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The representation and processing of compounds words

Abstract: Compound words may be the language structures that are most fundamental to human linguistic ability and most revealing of its dynamics. We review evidence to date on the representation and processing of compound words in the mind and highlight the implications that they have for the broader understanding of language functioning and lexical knowledge. Our examination of the nature of compounds focuses on their deceptive simplicity as well as their dual nature as words and lexical combinations. Compound processing appears to be advantaged when compounds belong to morphologically productive families and when they are both formally and semantically transparent. We also claim that current findings offer converging evidence that compound word processing is characterized by both whole word and constituent activation for compound types.

Keywords: morphology, compounding, compound words, processing, psycholinguistics, semantic transparency, compositionality, productivity

1 Introduction and overview

Perhaps the most fascinating thing about language is that, through apparently simple acts of creating and combining words, human beings are able to develop the extraordinary richness and suppleness of communication that characterizes our species. In this chapter, we focus on compound words, which may constitute the language structure that is most fundamental to the human ability to create new language entities from existing ones. In this way, compounding offers special insight into the representation and processing of multimorphemic words across languages. Compounds are prevalent across languages, they often play an important role in the creation of new words within a language, and the major constituents of compound words are typically easily identified by native speakers. These properties make compounding an ideal candidate for the cross-

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linguistic investigation of the effects of positional, morphological, and semantic factors in lexical representation and processing.

In the sections below, we examine these factors through an integrated lens with which we strive to bring together linguistic and psycholinguistic insights into the role of compounding in lexical ability and the organization of the mental lexicon. We begin in Section 2 below with perspectives on the overall nature of compounding. In Section 3, we discuss semantic issues, focusing on transparency. This is followed by a discussion of more formal aspects of compound constituency (Sections 4, 5, 6) and, in Section 7, the effects of productivity in representation and processing. We discuss the acquisition of compounding in Section 8 and conclude with a summary statement concerning the evidence to date on the representation and processing of compound words in the mind.

2 The nature of compounding

2.1 Deceptive simplicity

Compounding is perhaps the simplest of morphological phenomena. Yet, it is often the things that appear to be the simplest that turn out to be the most revealing. A compound such as *boxcar* seems exceedingly straightforward. We know that it is a type of car, not a type of box. We are perfectly comfortable that it is a type of railway carriage, not a type of automobile. We feel that it is well-named (being box-shaped). Yet, *tramcar*, *sidecar*, and *stockcar* feel equally well-named. From the simple compound *boxcar*, larger compounds are easily constructed. These would include three-constituent compounds such as *boxcar wheel*, four-constituent compounds such as *railway boxcar* and, potentially, considerably larger constructions (e.g., *railway boxcar inspection facility*) that are linguistically quite complex, but not particularly difficult to process.

As the examples above indicate, compounds in a language such as English exhibit headedness, incorporate a variety of semantic relations between constituents, and exhibit recursion. In English, the head of the compound, the element which typically determines the lexical category of the compound, is always the last element of a compound. Thus, *boxcar* is a noun because *car* is a noun. However, this consistency of lexical category leaves open many semantic possibilities for the ways in which the head of a compound be related to modifying elements. For example, a *boxcar* has a *box*, but a *tramcar* does not have a *tram* – it is rather the other way around.

2.2 Distinguishing between compound words and other morphologically complex structures

One would expect that even an idealized native speaker of English (in the Chomskyan sense of someone who has perfect knowledge of the language) would struggle to classify English suffixed words (e.g., *warmed, warming, warmly, warmth, warmer*) as being examples of either inflectional or derivational morphology (or indeed know what that distinction refers to). However, compound words such as *skateboard*, *chessboard*, or *billboard*, seem to be an entirely different matter. Native speakers of English typically know what they are and typically have no difficulty appreciating their word-internal structure. This ease of identification seems to be a linguistic phenomenon. The real-world objects to which these words correspond have very little in common in terms of their physical structure – a *skateboard* has wheels, *a chessboard* does not. A *chessboard* is typically small and horizontal, a *billboard* is typically large and vertical. Yet, virtually all native speakers of English would recognize these words as having a common linguistic structure. They are all composed of two word-like elements, of which the second is the element *board*.

This simple initial observation highlights the dual nature that makes compound words so revealing of fundamental aspects of language representation and processing. On the one hand, compound words typically contain very recognizable sub-elements. On the other hand, they are used as integrated structures with specific whole-word meanings. This dual nature is the theme to which we will return throughout this chapter.

2.3 The dual nature of compound words: Can a word contain more than one word?

The dual nature of compound words has captured the attention of language theorists from the time of antiquity. Aristotle was perhaps the first to address the matter (in the Poetics), mainly because he recognized that the dual nature of compounds was problematic for an atomic theory of word meaning. The word *hard* has an atomic meaning. The words *hardness*, *hardship* and *harden* are clearly related to *hard*, but they too can be described as having an atomic meaning. In contrast, the compound words *hardhat*, *hardwood* and *blowhard* seem clearly to be composed of elements which themselves have lexical meaning. That was Aristotle's problem and he solved it by claiming that words within compounds lose their individual meaning to the meaning of the whole.

Jackendoff (2002, 2010) has also focused on what compounds can tell us about language evolution and the consequences that the role of compounding in human history can have for our understanding of compound semantics and more broadly, for the placement of compounding in a taxonomy of language structures. Jackendoff points out similarities between his perspective and that of Fanselow (1985) who characterizes compounding as a relic of a simpler human language system. Under this view, compounding can be linked to the kinds of (reduced) syntactic analyses seen among persons with Broca's aphasia and deep dyslexia. Jackendoff (2010) claims that the links between contemporary compounding and our linguistic history as a species explains the differences between properties of compounding and those of other morphological structure. He states that compounding is not a grammatical phenomenon, but, rather, a protogrammatical one (Jackendoff 2010: 422).

In the discussion that follows, we will treat compound words as those words that are built upon two or more lexical elements (i.e, roots, stems, or words). In doing this, we acknowledge the paradoxical situation in which the term compound words seems to be quite easy for dictionaries to define (e.g., Cambridge Dictionary: "A word that combines two or more different words"; Mirriam Webster: "A word consisting of components that are words"; Oxford: "A word made up of two or more existing words"). Morphologists have had a rather more difficult time arriving at a characterization of compound words that is adequate typologically and theoretically (see, for example Anderson 1992: 294–305; Lieber and Stekauer 2009).

It should be noted that definitions of compound construction (even those in the *A-morphous* tradition) typically begin with the assumption that compound constituents, when they are free-standing elements (e.g., *box* and *car* in English) will be non-distinct from their forms as words. This assumption has been challenged by Libben (2014) in which it is claimed that the activities of compound word production and comprehension creates new lexical forms that acquire specific morphological properties as compound heads (e.g., *-car*) or modifiers (e.g. *box-*) that are related to, but distinct, from the free standing words from which they come. Libben (2017) has argued that *duality* is a central property of compound words (and indeed all morphological structures). Under this perspective no multimorphemic construction can be assigned a univocal morphological structure. Rather, as cognitive processes, multimorphemic words exist as morphological superstates, which have the 'potential' to assume a variety of actual morphological states, depending on situational and processing demands.

3 Matters of meaning: Semantic transparency and compositionality

For compound words, the term semantic transparency is much debated in linguistic theory (see Acquaviva 2017; Rainer et al.2014). It most often refers to the extent to which the constituents of compounds maintain their whole word meaning within the compound structure. The term semantic transparency is related to, but not identical to the notion of semantic compositionality (Gagné, Spalding, and Nisbet 2016), which addresses the extent to which the meaning of a compound is a function of the meanings of its constituents and the manner in which they are put together syntactically (see Pelletier 2016).

To be sure, some compound words are more semantically transparent than others. At the extremes are very transparent forms such as *mountaintop*, which seems to mean nothing more or less than "the top of a mountain". At the other extreme are words such as *humbug*, whose meaning ('something designed to mislead or deceive') seems to have nothing to do with either *hum* or *bug*. It seems, however, that these examples are quite atypical. The vast majority of compounds have semantic properties that are similar to the examples with which we began this chapter: *skateboard*, *chessboard*, and *billboard*. In all these cases, a language user may appreciate the contribution of each lexical element to the meaning of the compound word as a whole, but it is also the case that if a language user did not previously know the meaning of the whole compound word, it would be very difficult to figure it out on the basis of the meanings of the constituent elements alone.

The theoretical construct of semantic transparency has been defined in various ways in psycholinguistic research. Semantic transparency has been discussed from the perspective of the compound, but also from the perspective of each constituent. For example, it has been defined in terms of the degree to which the meaning of the compound is predictable from the constituents, but it has also been defined in terms of the degree to which the meaning of each constituent is retained. Finally, semantic transparency has also been equated with the degree of association and semantic similarity between the meanings of a compound and each of its constituents. These various theoretical ways of construing semantic transparency have resulted in different ways of operationalizing this variable in psycholinguistic experiments and there are three primary ways of measuring semantic transparency. First, semantic transparency of compound constituents have been classified categorically as either transparent or opaque (e.g., Libben 2010, Sandra 1990, Smolka and Libben 2017). In Libben (1998, 2010), this approach was used to create the following 2 X 2 classification

for bi-constituent compounds: transparent-transparent, opaque-transparent, transparent-opaque, opaque-opaque. A still finer gradation has been proposed by Mattiello and Dressler (2018).

A second way to measure semantic transparency has been to use participant ratings on a scale ranging from very opaque to very transparent (e.g., Fiorentino and Fund-Reznicek 2009; Libben et al. 2003). The specific aspect that is rated varies but the two most common ones are the degree to which the meaning of the compound is predictable from the constituents and the degree to which each of the constituents retain their meaning in the compound. A third way of operationalizing transparency is by using estimates of semantic distance based on patterns of co-occurrence of words, such as latent semantic analysis (e.g., Kuperman 2013). Semantic distance is an indication of the degree of association between two words. These various ways of operationalizing semantic transparency have been shown to reflect different aspects of semantic transparency (e.g., Gagné, Spalding, and Nisbet 2016).

Semantic transparency has played an important role in evaluating theories of morphological processing because it has been shown to influence processing in both comprehension and production tasks. In general, compounds with opaque constituents are more difficult to process than compounds with transparent constituents. For example, lexical decision latencies were shorter for compounds with a semantically transparent head than for compounds with an opaque head (e.g., Libben, et al. 2003). Similarly, in an eye-tracking study, gaze durations were longer for opaque compounds than for transparent compounds (Underwood, Petley, and Clews 1990). Typing the initial letter of a word took longer for compounds with opaque first constituents than for compounds with transparent first constituents (Gagné and Spalding 2014a). In terms of priming experiments, both transparent and opaque compounds show evidence of repetition priming, i.e., they both benefit from exposure to one of the constituents. However, only transparent compounds benefit from exposure to a word that is semantically related to one of the constituents (e.g., Sandra 1990). The locus of the difference in processing difficulty for transparent and opaque compounds appears to arise from the degree of competition or conflict between aspects of the whole-word and the constituents. For example, manipulations that aid parsing of the compound and the identification of the constituents (such as presenting the constituents in different colors or inserting a space between the constituents) benefitted the processing of transparent compounds but slowed the processing of opaque compounds (Ji et al. 2011). Studies measuring typing latencies (e.g., Libben and Weber 2014) found that there is an increase in latency for the first letter of the second constituent relative to the last letter of the first constituent and that this delay is smaller for fully opaque compounds than

for fully transparent or partially-opaque compounds. Although coming from a variety of tasks, these findings are similar in that they suggest that compound processing involves not only access of the entire word, but also access of the constituents.

Given that the constituents of a compound appear to be available during processing, this raises questions concerning the role of those constituents. In particular, are the constituents used to access the whole word recognition via conjunctive activation or are they actively involved in some sort of meaning construction process, as is the case during conceptual combination for novel combination (Gagné and Spalding 2009)? Central to this issue is the notion of compositionality (cf. Acquaviva 2017; Rainer et al. 2014). Is it the case that compounds are fully compositional in that their entire meaning can be derived solely from the constituents? Probably not. There are always aspects that are not directly known from the parts alone but are known only via the combination of those parts. However, in this sense, the same can be said of other constructions such as noun phrases. To take an example dating back to early work on conceptual combination, the knowledge that a *wooden spoon* is made of wood and that a *metal spoon* is made of metal can be determined from the linguistic construction and knowledge of the constituent concepts. However, the knowledge that wooden spoons are larger than metal spoons and are more likely to be used for cooking than for eating is not directly inherited from each constituent directly but is something that is inferred based on the combination, as well as from world knowledge. Thus, the lack of full predictability in terms of meaning does not necessarily entail that compounds are not compositional. On the contrary, even partial compositionality provides some aspects of a compound's meaning. For example, people can determine that a raspberry is some type of berry even though they are not entirely sure what the "rasp" contributes to it. Indeed, knowledge of the constituents does allow for the creation of a gist-based interpretation and the ease of construction of this interpretation influences ease of processing (e.g., Gagné and Spalding 2014b; Schmidtke et al. 2016).

4 Compound heads and compound modifiers

Relations among compound words and their constituents offer a special opportunity to understand how word and constituent meanings interact in lexical representation and processing. Moreover, it creates comparable opportunities across languages. As Dressler (2006) has noted, compounding is a near ubiquitous feature of word formation across languages. And, the fact that compound

words, by definition, are composed of two or more lexical elements, makes them an ideal word type with which to examine cross-linguistic similarities and differences. For example, in English, as in all Germanic languages, all compounds are "head-final" – the last element of the compound carries its grammatical features and typically signifies its semantic category. Thus, whereas a *skateboard* is a type of *board* (because *board* is the final element, a *boardroom* could never be a type of *board*. It must be a type of *room*. There are languages for which this order is reversed. In Hebrew, for example, all compounds are head initial so that the word *chessboard* has the form *board-checkmate* (*lu'ach shachmat*). French, like other Romance languages has both head-initial and head-final compounding, with a preference for the head-initial variation. Thus, in French, the compound *skateboard* is a compound with board as its initial element (*planche à roulette)*.[1]

5 Non-lexical elements within compounds

As the French example above illustrates, not all languages represent compound words as simple concatenations of lexical elements. The compound *planche à roulette*, for example contains the preposition *à,* (meaning *to* in English). The presence of such grammatical elements is not at all uncommon and can also be seen in some (rare) English forms such as *man-of-war*. Although prepositions within compounds seem to signal the semantic relation between the lexical elements of a compound, it is not clear that they are used by language users during lexical comprehension or that they add comprehensibility. The word for *potato* in French is the compound *pomme de terre* (apple of the earth), which contains the preposition *de* (meaning *of*). The words for *apple* in Dutch and Austrian German contain the same lexical elements, with no preposition (*ardappel, Erdapfel*, respectively) and, of course, have the exact same meaning. In Hebrew and in Persian it has the same lexical elements (*earth* and *apple*), but, again, no intervening prepositional element.

1 The compounds we cite as examples can be described as endocentric (see Bisetto & Scalise 2005). These are typically words for which the compound is a hyponym of its head element (e.g., *housecat* is a type of *cat, boxcar* is a type of *car*). Exocentric compounds (e.g. *egghead*, *scarecrow*) are less common and show a much less straightforward relation between the final element and the whole compound (e.g., An *egghead* is not a type of *head*, but rather a type of person; a *scarecrow* is not a type of *crow*, but rather a figure of a man placed in a field in order to scare crows away).

In addition to overt prepositions, compounds can contain internal elements, most often referred to as interfixes. A very common type of interfix is the vowel 'o', which can be seen in the English word *gasometer* and *thermometer* (Dressler and Barbaresi 1991). This particular interfix can be traced back to a thematic vowel in Latin and Ancient Greek. It is widespread in Romance languages and Modern Greek, e.g. Italian *sessu-o-fobo* 'sex-o-phobic', Greek. *xart-o-péktis* 'card player' (< *xartí* 'card' and *péktis* 'player', Ralli 1992: 152), as well as in Slavic languages, e.g. Polish *kraj-o-znawstwo* (literally 'country science', meaning the study of national customs). Germanic languages such as Dutch commonly also show interfixes, as does German, which has a very complex system of interfixation in which compound words can have no interfix or the interfixes 'e', en', 'n', 's', and 'er', as in the word *Kindergarten*, which is composed of the elements *kind+er+garten*, meaning *child* + interfix + *garden*. Although it seems that, in principle, the presence of such interfixes could serve as constituent boundary markers that aid in the on-line processing of compound words, current evidence suggests that compounds with interfixes are processed more slowly than those without interfixes (Dressler et al. 2001).

6 Compound words across writing systems

As the French example above illustrates, not all languages represent compound words in their orthography as single words. German, as a language, is famous in the popular literature for having extremely long compounds. However, as shown in our examples of *boxcar wheel* and *railway boxcar* above, the presence of three constituent and four constituent compounds is not unusual in English either. The difference, of course is that German compounds are written without spaces between constituents whereas, in English, compounds with more than two constituents are written with at least one space at the point of the major constituent boundary. The result, from a processing perspective, is that a person reading a German compound is faced with the challenge of finding the constituent morphemes. At the other extreme are writing systems for Chinese (and Japanese Kanji) in which the reader has the opposite challenge. In Chinese, which also has a great deal of compounding, the reader needs to correctly group characters so that constituent morphemes are joined into compound structures because the constituent morphemes are represented as single characters surrounded by spaces (see Miwa, Libben, and Yu 2017).

It is not always the case that compounds are represented in a consistent form in a language's writing system. In English, whether a compound is written

as two words, as a hyphenated word, or as a single word is generally related to the extent to which it is lexicalized. There are, however, many exceptions (e.g., *ice cream*) in which a high frequency compound is written as two words, or in different ways, depending on context (e.g., *ice cream* vs. *ice-cream cone*). As reported by Bertram (2012), Finnish has shown a tendency to use hyphenation to increase reading transparency. Bertram et al.(2011) have also reported the development of within-experiment processing advantages when hyphens are inserted into Dutch and Finnish compounds that are normally written as one word. These apparent examples of hyphenation advantages in the processing of existing compounds points to the conclusion that facilitating constituent access has processing advantages and thus that such constituent access is integral to normal compound word processing.

7 Productivity

Productivity of word formation is a multifaceted linguistic construct (see Bauer 2001; Dal and Namer 2017; Plag 1999) that basically refers to the potential to form new words to express a concept with a given pattern or word-formation rule.

As we noted at the outset of this chapter, compounding, particularly in languages such as English and German is extremely productive. New words will often be coined through compounding. Because the meanings of newly coined compounds are scaffolded by the meanings of the words to which their constituents are related, they are much easier to understand than monomorphemic neologisms would be. For example, the 2017 additions to the Mirriam Webster English dictionary include the compounds *abandonware*, *binge-watch*, *photobomb*, and *humblebrag*. It is testimony to the productivity of compounding as a word formation process in English that the reader will not be terribly surprised to learn that *humblebrag* means 'to make a seemingly modest, self-critical, or casual statement or reference that is meant to draw attention to one's admirable or impressive qualities or achievements'.

It is noteworthy that *humblebrag* is easily understood despite the fact that neither the constituents *humble* nor *brag* commonly participate in English compounding. The effects of compound productivity are yet stronger when there is a known pattern. For example, given the pattern *Brazil nut*, *peanut*, *pine nut*, and *hazelnut*, a new compound (e.g., *orange nut*) is easily incorporated into the morphological family.

Productive patterns differ among languages along a number of dimensions, including obligatoriness. In Slavic languages, for example, the medial insertion of the interfix *–e-* or *–o-* is obligatory (e.g. Russian *zeml´+e+tr`asenie* 'earthquake', where the interfix *–e-* replaces the feminine nominative singular stem ending *-a* of *zeml´a* 'earth').

More productive patterns produce more new words than less productive patterns. This relates to the profitability of a pattern in both type and token frequency. However profitability may also be restricted by grammatical restrictions, for example in the above-mentioned Russian pattern, where after a root-final palatalized consonant, such as *l'*, an *-e-*interfix has to be inserted, whereas it is an *-o-*interfix that must be inserted after a root-final non-palatalized consonant. An additional consideration is that pragmatics may have an impact on frequency, e.g. which pattern is deemed to be fashionable.

Dressler (2007) has argued that the most productive patterns apply to new foreign words whose shape is thereby adapted to conditions holding for earlier existing words. An example is the German compound *Firm+en+gruppe* 'group of firms', where the *-en-* interfix replaces the final stem vowel of *Firma*. Less productive rules may have more restricted application, so that they apply to native words, but not to foreign words. The reason for this is that creating a new word on the basis of a new foreign word violates existing lexical norms more than creating a new word on the basis of a well-established existing word.

Productivity is clearly a scalar concept ranging from fully productive patterns to unproductive ones. No new words are created non-intentionally or subconsciously, i.e. with little language awareness via an unproductive pattern (see Dal and Namer 2017: 71–73). But poets (and, similarly, advertisers) may use unproductive patterns in creating occasionalisms for a poetic function at a specific place in a text. For example, in his novel *Der Tod des Vergil* 'The Death of Vergil', the Austrian poet Hermann created many 'occasional' compounds, such as *Tod und Aber+tod* 'deaths and deaths again' with the isolated first member *aber*, which recurs only in the unproductive compound *aber+mals* 'again' and in the unproductive pattern restricted to high numbers, such as *hunderte und aber+hunderte* 'hundreds upon hundreds of'.

Although the notion of productivity refers to potential words that can be created through a word formation pattern, when that potential is realized, it shapes the patterns of actual words in the language. Thus, the richness of compounding in a language is very much related to the number of productive compounding patterns that the language possesses.

8 The acquisition of compound knowledge

Productivity is also important for language acquisition: In languages with rich and productive compounding, the degree of richness of compounding in child-directed speech is predictive for the age at which compounds become productive in child speech. As reported in Dressler, Ketrez, and Kilani-Schoch (2017), this occurs earlier in children acquiring Danish, German, Estonian, Finnish and Saami than in acquiring French, Greek, Russian and Hebrew, where compounding is less productive (cf. Berman 2009; Dressler, Lettner, and Korecky-Kröll 2010 and the chapter by Keuleers, Ravid, and Dressler 2020, in this volume).

Productive use of compounding by children is demonstrated in the frequency of compound types and the co-occurrence of at least a small family size of their compound members either in the same position in a compound and/or by being produced as autonomous words. This is most often followed by children's creative formation of novel words, such as Danish *bamse+hund* 'teddy bear dog', *hunde+mann* 'dog man' (both produced at age 2;4, Kjærbæk and Basbøll 2017). All such neologisms produced by children are morphosemantically transparent, which is not the case for adults (Mattiello and Dressler 2018), who often form new morphosemantically opaque compounds by analogy to already existing morphosemantically opaque compounds as in *babymoon* created in analogy to *honeymoon*. This difference points to a view in which compounding may begin with spontaneous productivity from which later analogical patterns develop.

Early emergence of compounding is facilitated by morphotactic (or phonological) transparency, which in turn facilitates morphological decomposition of complex words and word forms (cf. Aksu-Koç and Slobin 1985; Dressler, Ketrez, and Kilani-Schoch 2017). Thus, in German, compounding that involves the simple concatenation of words (e.g. *Polizei+auto* 'police car') emerges earlier than any compounding patterns that insert an interfix (or linking morpheme) between the two words (e.g. *-n*-interfix in *Orange+n+zuckerl* 'orange candy'). Productivity and transparency enable children acquiring agglutinating languages, such as Finnish and Saami, to produce compounds precociously. Furthermore, exocentric compounds (e.g. *hot-head*) are more opaque than endocentric ones, because they only have a covert head, i.e. the head must be reconstructed. This explains their rarity in adult languages and especially in child-speech.

The approach of Lexical Typology, which compares in an onomasiological way whether complex concepts are expressed by compounds, derivations, multilexical words, phrases or simplex words in various languages, allows us to characterize the relative prominence of compounding in these languages and also to predict the prominence of compounding in child language (Dressler, Ketrez, and Kilani-Schoch 2017), both in terms of early emergence and in type

and token frequency, provided that the prominence in child-directed speech does not differ much from prominence, as found in corpora, dictionaries and grammars.

Since compounded nouns are the most diffused types of compounds, probably due to a certain noun bias of many languages, it is no wonder that compounded nouns are often the first to emerge in child speech. Moreover, both child-directed and child speech show in most languages of the sample studied in Dressler, Ketrez, and Kilani-Schoch (2017) a clear preference for a noun in the non-head position. In some of them noun-noun compounds are the only ones produced in early child speech.

9 Conclusions and implications for the mental representation and processing of compound words

Our discussion of compound words began with the claim that compounding may be the oldest of human morphological processes. As the considerations above suggest, it may also be the best. Because the morphological components of compounds are relatively unconstrained positionally (e.g. a noun such as *board* can be both the modifier in a compound noun such as *boardroom* and the head in a compound noun such as *surfboard*), a large number of compounds can be created from a small number of lexical constituents. The development of compound families may serve to organize lexical knowledge in the mind so that conceptual associations are scaffolded by lexical overlap.

An important feature of compounding is its transparency of structure. As we have noted above, native speakers of a language can easily identify compounds as words that contain lexical subunits. Thus, at the conscious level and in the automatic processes of online lexical processing, compounds have constituent structure.

It seems that this dual nature has substantial processing advantages. It maximizes the opportunity for meaning creation, it maximizes the opportunity for linkage within the mental lexicon, and it provides both the means and motivation for lexical expansion across the lifespan and within a language community. Compound constituents play a role not only in word creation, but also routinely during language comprehension and production. If this were not the case, it would be difficult to explain why the semantic transparency of known compound words would play a role in lexical recognition and production. Indeed, numerous

studies have demonstrated that when a compound word such as *boxcar* is encountered its processing by native speakers of a language includes the activation of *box* and *car* as distinct units (Gagné 2017; Libben 2014). At present, it is less clear whether constituent activation effects are present when compound words are read in connected text and the extent to which the effects seen in visual word recognition are as evident in auditory processing or in language production, for which there has thus far been considerably less experimental evidence. Nevertheless, it seems to be the case that a summary statement concerning evidence to date on the representation and processing of compound words in the mind might be as follows.

Compound words that are easiest to process are those that belong to productive patterns, are morphologically simple (without interfixation), and are semantically transparent. Evidence thus far obtained in studies of online compound processing suggests that both whole word representations and constituents of compound words are activated. This activation is present whether or not compound words are semantically transparent and whether or not they are written with spaces, without spaces, or with hyphens. Thus, compound words are both greater than the sum of their parts and greater than the division of their wholes.

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