modifier. For instance, the compound *seatbelt* refers to a *BELT* that is modified by *SEAT*. Thus, the constituent-based meaning computed from lexical processing is incongruent with the object referent *BELT*, leading to decreased relatedness judgements. Crucially, both reasons (i.e., left-to-right parsing and semantic integration) jointly point towards obtaining a modifier "constituent" advantage.

The decrement in accessing pseudocompound "constituents" was predicted by models positing cascading processes. To reiterate, these models rely on, first, co-activating all potential constituents computed from word recognition. In this case, both compound words (e.g., *bedroom*) and its probed constituents (e.g., *bed*) are judged related to the object (e.g., *BED*). By contrast, the recognition of the pseudocompound word involves the semantic access of its "constituents" (e.g., *fan* and *fare*) and full word (e.g., *fanfare*). However, the representations for full word and "constituents" compete which results in "constituent" inhibition. Given that the full word meaning remains activated, the picture (e.g., *FAN*) is thus judged as being less related to the full word.

To a first approximation, it seems that cascading processes cannot account for the preferential access of the first "constituent" over the second. However, the activation of embedded constituents can be triggered by initially identifying the leftmost constituent (see Taft & Forster, 1976; Libben, 1994). Thus, the meaning of the first followed by the second "constituent" can be quickly accessed and integrated with the full word meaning resulting in an inhibition for semantically unrelated "constituents".

Our results seem to be at odds with the predictions of models positing a prelexical parser that is entirely blind to the semantics of morpho-orthographic segments. A semantically blind system wouldn't distinguish between compounds and pseudocompounds, not at least when scanning one of its constituents. If the system reads left-to-right, a semantically blind morpho-orthographic mechanism should treat both compounds and pseudocompounds as yielding potential morphemes. If the system is morphologically savvy and a "head hunter" it should treat the second morpho-orthographic sequence as a potential morpheme. But our results show significant differences in RTs and accuracy between compounds and pseudocompounds at both segments. However, it is possible that the lexical parsing mechanism first identifies the leftmost constituent (thus, relying on a left-to-right pre-lexical algorithm) but with semantic information quickly ruling out misparses. That would be the case of a pseudocompound whose "constituent" *fan* is accessed but quickly ruled-out upon accessing the full word *fanfare*. The whole word meaning can be accessed via a postlexical route (proposed by dual-route models) or following a semantically anomalous composition of parsed "constituents". This in effect would reflect in faster and more accurate judgements for compounds given that the full word meaning is related to the meaning of the head, even if the referent picture stands for the head only (viz., the picture *BELT* is not the referent of a seatbelt but only of a generalized belt).

It is clear that the time-course of visual word recognition is faster than the time it takes to make a semantic judgement about a word and a picture. With our method, we aimed to capture the early moments of visual word recognition and lexical access by relying on a short (133 ms) presentation of words and pictures dichoptically, that is, without foveation. So, it is possible that the lexical targets—and thus their morpho-orthographic parsing—were degraded, limiting the scope of our results. However, it is important to note that the judgement accuracy for single constituents at the same spatial position as their embedded counterparts yielded high accuracy (around 90% for the first constituent and 80% for the second constituent) suggesting that parafoveal viewing was sufficiently clear to enable morpho-orthographic parsing.

Taken together, our findings support a model whereby the visual word recognition system produces left-to-right constituent recognition, with these constituents (or even pseudo-constituents) accessing their lexical entries, but with morpho-semantic processes rapidly ruling out misparses. In other words, "constituent" meanings are accessed, though only the representation of semantically related "constituents" remain active. Our suggestion is that both constituents and full words token their concepts; but while the concept BED is compatible with the complex word *bedroom* (and, thus, the concept BEDROOM), the concept FAN is incompatible with the monomorphemic word *fanfare* and is rapidly suppressed. This view is compatible with a model of visual word recognition that produces multiple parses that are initially insensitive to the semantics of morpho-orthographic sequences, but which are quickly evaluated by semantic-composition processes.

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