Marrying cognitive-linguistic theory and corpus-based methods: On the compositionality of English V NP-idioms

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Abstract

This paper presents a corpus-linguistic compositionality measure for V NP-Constructions (*make a point*, *take the plunge*) that implements fundamental assumptions of Construction Grammar:

- the *semantic contributions* made by all component words to the constructional meaning are quantified;
- the component words' semantic contributions to the constructional meaning are weighted as a function of their *cognitive entrenchment*;
- the component words' semantic contributions are assessed both in terms of how much of their own *meaning potential* they contribute to the construction, and conversely, how much of the constructional semantics is accounted for by the component word.

The results obtained for more than 13,000 tokens of 39 V NP-Constructions extracted from the *British National Corpus* tie in well with established findings from psycho-linguistic research. Ultimately, the model strengthens the case for usage-based approaches to grammar, demonstrating that a seemingly intuition-based, complex phenomenon can be modeled bottom-up using performance data.

Keywords: collocation, compositionality, constructicon, Construction Grammar, corpus linguistics, entrenchment, idioms, semantic similarity, semantic weight, V NP-Construction

1. Introduction

One of the most popular topics in contemporary cognitive-semantic research is phraseology, more specifically, the nature of phraseological expressions and their role in language theory. The growing recognition of phraseological units as a major part of language has sparked interest in quantitative approaches to compositionality, which appears to be a very important parameter along which phraseological expressions vary. Compositionality is defined as "the degree to which the phrasal meaning, once known, can be analyzed in terms of the contributions of the idiom parts" (Nunberg *et al.* 1994:498). An adequate compositionality measure would constitute an important step towards the (automatic) identification of phraseological units, which in turn may inform the daily work of lexicographers and language teachers, further progress in fields of natural language processing such as machine learning and machine translation, and ultimately advance our theoretical understanding of the most fundamental issue in linguistics, the creation of meaning.

While a number of compositionality measures have been proposed lately, the issue I would like to address in this paper is that although these approaches are often very impressive with regard to the quantities of data taken into consideration and the computational skills involved, it appears that most of these measures are not explicitly framed in any particular theoretical framework. Little attention is paid to the question if and to what extent the assumptions underlying the compositionality measure are compatible with a theory of language at a more general level. What is more, the quality of the data used to test the measures is often compromised in favour of large sample sizes and extraction speed such that the constructions of interest are extracted fully automatically and not checked manually for false hits, which may, of course, distort the results considerably (and even affect them adversely such that the measures proposed may indeed perform much better in reality than they do on these unreliable data sets). This paper presents a step towards closing these gaps by presenting a corpus-linguistic compositionality measure for V NP-Constructions (*make a point*, *take the plunge*) extracted from the *British National Corpus*; cf. section 3. The measure presented in section 4 goes beyond previous approaches in trying to implement fundamental assumptions of cognitive-linguistic / constructionist approaches to language, more specifically, a constructionist perspective that is briefly outlined in section 2. Section 5 presents the results thereby obtained; section 6 concludes.

2. A constructionist perspective on compositionality

Our understanding of compositionality (sometimes also referred to as decomposability), that is, the degree to which the meanings of the component words of a phrasal expression contribute to the meaning of that phrase, has

undergone dramatic changes over the last decades. For most of the last century, the discipline of linguistics has been dominated by a Chomskyan view of language, in which compositionality was defined as a binary concept that divided language into idioms and non-idioms. Idioms seemed to undermine the sharp division between grammar and lexis as assumed by generative approaches: on the one hand, they behave like composite, rule-derived structures with regard to their potential to undergo syntactic transformations or modifications; on the other hand, idioms encode unitary semantic concepts, which makes them word-like. Consequently, idioms were mostly treated as exceptions and a phenomenon that is marginal to language (Sonomura 1996).

More recently, however, the generative-transformational paradigm with its sharp distinction between syntax and the lexicon, its primary emphasis on syntax and relative neglect of semantics for an adequate description of language, and its claim that the core grammar of the human language faculty is actually innate, triggered a variety of critical responses from the fields of linguistics, psycholinguistics, and psychology. Together, these responses have contributed to establishing Cognitive Semantics as a field of research. Discourse-analytical approaches lay the foundation for a new role of semantics in linguistic research by emphasizing that phraseological units are not a marginal phenomenon in language, but on the contrary are highly prominent and therefore indispensable units of a language (Wray 2002). This view ultimately also entailed that the boundaries between idioms, collocations, and other multi-word units are fuzzy; idioms and collocations are supposed to overlap to some extent on a continuum of fixed expressions (Fernando 1996).

A scalar conception of compositionality also received considerable empirical support from various psycholinguistic studies. All in all, these studies suggest that the literal meanings that are activated during processing facilitate idiomatic construction comprehension to the extent that they overlap with the idiomatic meaning. To give but one example, Gibbs and colleagues (Gibbs and Nayak 1989; Gibbs *et al.* 1989) demonstrated that subjects can distinguish between at least three classes of idiomatic constructions in terms of their compositionality, and that sentences containing decomposable constructions are read faster than those containing non-decomposable constructions (for further studies making similar points, cf. Peterson and Burgess 1993; Titone and Connine 1994; McGlone *et al.* 1994; Glucksberg 1993).

In this paper, I adopt a constructionist perspective on compositionality, more specifically, the Goldbergian version of Construction Grammar (Goldberg 1995, 2006); in the following, I will briefly outline how this framework elegantly handles the above-mentioned findings.

In Construction Grammar, a construction is defined as a symbolic unit, that is, a form-meaning pair; given this definition, constructions are not restricted to the level of words, but pervade all layers of language, from morphemes to words to combinations of words. The side-by-side of simplex and complex as well as lexically specified and totally unspecified constructions which are continuously changing on the basis of language input and output ultimately supersedes the distinction between syntax and the lexicon. Instead, the totality of these constructions is often assumed to be stored in the so-called 'constructicon', an expanded lexicon. The constructicon can basically be described as a network of constructions which is organized in analogy to what is known about other conceptual categories, i.e., principles like inheritance, prototypicality, and extensions are some of the major organizational principles. Consider Table 1 for a schematic representation of the constructicon.

Table 1. A schematic representation of the constructicon (from Goldberg 2006:5)

Morpheme	*pre-, -ing*
Word	*avocado, anaconda, and*
Complex word	*Dare-devil, shoo-in*
Complex word (partially filled)	[N-s] (for regular plurals)
Idiom (filled)	*going great guns, give the Devil his due*
Idiom (partially filled)	*jog* <someone's> *memory, send* <someone> *to the cleaners*
Covariational Conditional	The Xer the Yer (e.g. *the more you think about it, the less you understand*)
Ditransitive (double object)	Subj Obj1 Obj2 (e.g. *he gave her a fish taco; he baked her a muffin*)
Passive	Subj aux VPpp (PP_{by}) (e.g. *the armadillo was hit by a car*)

As can be seen in Table 1, constructions range from simple and fully lexically specified to increasingly complex, lexically partially or not specified constructions. Lexically nearly or fully specified complex constructions, which occupy the middle range of the constructicon, are referred to as idioms, which may be interpreted as implying that they are non-compositional (to a considerable extent at least). However, it should be

noted here that while the integration of non-compositional expressions has been a major impetus for the development of Construction Grammar, complex constructions are not necessarily non-compositional: even highly compositional expressions that are used sufficiently often to become entrenched in the speaker's mental lexicon qualify as constructions (Goldberg 2006:64). Indeed, both lexico-syntactic variability and compositionality prevail at all levels of the constructicon (Croft and Cruse 2004), albeit in different shades of prominence and relative importance. This way, Construction Grammar licenses an understanding of compositionality as a scalar phenomenon that captures the whole range of constructions from fully compositional to metaphorical to perfectly non-compositional. Accordingly, the level of constructions referred to as idioms in Figure 1 can be expected to cover constructions like *write a letter* (as compositional and combinations that are assembled on the spot of words from the constructicon), to metaphors like *break the ice*, to highly non-compositional constructions such as *kick the bucket*. Only the latter are traditionally referred to as idioms, but given our understanding of compositionality as scalar in nature, we can regard fully compositional and fully opaque constructions as two extremes on an idiomaticity *continuum*. This way, all constructions at this level of syntactic complexity and lexical specification in the constructicon can be referred to as idioms, or maybe, to avoid confusion with the traditional usage of the term, as idiomatic constructions.

Next to the conception of compositionality as a scalar phenomenon, a constructionist perspective entails a number of working assumptions that an adequate compositionality measure should be able to incorporate. Firstly, it is assumed that any complex construction comprises a number of smaller constructions, all of which make a semantic contribution to that complex construction (in other words, constructions further up in the constructicon as shown in Figure 1 feed into the semantics of constructions further down of which they are part; cf. Goldberg 2006:10). In the case of V NP-Constructions as investigated here, this means that both the verb and the noun phrase of a V NP-Construction are expected to make a contribution. This actually stands at odds with most existing measures, which take only the contribution of, say, the head of a phrase into account.

Secondly, constructions are assumed to be differently entrenched in the constructicon depending on – among other things – their frequency of use. Accordingly, a theoretically informed measure should (i) license the possibility of component words making variably large contributions (since there is no reason to assume that verbs and noun phrases make equally large contributions to V NP-Constructions), and (ii) the measure should be item-specific in the sense that the contribution of any component word can be differently large depending on the construction in which it occurs. For instance, it is desirable to have a measure that licenses the possibility that the contribution made by *point* in *see a point* is higher or lower than in *make a point*.

In a nutshell, the agenda is to develop a corpus-linguistic measure that is based on a large-scale data sample (in order to obtain representative results), that takes all the component words of the construction into consideration, that assesses the relative contribution made by each component word and integrates these numbers into an overall compositionality index value for that construction, and that, last but not least, reflects potential interval-scaled differences in the entrenchment of the complex construction and its component lexical constructions.

3. V NP-Constructions in the *British National Corpus*

All instantiations of 39 V NP-Constructions (13,141 tokens total) were retrieved from the *British National Corpus* (BNC), which is the largest publicly available corpus of contemporary British English to date. The construction types were primarily selected on the basis of the *Collins Cobuild Idiom Dictionary*. 262 V NP-Constructions are listed in the dictionary, 33 of which occur more than 90 times in the BNC (this frequency threshold had to be met to license statistical evaluation). While the definition of idiom in this dictionary already captures a substantial part of the idiomaticity continuum, in order not to bias the sample towards one end of the continuum, the sample was extended by another six constructions randomly selected from a concordance of all verb-noun phrase sequences in the BNC that occur more than 100 times (*call* DET *police*, *close* DET *door*, *make* DET *point*, *see* DET *point*, *tell* DET *story*, and *write* DET *letter*). (1) lists all 39 V NP-Constructions with their frequencies (in all their variant forms) in parentheses.

(1) bear DET[1] fruit (90), beg DET question (163), break DET ground (133), break DET heart (183), call DET police (325), carry DET weight (157), catch DET eye (491), change DET hand (212), close DET door (827), cross DET finger (150), cross DET mind (140), deliver DET good (145), do DET trick (155), draw DET line (310), fight DET battle (192), fill/fit DET bill (116), follow DET suit (135), foot DET bill (109), get DET act together[2] (142), grit DET tooth (164), have DET clue (232), have DET laugh (98), hold DET breath (292), leave DET mark (145), make DET headway (136), make DET mark (213), make DET point (1,005), make/pull DET face (371), meet DET eye (365), pave DET way (269), play DET game (290), scratch DET head (100), see DET point (278), take DET course (294), take DET piss (121), take DET plunge (115), take DET root (113), tell DET story (1,942), write DET letter (1,370)

All instances of the verb and the noun phrase, both with the verb preceding the noun phrase and vice versa, within the context window of one sentence were searched for; the resulting concordances were cleaned manually. The maximally inclusive search expression ensured that all matches of the constructions in question would be retrieved, and the manual checkup ascertained that only true matches remained in the final data sample.

4. Weighting the semantic contributions of words to constructions

Starting out from the assumption that compositionality is a function of the semantic similarity of the constituent words and the phrasal expression, a number of corpus-linguistic compositionality measures have been proposed lately. Some measure compositionality via the ability to replace component words without losing the idiomatic interpretation of the construction (Lin 1999; McCarthy, Keller and Carroll 2003); others measure it via the semantic similarity of the contexts of the constructions compared with those of the component words (Schone and Jurafsky 2001; Bannard, Baldwin and Lascarides 2003; Bannard 2005).

The measure presented here also adopts the latter approach: the working hypothesis is that the semantic similarity of two words or constructions is reflected in the extent to which they share collocates. Collocates of words are "the company they keep", that is, words that occur more often in a (usually user-defined) context window left or right of the word than would be predicted on the basis of the word's general frequency. The more semantically similar two words or constructions are, the more similar their contexts will be, which can be measured by looking into the collocates of these words and constructions. As a matter of fact, Berry-Rogghe (1974) presented a measure along this line of thought. In a study on verb particle constructions (VPCs), Berry-Rogghe defined the compositionality of a VPC as the overlap between the sets of collocates associated with the particle P and the VPC respectively (Berry-Rogghe 1974: 21-22). Technically speaking, this overlap can be converted into an index value R that is computed by dividing the number of collocates shared between the VPC and the particle by the total number of collocates of the VPC as shown in (2). R can range between 0 when there is no overlap at all, so the VPC is perfectly non-compositional, and 1 when the collocate sets of the particle and the VPC match perfectly, i.e. the VPC is fully compositional.

(2) $$R = \frac{\text{n collocates P} \cap \text{VPC}}{\text{n collocates VPC}}$$

For the present study, original R was improved in several ways. First of all, the analysis was based on the 100 million word *British National Corpus* rather than Berry-Rogghe's 202,000 word corpus (of texts by D. Lessing, D.H. Lawrence, and H. Fielding), which provides a more comprehensive semantic profile of the component words and the construction.

Secondly, while Berry-Rogghe used the z-score as an association measure to identify significantly associated collocates, I opted for the Fisher Yates Exact (FYE) test instead (which is the arguably better choice for a variety of reasons that I cannot outline here in detail for reasons of space; for a more detailed account, cf. Stefanowitsch and Gries 2003: 217-8). Also, I did not include all significantly associated collocates into the collocate sets that were checked for overlap; instead, collocates had to yield an association strength of FYE≥100[3] to enter into a collocate set.

Last but not least, Berry-Rogghe focused only on the contribution made by one component word, the particle, and therefore totally disregarded any potential contribution made by the verb. As outlined above, this procedure is not reasonable from a constructionist perspective since it is assumed that all component words make a contribution to the constructional meaning. Consequently, for the V NP-Constructions investigated here, the major question is how to combine the R-values for both the verb and the noun phrase into one overall compositionality index value. How do we determine their relative importance, bearing in mind the different expectations that we have from a constructionist point of view?

The solution that I would like to suggest here is an extension of R. In a first step, the original R-value is computed for each component word W, which reflects how much of the semantics of a construction C that W is part of is accounted for by W. In a second step, the original R-value is weighted by what I will henceforth refer to as W's share. The share reflects how much of *itself* W contributes to C. Technically speaking, it is the ratio of the number of collocates shared between W and C divided by the total number of collocates of W. Consider the corresponding formula in (3).

(3) $$\text{contribution}_W = R \times \text{share}W = \frac{\text{n collocates W} \cap \text{C}}{\text{n collocates C}} \times \frac{\text{n collocates W} \cap \text{C}}{\text{n collocates W}}$$

Let me illustrate the motivation for this approach to weighting the contribution of a component word with an example. Consider the V NP-Construction *make* DET *mark*. Obviously, *make* is a high-frequency verb, and since the number of significant collocates a word will attract is naturally correlated with its overall frequency of occurrence, *make* has many significant collocates (even given my highly restrictive association strength threshold). The noun *mark*, on the contrary, is much less frequent, and consequently, it attracts fewer significant collocates. In sum, the collocate sets of *make* and *mark* differ in size considerably. From this, we can deduce that *make* stands a much higher chance to contribute to *any* construction's semantics than *mark*; what is more, since lexically fully specified complex constructions cannot be more frequent than their component words and accordingly always have relatively smaller collocate sets, the resulting overlap between a highly frequent component word's collocates and the construction it is part of will be quite high *by default*. In the case of *make* DET *mark*, original R actually amounts to 1.0: *make* DET *mark* attracts 33 significant collocates, all of which it shares with *make*'s collocate set. In other words, the semantic contribution of *make* to *make* DET *mark* may be considered extremely high when looking only at how much of the construction's semantics is accounted for. When we look into the opposite direction, however, we see that at the same time, *make* contributes only a fraction of its meaning potential: the 33 collocates it shares with *make* DET *mark* constitute only a small share of its total collocate set comprising 4,234 collocates. This calls for a re-evaluation of the semantic similarity between *make* and *make* DET *mark*. By multiplying the original R-value by the share value, we achieve exactly that.

For *mark*, a totally different picture emerges: the overlap between *mark*'s collocate set and that of *make* DET *mark* is 31, which again indicates a high semantic contribution, and since *mark* attracts 298 collocates overall, the share of 31 out of 298 is relatively high. That is, *mark* is semantically much more similar to *make* DET *mark* than *make* is in the sense that it is much more semantically tied to this construction, while *make* occurs in so many different contexts so much more often that one cannot speak of a specific semantic association between *make* and *make* DET *mark*.

In sum, the overall compositionality value of a construction C is defined as the sum of the weighted contributions of all its component words W (in the case of V NP-Constructions, the verb and the noun phrase). In order for the overall compositionality value to range between 0 and 1, it would principally be necessary to divide it by the number of component words that entered the computation (here: two); however, for the V NP-Constructions and the VPCs discussed here, the values were extremely small already, so the values reported here are not divided. However, this not a problem as long as only the results of one analysis are compared (since the ranking of the constructions remains the same), but once results from several analyses are compared, it may be reasonable to do the division in order to stay within the range from 0 to 1.

5. Results

Let us turn to the results for the whole data sample of V NP-Constructions. Figure 2 provides an overview (cf. also Table 2 in the appendix for the exact values).

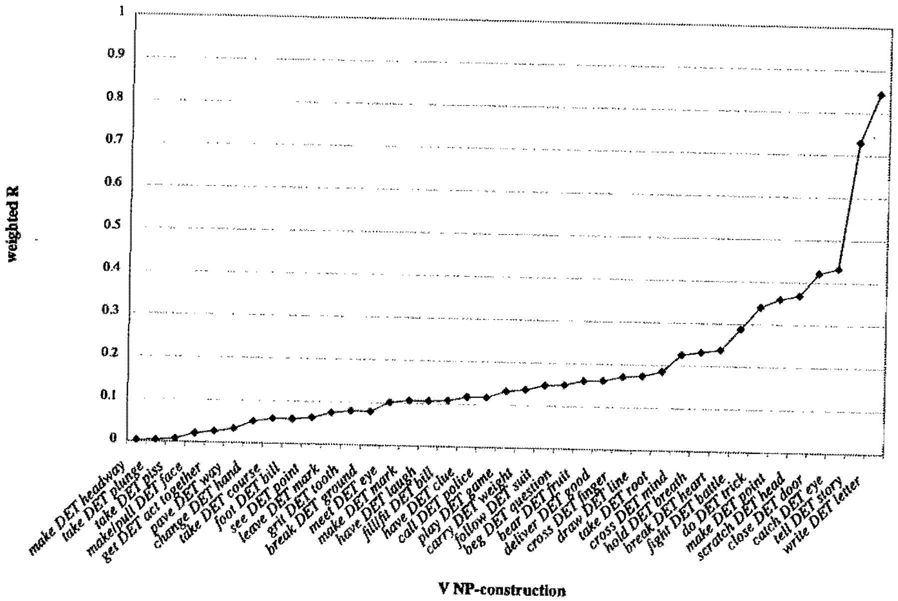

Figure 1. V NP-Constructions and their weighted *R*-values

As can be seen in Figure 1, the weighted *R*-measure neatly reproduces what we would expect from established idiom taxonomies (e.g. Fernando 1996; Cacciari and Glucksberg 1991): core idioms like *make* DET *headway* and *take* DET *plunge* rank lowest in compositionality; metaphorical expressions like *make* DET *mark* and *meet* DET *eye* occupy the middle ranks; quasi-metaphorical constructions, the literal referent of which is itself an instance of the idiomatic meaning (Cacciari and Glucksberg 1991), like *cross* DET *finger*, *hold* DET *breath*, and *scratch* DET *head*, tend to rank even higher in compositionality; and most of the constructions that were not picked from the idiom dictionary rank highest, with *write* DET *letter* yielding the highest weighted *R*-value.

Note also that the majority of items is assigned a fairly non-compositional value on the scale from 0 to 1, which ties in nicely with the fact that most of these were actually obtained from an idiom dictionary; items such as *write X letter* and *tell X story*, on the other hand, were selected so to test if items that are intuitively assessed as (nearly perfectly) compositional are actually treated accordingly by the measure – so weighted *R* proves very accurate since these items do not only rank highest, but moreover, their compositionality values are very high in absolute terms (.73 for *tell X story* and .84 for *write X letter*).[4]

6. Conclusion

The extension of Berry-Rogghe's *R*-value presented here provides very satisfactory results, and there are several strong indications that it is indeed valid. For one, the correlation between the weighted *R*-values and the corpus frequency of the V NP-Constructions is very high ($r_{Pearson}$=.802), which stands in accord with Barkema's (1994: 26) results, where corpus frequencies were correlated with intuitively assessed compositionality values. At the same time, the measure does not merely equate compositionality with frequency of occurrence but also manages to model aspects of compositionality that go beyond frequency, as is evidenced by the fact that the resulting ranking departs from a purely frequency-based ranking for V NP-Constructions that are relatively frequent and relatively opaque (consider, e.g., *make* DET *face*, which is the sixth most frequent construction in the sample with a corpus frequency of 371, yet obtains the fourth lowest *R*-value of .021), and vice versa (an example here is *break* DET *heart* with only 183 attestations in the BNC but a fairly high *R*-value of .238).

What is more, the corpus-linguistic definition of compositionality presented here derives a lot of plausibility from its compatibility with theoretical premises:

- the measure stands in accord with the constructionist view that a complex construction is a manifestation of several smaller constructions, and that every one of them contributes to the meaning of the complex construction;

- the measure implements the central assumption of many cognitive approaches to grammar that constructions are entrenched in the mental lexicon to different extents;

- the measure leaves room for a potential backward influence of the construction's semantics on the (weightings in the often polysemous network of) the constituent word's semantics.

To conclude, this paper presents a first step towards a theoretically informed and performance-based compositionality measure referred to as weighted *R* that may be used not only for assessing the compositionality of V NP-Constructions, but that is principally applicable to any kind of construction.[5] Beyond that, weighted *R* may prove a useful tool for quantitative approaches to related issues in Cognitive Semantics. For instance, it could be employed to quantify the degree of semantic bleaching of verbs, which could inform the investigation of incipient grammaticalization processes, particularly with regard to the question to what extent the degree of bleaching is context-dependent. On this note, I hope that the present paper contributes to the growing awareness of the vast potential that resides in marrying cognitive-linguistic theory and corpus-based methods.[6]

Appendix

Table 2. V NP-Constructions and their weighted *R*-values

V NP-Construction	weighted *R*	V NP-Construction	weighted *R*
make DET *headway*	.003	*carry* DET *weight*	.137
take DET *plunge*	.004	*follow* DET *suit*	.147
take DET *piss*	.008	*beg* DET *question*	.150
make/pull DET *face*	.021	*bear* DET *fruit*	.160
get DET *act together*	.026	*deliver* DET *good*	.161
pave DET *way*	.033	*cross* DET *finger*	.171
change DET *hand*	.051	*draw* DET *line*	.174
take DET *course*	.058	*take* DET *root*	.185
foot DET *bill*	.058	*cross* DET *mind*	.225
see DET *point*	.062	*hold* DET *breath*	.232
leave DET *mark*	.074	*break* DET *heart*	.238
grit DET *tooth*	.079	*fight* DET *battle*	.288
break DET *ground*	.079	*do* DET *trick*	.340
meet DET *eye*	.101	*make* DET *point*	.359
make DET *mark*	.106	*scratch* DET *head*	.368
have DET *laugh*	.106	*close* DET *door*	.421
fill/fit DET *bill*	.108	*catch* DET *eye*	.432
have DET *clue*	.117	*tell* DET *story*	.730
call DET *police*	.117	*write* DET *letter*	.844
play DET *game*	.132		

Notes

1. DET stands for any kind of determiner, including a zero determiner.
2. While this is not a V NP-Construction, it was included in several pre-tests and is reported alongside the V N P-constructions.
3. The regular output of a FYE test is a *p*-value; since these values are sometimes so extremely small that they become extremely difficult to interpret and cumbersome to report, Gries at al. (2005: 648) suggest to report the *p*-value's negative logarithm to the base of 10 instead; a converted value of ≥ 1.3 is equivalent to a 5% probability of error. Accordingly, a FYE value of ≥ 100 indicates an extremely high association strength. A series of pre-tests to the results reported here showed that not only is this threshold value maximally conservative with regard to which collocates enter into the collocates sets, the resulting *R*-values also spread widest with this threshold, which is desirable if the whole span of a continuum is intended to be modeled.

4. While individual rankings may not make too much sense intuitively, such as *call X police* obtaining a middle rank only, this does not necessarily mean that the measure *per se* is flawed; more likely, this result is a side-effect of the yet limited sample size for these kinds of expressions.
5. Future research should systematically explore what kind(s) of measure(s) are suited best to model the association strength between constructions at different levels of schematization: weighted *R* is just one of many collocation-based association measures that are compatible with constructionist premises, if only highlighting different aspects of the syntagmatic and paradigmatic dimensions of constructional interaction. A first example of such a contrastive analysis is presented by Speelman *et al.* (2009), who contrast Gries and Stefanowitsch's *collostructions* (Stefanowitsch and Gries 2003) and *co-varying collexemes* (Gries and Stefanowitsch 2004) for measuring the association strength between different inflectional variants of Dutch attributive adjectives and their head nouns.
6. For a corpus-linguistic approach that addresses the question how the present compositionality measure competes with other variables that jointly characterize the overall idiomaticity of V NP-phrases, cf. Wulff (2008).

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