Dirk Pijpops*, Dirk Speelman, Freek Van de Velde and Stefan Grondelaers

Incorporating the multi-level nature of the constructicon into hypothesis testing

https://doi.org/10.1515/cog-2020-0039
Received April 15, 2020; accepted August 15, 2021; published online September 15, 2021

Abstract: Construction grammar organizes its basic elements of description, its constructions, into networks that range from concrete, lexically-filled constructions to fully schematic ones, with several levels of partially schematic constructions in between. However, only few corpus studies with a constructionist background take this multi-level nature fully into account. In this paper, we argue that understanding language variation can be advanced considerably by systematically formulating and testing hypotheses at various levels in the constructional network. To illustrate the approach, we present a corpus study of the Dutch *naar*-alternation. It is found that this alternation primarily functions at an intermediate level in the constructional network.

Keywords: alternation; argument structure; constructional networks; distributional vectors; lexical origin hypothesis

1 Introduction

The basic units of description in construction grammar are its constructions, pairings of meaning and form, that are organized into a network structure called the constructicon. This constructicon has a vertical dimension ranging from concrete, lexically-filled constructions to entirely schematic ones, with several levels of partially schematic constructions in-between (Goldberg 2006: 18, 215; Hilpert 2019: 57–58; Iwata 2008: 35–40). According to usage-based linguists, the exact design of this vertical dimension should not be defined a

***Corresponding author: Dirk Pijpops**, RU Lilith, Département de langues modernes, Université de Liège, Liège, Belgium, E-mail: Dirk.pijpops@uliege.be
Dirk Speelman and Freek Van de Velde, RU QLVL, Department of Linguistics, KU Leuven, Leuven, Belgium, E-mail: dirk.speelman@kuleuven.be (D. Speelman), freek.vandevelde@kuleuven.be (F. Van de Velde)
Stefan Grondelaers, Centre for Language Studies, Radboud University Nijmegen, Nijmegen, Netherlands, E-mail: stef.grondelaers@ru.nl

priori, but should rather be the result of empirical research (Diessel 2019; Goldberg 1995: 67–100; Langacker 1988a). If that is to be the case, then we need to develop research designs that explicitly take this dimension into account from the get-go (cf. Levshina and Geeraerts 2010; van Trijp and Steels 2012). In this paper, we propose such a design (for other approaches, see (Levshina 2012; Wible and Tsao 2020)).

To illustrate the design, the present paper describes an alternation study. Alternation studies are a type of corpus-based research that is commonly employed within construction grammar (Levshina 2011; Pijpops and Speelman 2017). In such a study, the researcher starts from two formal variants, e.g., two argument structure constructions, and hypothesizes a semantic distinction between both. Next, that distinction is operationalized, and a relation is predicted between the operationalization and the use of the variants. If such a relation is found, the hypothesis is regarded as confirmed.

These alternation studies often find very concrete meaning distinctions between particular argument structure constructions. For instance, Lenci (2012: 13–15) finds that when the Italian verb *decidere* 'decide' is used in one argument structure construction in, e.g., (1a), it implies that a decision is taken to perform an action. When it is used in the alternative argument structure construction in, e.g., (1b), however, the sentence merely implies that a decision is taken on whether or not to approve an action. Similarly, he finds that if the verb *rimproverare* 'reproach' is used in one argument structure construction in, e.g., (2a), it implies that both participants are physically present, whereas this implication does not arise when the verb is used in the alternative argument structure construction in (2b). The question is then how we can hypothesize such meaning distinctions a priori, based on theoretical mechanisms.

(1) a. *L'assemblea ha deciso l'acquisto della società.* (Lenci 2012: 14)
'The assembly decided the purchase of the company'
b. *L'assemblea ha deciso sull'acquisto della società.*
'The assembly decided on the purchase of the company'

(2) a. *Gianni ha rimproverato suo padre per questo.* (Lenci 2012: 12)
'John reproached his father for this'
b. *Gianni ha rimproverato questo a suo padre.*
'John reproached this to his father'

Theoretical accounts of argument structure typically refer to semantic notions such as affectedness, involvement or agency (Dowty 1991; Langacker 1991: 304–329). However, such high-level semantic notions are often too vague to directly account

for the various observed meaning distinctions, as Lenci (2012: 14) notes: "the type of semantic contrast […] can hardly be explained in terms of general categories". Perek (2014: 64) formulates essentially the same point of critique when discussing a proposal by Dixon (1991: 280). That proposal tried to explain the various semantic distinctions expressed by the English *at*-alternation by referring to a contrast between an emphasis on the effect of the activity versus an emphasis on the subject's engagement in the activity. Perek (2014: 64) notes: "such an abstract characterization must still go a long way towards the actual semantic contribution with individual verbs" (cf. also Croft 2003: 56–58). More generally, Dąbrowska (2017: 23–25, 37) argues that distinctions based on such high-level notions are often too vague to be falsifiable, and difficult to operationalize. In sum, corpus linguists often find that argument structure alternations express very tangible meaning distinctions for particular verbs, but these distinctions are too specific to be directly explained by any high-level semantic notion.

It might be the case that we simply have to posit all these local meaning distinctions for individual constructions, without being able to derive them from theoretical mechanisms. This option is not particularly appealing, however, especially not to cognitive linguists, who take an explicit interest in meaning (Geeraerts 2006: 3; Langacker 1988b: 6–11). Such an approach trades theoretical simplicity for descriptive coverage, and we want both. We want to be able to explain as many empirical facts as possible using as few theoretical assumptions as possible.[1] As such, we are presented with the following challenge. How do we hypothesize semantic distinctions that are specific enough to yield clearly falsifiable and successful predictions regarding language variation, while only relying on general mechanisms? One way to tackle this challenge, as we will argue in this paper, lies in incorporating the multi-level nature of the constructicon into hypothesis testing. This may be done by taking a single theoretical mechanism, and systematically applying it at various levels in the vertical dimension of the constructicon.

Section 2 supplies the theoretical background. It presents the challenge in detail and discusses the theoretical mechanism that we will apply at various levels. Section 3 introduces our case study and our hypotheses, after which Section 4 presents the data, and Section 5 puts the hypotheses to the test. Lastly, Section 6 discusses the results and conclusions.

1 For example, an account that can explain a number of observations in language acquisition without assuming an innate language acquisition device would be preferable to an account that explains the same observations by assuming such a device.

2 Theoretical background

2.1 Challenge

The challenge with which we are faced can be illustrated as follows. Consider the *at*-alternation in (3). Assuming that the meaning of the verb *chip* is 'to break off small fragments' and the meaning of the *at*-construction is 'direct action at' (Goldberg 1995: 63; Perek and Lemmens 2010), we get the compositional meaning for sentence (3a): 'Sam directs actions at and breaks off small fragments from the rock'. However, the meaning of sentence (3a) is more specific than that. It also includes that the action of chipping is repeated or takes place in a bit-by-bit fashion (Broccias 2001: 77; Perek 2015: 127–129). This bit-by-bit meaning has to be contributed by the *at*-construction, because it is no longer present in the utterance when we replace the *at*-construction by the transitive construction, but retain all other elements, as in (3b).

(3) a. *Sam chipped **at** the rock.* (Broccias 2001: 77)
b. *Sam chipped the rock.*

The sensible solution then seems to be to update the meaning of the *at*-construction, and make it more specific, e.g., to replace its meaning 'direct action at' by 'repeatedly act on'. However, this would be fallacious, since this meaning is not present when the *at*-construction is combined with the verb *slap*, as in (4a). Here, the *at*-construction implies that the action was not necessarily successful, i.e., that the object is not necessarily hit (compare [4b], see Broccias 2001: 73–76; Perek 2015: 134–139).

(4) a. *He slapped **at** it with his other hand, but it was beneath his thumbnail before he could get at it.*
(British National Corpus, corpus-id: FS8-1809, cited in Perek 2015: 134)
b. *In turn he slapped her thigh and smiled at her (…)*
(British National Corpus, corpus-id: FS8-1809, cited in Perek 2015: 136)

It appears that the specific meaning distinction expressed by the *at*-alternation is dependent upon the verb in question and cannot be simply traced back to a single semantic notion (Perek 2014). Still, the question remains: how could we have predicted the correct specific meaning distinction for each verb, while only relying on general mechanisms? One possible answer is: by taking a general mechanism, and systematically applying it at several levels in the vertical dimension of the constructicon. Section 3 will illustrate how this works in practice. Section 2.2 first introduces the mechanism that we will apply at various levels.

2.2 Lexical origin mechanism

All predictions formulated in this paper will be based on the mechanism described by the lexical origin hypothesis (Goldberg 1999; Goldberg et al. 2004; Perek and Goldberg 2015). The mechanism states, in short, that constructions with open slots obtain their meaning from the prototypical lexical fillers of their slots, i.e., from the fillers that are statistically biased to appear in the slots. For example, say that the English verb *give* is often used with simple, informationally light recipients, like *me* or *you*. That would cause it to often appear in the ditransitive construction (Thompson 1990). Crucially, this ostensible lexical bias of the verb *give* for the ditransitive construction is not (yet) caused by its meaning – otherwise, the lexical origin mechanism would be circular. In a next step, language users subconsciously notice this ostensible lexical bias and come to associate the meaning of *give*, viz. 'transfer of possession', with the ditransitive construction.[2] At that point, the ditransitive construction has obtained the meaning 'transfer of possession' through the lexical origin mechanism. In this way, we can hypothesize a meaning for a particular argument structure construction by looking at their most prototypical slot fillers.

The next step would be to test such a hypothesis. There are at least two ways of doing so by means of corpus data. The first is to apply the semantic coherence principle. This principle requires "that the semantic frame evoked by the verb be semantically compatible with the meaning of the construction" (Perek 2015: 24). That is, a lexical filler, e.g., a verb, will more readily combine with a construction that is semantically coherent, i.e., that has a similar or a compatible meaning. For instance, say that we want to test whether the English ditransitive construction indeed carries the meaning 'transfer of possession'. We could then predict that verbs other than *give* that are also compatible with this meaning, also prefer the ditransitive construction, even when they are not used with informationally light recipients (Gries and Stefanowitsch 2004: 101–107). A second means of testing the meaning of an argument structure construction is to compare instances of a single verb (Goldberg 1995: 146–147; van Trijp 2015: 626–627). For example, we could predict that when the meaning of an occurrence of the verb *send* tends more towards a transfer of possession, as in (5a), it would appear more often in the ditransitive construction, whereas when it tends more towards a physical

2 We talk about the emergence of constructional meaning in a community of language users here (Geeraerts 2010; Steels 2000, 2011; van Trijp and Steels 2012). The example of the ditransitive construction is given for illustration purposes only. In reality, its semantics are more complex (e.g. Croft 2003: 53–59, Gries and Stefanowitsch 2004: 107).

movement without a transfer of possession, like (5b), it would more likely appear in another argument structure construction.

(5) a. *When my fiancé sent me my birthday present, (…)*
(taken from COCA, Davies 2008)
b. *It was at the very beginning (…) that he sent an emissary to me.*
(taken from COCA, Davies 2008)

Summarizing, the lexical origin mechanism can be used to study the choice between two schematic constructions by going through the following steps.

Step 1. Identify the most prototypical lexical fillers of both constructions.
Step 2. Use these fillers to hypothesize a meaning distinction between both constructions.
Step 3. Test this hypothesis by making two predictions:
i. Lexical fillers that are more semantically coherent with the meaning of one of the constructions, will more likely appear in that construction, and vice versa.
ii. Among the occurrences of one and the same lexical filler, occurrences that are more inclined towards the meaning of one of the constructions, will more likely appear in that construction.

3 Hypotheses

In this section, we use the lexical origin mechanism to formulate predictions at several levels in the vertical dimension of the network. Before we can do that, we need to determine what these levels are. This is done in Section 3.1. Next, Sections 3.2, 3.3 and 3.4 apply the three steps of the lexical origin mechanism described above to distinct levels. Finally, Section 3.5 gives an overview of all hypotheses and their predictions.

3.1 Levels in the vertical dimension

As a case study, we investigate the alternation between the Dutch transitive argument structure and a variant with the preposition *naar*, as in (6)–(7). This alternation occurs with 13 verbs, viz. *bellen* ‘ring’, *graaien* ‘grasp’, *grabbelen* ‘scramble’, *grijpen* ‘grab’, *happen* ‘snap’, *jagen* ‘hunt’, *opbellen* ‘ring up’, *peilen* ‘gauge’, *schoppen* ‘kick’, *telefoneren* ‘phone’, *verlangen* ‘desire’, *vissen* ‘fish’ and *zoeken* ‘search’ (Pijpops 2019: 51).

(6) a. *maar de politiek verlangt nu scherpere maatregelen*
But the politics desires now sharper measures
om de inburgering te verbeteren.
to the naturalization to improve
'But politicians now desire more severe measures to improve naturalization.'

b. *maar de politiek verlangt nu naar scherpere*
But the politics desires now to sharper
Maatregelen om de inburgering te verbeteren.
measures to the naturalization to improve
'But politicians now desire more severe measures to improve naturalization.'
(Sonar-id: WR-P-P-B-0000000479.p.152.s.1)[3]

(7) a. *Je zoekt woorden als trom en trooster*
you search words like drum and consoler
'You search for words like drum and consoler.'

b. *je zoekt naar woorden als trommel en trooster*
you search to words like drum and consoler
'You search for words like *drum* and *consoler*.'
(Sonar-id: WR-P-P-G-0000005610.p.24.s.2)

At which levels in the vertical dimension can this alternation be studied? To answer this question, we need to map out a potential constructional network for the alternation, ranging from instantiated constructs to entirely schematic constructions (cf. Diessel 2015: 207–209; Langacker 1988: 132–133). The result of our attempt can be seen in Figure 1 (cf. Iwata 2008: 35–40; Langacker 2000: 122–124; Traugott 2007: 525). We start from the bottom level with individual constructs, i.e., instantiated utterances, such as (8)–(10).

(8) *In Algerije zoeken reddingswerkers naar slachtoffers*
In Algeria search resue_workers to victims
van de overstromingen.
of the floods
'In Algeria, rescue workers are searching victims of the floods.'
(Sonar-id: WR-P-E-G-0000005872.p.67.s.1)

3 When an example is taken from the Sonar corpus, its corpus-id is mentioned (Oostdijk et al. 2013a).

Figure 1: Various levels in the vertical dimension of the constructional network at which the alternation can be studied. Only the prepositional variants are shown.

(9) *Reddingswerkers zoeken ook nog altijd naar slachtoffers.*
Rescue_workers search also still always to victims
'Rescue workers are also still searching victims.'
(Sonar-id: WS-U-E-A-0000375701.p.1.s.8)

(10) *Duikers zoeken nu naar nog mogelijke slachtoffers.*
Divers search now to other possible victims
'Divers are now searching for other possible victims'
(Sonar-id: WS-U-E-A-0000373931.p.1.s.3)

We can discern a first micro-level by distinguishing four constructional slots: a subject slot, a verb slot, a preposition slot and an object slot. For (8)–(9), that would lead to the construction *[reddingswerker zoek naar slachtoffer]* (lit. 'rescue worker search to victim'). For (10), that construction would be the construction *[duiker zoek naar slachtoffer]* (lit. 'diver search to victim'). Of the four slots, we need to open one slot to distinguish a higher level. We prefer not to open the preposition slot, for two reasons. First, it forms the most obvious difference between both variants of the alternation, since it is the slot that disappears in the transitive construction. Second, the filler of this slot is typically used in previous research to distinguish between constructions, such as the English *at*-construction and *into*-construction (Broccias 2001; Goldberg 1999; Huber 2013).

This leaves the subject slot, the verb slot, and the object slot. Of these three, we prefer not to open the verb slot, for two reasons. The first is the pivotal role of the verb in theoretical accounts of argument realization. Although this role is downplayed in accounts that employ schematic argument structure constructions, compared to so-called lexicalist accounts (e.g., Müller and Wechsler 2014), it is generally maintained that its influence is more important than that of the subject and object slots (Boas 2014; Goldberg 2013). The second reason is that the verb slot is the remaining open slot that varies least in the alternation, exhibiting only 13 different fillers, viz. the verbs mentioned above.

Now two slots remain, the subject slot and the object slot. Of these two, we decide to keep the object slot fixed, for two reasons. First, of the remaining slots, the object is the one that is most directly affected by the alternation, since the object may appear either in a nominal or a prepositional constituent. Second, objects seem to lend themselves better to constructionalization than subjects. That is, there appear to be a lot more idioms with a fixed object slot and an open subject slot, such as English *spill the beans, bite the bullet, kick the bucket,* or Dutch *het varkentje wassen* 'handle something', *een oogje dichtknijpen* 'turn a blind eye', or *de plank misslaan* 'be way off', than idioms with a fixed subject slot and open object slot.

By opening the subject slot, we distinguish a first meso-level. For the concrete constructions *[reddingswerker zoek naar slachtoffer]* (lit. 'rescue worker search to victim') and *[duiker zoek naar slachtoffer]* (lit. 'diver search to victim'), this leads to the slightly more schematic construction *[NP zoek naar slachtoffer]*

(lit. 'NP search to victim'). This construction is instantiated in (8)–(10), though not in (7b). Next, opening the object slot creates the second meso-level, with constructions such as *[NP zoek naar NP]* (lit. 'NP search to NP'), that is instantiated both in (7b) and (8)–(10). Constructions at this level are intermediate in terms in schematicity. They correspond to the verb-specific constructions in Croft (2003: 58).

Opening the verb slot then leads to the third meso-level, with highly schematic constructions such as *[NP V naar NP]* (lit. 'NP V to NP'), which we call the *naar*-construction. That construction is instantiated in (6b), (7b), and (8)–(10). Finally, opening the preposition slot creates a fully schematic macro-level, resulting in the six levels in Figure 1. It would be possible to distinguish additional intermediate levels. For instance, between the level with an open object slot and the level with an open verb slot, one could distinguish a level of verb-class-specific constructions (Croft 2003: 56–57), or between the level with only an open subject slot and the level with an open object slot, one could posit a level of object-class-specific constructions. Still, the levels in Figure 1 may already be considered important milestones in the continuum from concrete to schematic. At this point, we do not claim that all levels in Figure 1 are cognitively real. They merely present levels at which the alternation can be investigated.

If we investigate the alternation at the level with an open verb slot, we would study the choice between the *naar*-construction and the transitive construction. This would mean that all examples like (6)–(10) instantiate the same choice that we expect to be driven by the same factors. Hence, all instances like (6)–(10) should be taken up in a single dataset, and analyzed together.

If we investigate the alternation at the level with an open object slot and a fixed verb slot, we would study (i) the choice between the *verlang-naar*-construction and the transitive *verlang*-construction, (ii) the choice between the *zoek-naar*-construction and the transitive *zoek*-construction, and so on. Since these would all constitute separate choices, the factors that drive one choice may be quite different from the factors that drive another choice. Hence, we would make one dataset for the verb *verlangen* 'desire', that would only contain instances the instances of that verb, such as (6), and we would make another dataset for the verb *zoeken* 'search', that would only contain instances of that verb, such as (7)–(10).

If we investigate the alternation at the level with only an open subject slot, we would study (i) the choice between the *zoek-naar-slachtoffer*-construction and the transitive *zoek-slachtoffer*-construction, (ii) the choice between the *zoek-naar-woord*-construction and the transitive *zoek-woord*-construction, and so

on. Since these would all constitute different choices, the factors that drive one choice may be quite different from the factors that drive another choice. Hence, we would make a separate dataset for the verb *zoeken* 'search' with the theme *woord* 'word', that would only contain instances such as (7), and another dataset for the verb *zoeken* 'search' with the theme *slachtoffer* 'victim', that would only contain instances such as (8)–(10) and so on.

We now have a theoretical mechanism, viz. the lexical origin mechanism, and several clearly defined levels in the vertical dimension. Next, we need to decide at which level we want to apply the lexical origin mechanism. We can already count out the level of the constructs and the micro-level: it is simply not possible to apply the lexical origin mechanism to these levels, because the mechanism requires open constructional slots. Furthermore, we decide not to apply the lexical origin mechanism to the fully schematic macrolevel. The reason is that the literature on Dutch argument structure generally distinguishes between various prepositions (Broekhuis 2004: 122; Van Hout 1996: 94–98, 118–119; Van Voorst 1996: 235–236, 241–241), as do studies on closely-related languages (e.g., Adler 2011; Perek and Lemmens 2010). We also refrain from applying the lexical origin mechanism to the level with only an open subject slot, for now. The reason is that investigating the alternation at very low levels in the vertical dimension leads to problems of data sparsity, as will become apparent in Section 5. That leaves the level with an open verb slot and the level with an open object slot and a fixed verb slot. Applying the lexical origin mechanism at those two levels will lead to predictions that relate to those levels and to the directly underlying level with only an open subject slot, as we will see in the following sections. Section 3.2 will apply the lexical origin mechanism to the level with an open verb slot, and Section 3.3 will apply it to the level with an open object slot and a fixed verb slot.

3.2 Prediction at the level with an open verb slot

Applying the lexical origin mechanism to the level with an open verb slot means that we want to hypothesize a meaning distinction between the *naar*-construction and the transitive construction. Step 1 of the lexical origin mechanism requires us to identify the most prototypical lexical fillers of both constructions (see Section 2.2). It does not specify, however, of which slot we should take the prototypical fillers. Since the current level was created by opening up the verb slot, we choose the verb slot (as is done in, e.g., Colleman 2009). A widely used technique to identify the prototypical fillers of a slot is collostructional analysis (Stefanowitsch and Gries 2003). As such,

we run collostructional analyses on the verb slots of the transitive construction and the *naar*-construction.[4] Tables 1 and 2 contains the top 5 collexemes of these constructions ranked by decreasing collostructional strength.

Table 1: Top 5 collexemes of the verb slot of the transitive construction.

Transitive construction			
Verb	**Freq. in the transitive construction**	**Total freq.**	**Collostr. strength**
hebben 'have'	1,018,067	3,396,725	4,101,778
krijgen 'get'	415,605	586,452	2,602,924
doen 'do'	413,745	668,486	2,410,269
zien 'see'	250,188	502,628	1,297,011
nemen 'take'	189,477	263,637	1,190,952

Table 2: Top 5 collexemes of the verb slot of the *naar*-construction.

***Naar*-construction**			
Verb	**Freq. in the *naar*-construction**	**Total freq.**	**Collostr. strength**
gaan 'go'	111,993	953,918	923,830
kijken 'look'	49,621	130,567	532,119
trekken 'travel'	27,672	101,643	272,823
verwijzen 'refer'	19,787	23,787	258,146
komen 'come'	39,974	798,696	251,058

Based on the lexical origin mechanism, we expect the meaning of the transitive construction and *naar*-constructions to derive from the verbs in Tables 1 and 2. Step 2 hence proposes to use these prototypical lexical fillers to hypothesize a meaning distinction between both constructions. One possible way to interpret the

4 In the nomenclature of the Alpino-parses of the Sonar-corpus, an occurrence of the transitive construction was defined as an occurrence of a verb with a direct object, without any other object being present (van Noord 2006). An occurrence of the *naar*-construction was likewise defined as an occurrence of a verb with a prepositional complement or a prepositional locative/directive complement with the preposition *naar* 'to', without any other object being present. The material from the Sonar-components with text messages, chat logs, tweets and discussion lists was not used, because the quality of the parses in this material was deemed too low (Oostdijk et al. 2013b: 49–50). All collostructional analyses were run using publicly available R-code from Gries (2007). The collostructional strength measures are based on log-likelihood (Stefanowitsch and Flach 2016: 115–116).

rankings in Tables 1 and 2 is in terms of directionality. That is, the verbs ranking highest in collostructional strength for the *naar*-construction appear to share a common meaning element of directionality. Meanwhile, such a shared semantic element is less evident for the transitive construction. This leads to the following hypothesis, which we call the Directionality Hypothesis: the *naar*-construction expresses directionality, while the transitive construction does not.[5]

Step 3 gives two ways of testing such a hypothesis. Its first prediction states: lexical fillers that are more semantically coherent with the meaning of one of the schematic constructions, will more likely appear in that construction, and vice versa. That is, verbs that are more semantically coherent with the meaning of the *naar*-construction, will more likely appear in the *naar*-construction, and vice versa. Likewise, the second prediction of Step 3 reads as follows: among the occurrences of one and the same verb, occurrences that are more inclined towards the meaning of the *naar*-construction, will more likely appear in the *naar*-construction. To test this second prediction, we will have to limit the dataset to only the occurrences of a single verb. This means studying the alternation at the level with a fixed verb slot and an open object slot. We will therefore return to this prediction in Section 3.3.

To operationalize the first prediction, we need a measure of semantic coherence. This can be obtained by using distributional vectors (cf. Levshina and Heylen 2014; Perek 2018). Distributional vectors are based on the idea that words with similar meanings tend to occur in similar textual contexts. These textual contexts can be represented as mathematical vectors, whereby each number indicates how often a word occurs with a particular context feature, e.g., how often a verb occurs with a particular subject. In that way, words with similar meanings tend to have similar vectors. For accessible introductions to distributional vectors, see Turney and Pantel (2010), Padó and Lapata (2010) and Lenci (2018).

We calculate distributional vectors for all alternating verbs and for all verbs in the top 5's collexemes. The context features of the vectors, 5000 in total, are based on seven dependency relations employed in Levshina and Heylen (2014: 31).[6] We blind the context features of the distributional vectors to our variants to prevent circularity. Concretely, the context features do not distinguish between direct objects and prepositional objects with *naar* 'to'. In calculating the distributional

5 Note that the results in Tables 1 and 2 alone do not prove that the *naar*-alternation expresses directionality. For one, the lexical biases of the listed verbs may be driven by other motivations than semantics. The influence of complexity, for instance, can also cause a particular verb to appear often in a construction, as in the example of English *give* in Section 2.2. For another, Tables 1 and 2 provides no information on the 13 alternating verbs.

6 These relations respectively corresponds to the Alpino REL-tags *su, obj1, obj2, pc, ld* with the *cat*-tag not equal to *pp*, ld with the CAT-tag equal to *pp*, and *predc*.

vectors, instances of the verbs *hebben* 'have', *krijgen* 'get', *doen* 'do' and *gaan* 'go', where these verbs were used as auxiliaries, are skipped.[7] Context features that correspond to function words are also disregarded. Only the 5,000 most frequent context features are retained and their co-occurrence frequencies are weighted through positive point-wise mutual information.

Finally, the measure SEMANTIC COHERENCE OF THE VERB TO THE *NAAR*-CONSTRUCTION is calculated for each alternating verb as in Eq. (1). This measure takes the average cosine similarity of the vector of an alternating verb to the vectors of the top a collexemes of the transitive construction, and subtracts this from its average cosine similarity to the vectors of the top a collexemes of the *naar*-construction. The parameter a was set to 5. For the mathematical definition of the cosine similarity between two vectors, viz. $sim_{cm}(\overrightarrow{verb_1}, \overrightarrow{verb_2})$, see Weeds et al. (2004). Lastly, the resulting value is multiplied by 10. This multiplication is used because cosine similarities range between 0 and 1, and differences between them hence range between –1 and 1. When such a measure is entered into a regression model, it yields markedly high estimates. Multiplying the measure itself by 10 simply lowers these estimates by a factor of 10, but it has no qualitative effect on the regression model.

SEMANTIC COHERENCE OF THE VERB TO THE *NAAR*-CONSTRUCTION of the alternating $verb_i$

$$= 10\left(\frac{\sum_{n=1}^{a} sim_{cm}\left(\overrightarrow{\text{naar-}cxn\ collexeme_n}, \overrightarrow{verb_i}\right)}{a} - \frac{\sum_{n=1}^{a} sim_{cm}\left(\overrightarrow{transitive\ cxn\ collexeme_n}, \overrightarrow{verb_i}\right)}{a}\right) \quad (1)$$

Equation 1: Operationalization of the semantic coherence of the verbs.

In sum, the measure SEMANTIC COHERENCE OF THE VERB TO THE *NAAR*-CONSTRUCTION is higher the closer the vector of an alternating verb is to the vectors of the 5 most prototypical fillers of the verb slot of the *naar*-construction, viz. *gaan* 'go', *kijken* 'look', *trekken* 'pull', *verwijzen* 'refer' and *komen* 'come'. Meanwhile, the measure is also higher the more distant the vector of the alternating verb is from the vectors of the 5 most prototypical fillers of the verb slot of the transitive construction, viz. *hebben* 'have', *krijgen* 'get', *doen* 'do', *zien* 'see' and *nemen* 'take'. In other words, an alternating verb has a higher value for the measure when its meaning is closer to the most prototypical verbs of the *naar*-construction, and more distant from the

7 This is done by checking whether these verbs had a verbal complement (Alpino REL-tag *vc*).

most prototypical verbs of the transitive construction. We therefore make the following prediction:

> Prediction a of the Directionality Hypothesis: SEMANTIC COHERENCE OF THE VERB TO THE *NAAR*-CONSTRUCTION will have a positive effect on the use of the prepositional variant among the instances of the alternating verbs.

3.3 Predictions at the level with an open object slot and a fixed verb slot

To apply the lexical origin mechanism to argument structure constructions at the level with an open object slot and a fixed verb slot, we go through the same three steps as above. We limit ourselves to two verbs for reasons of space. In order to reduce problems of data sparsity, we choose the verb with the most balanced distribution between the variants, viz. *verlangen* 'desire', and the most frequent verb, viz. *zoeken* 'search'. This means that we investigate the choice between the *verlang-naar*-construction and the transitive *verlang*-construction, and the choice between the *zoek-naar*-construction and the transitive *zoek*-construction. We start with *verlangen* 'desire'.

Step 1 of the lexical origin mechanism requires us to identify the most prototypical lexical fillers of both constructions. The *verlang-naar*-construction and the transitive *verlang*-construction have only two open slots: the subject slot and the object slot. Since the current constructional level was created by opening up the object slot, we go for the object slot. We call the fillers of the object slot 'theme lemmas': these are the lemmas of the syntactic head of the theme argument, for instance *omgeving* 'environment' in (11) (cf. Pijpops et al. 2018: 530).[8] To identify the most prototypical fillers of the object slots, we run collostructional analyses on the object slots of the transitive *verlang*-construction and the *verlang-naar*-construction. Tables 3 and 4 contains the top 5 collexemes of these constructions ranked according to decreasing collostructional strength.

(11) *Terwijl bezoekers net een authentieke omgeving verlangen*
though visitors just a authentic environment Desire
'Even though visitors desire an authentic environment, … '
(Sonar-id: WR-P-P-G-0000179977.p.9.s.6)

8 In Alpino terms: we recursively selected the child-node with the REL-tag *hd*, resolving indexation and conjunction. Finally, we took at the ROOT-tag of the deepest head, and combined it with its POS-tag, in keeping with Levshina and Heylen (2014).

Table 3: Top 5 collexemes of the object slot of the transitive *verlang*-construction.

Transitive *verlang*-construction			
Theme lemma	**Freq. in the transitive *verlang*-cxn**	**Total freq.**	**Collostr. strength**
bewijs 'proof'	18	24,734	179
tegenprestatie 'countereffort'	10	901	154
bijdrage 'contribution'	14	26,136	131
offer 'sacrifice'	10	3,122	129
garantie 'guaranty'	12	12,060	127

Table 4: Top 5 collexemes of the object slot of the *verlang-naar*-construction.

***verlang-naar*-construction**			
Theme lemma	**Freq. in the *verlang-naar*-cxn**	**Total freq.**	**Collostr. strength**
kind 'child'	39	251,250	262
leven 'life'	35	169,360	255
rust 'rest'	26	52,595	234
dood 'death'	24	51,814	213
huis 'house'	26	145,482	181

Step 2 proposes to use these prototypical lexical fillers to hypothesize a meaning distinction between both constructions. As the most prototypical slot fillers of the object slot of the transitive construction, we find theme lemmas that are typically demanded. Conversely, in the object slot of the *naar*-construction, we prototypically find theme lemmas that are longed for. In this way, we could interpret the results in Tables 3 and 4 as indicating a difference between 'demand' and 'long for' (cf. Broekhuis 2004: 122). We call this the Longing Hypothesis.

Step 3 gives us two predictions. The first prediction reads: theme lemmas that are more semantically coherent with the meaning of the *verlang-naar*-construction, will more likely appear in the *verlang-naar*-construction, and vice versa. Meanwhile, the second prediction reads: among the occurrences of one and the same theme lemma, occurrences that are more inclined towards the meaning of the *verlang-naar*-construction, will more likely appear in the *verlang-naar*-construction, and vice versa. To test this second prediction, we will have to limit the dataset to only the occurrences of a single theme lemma. In other words, we will have to study the alternation at the underlying level with only an open subject slot. We will therefore return to this prediction in Section 3.4.

To operationalize the first prediction, we again use distributional vectors. For each full-nominal theme lemma, a distributional vector is calculated with 5,000 context features based on eight dependency relations taken over from Levshina and Heylen (2014: 30). Context features with the verb *verlangen* 'desire' are ignored to avoid circularity, as are context features that correspond to function words. Only the 5,000 most frequent context features are retained in the vectors, and the frequencies are weighted through positive point-wise mutual information. Finally, the measure SEMANTIC COHERENCE OF THE THEME TO THE *VERLANG-NAAR*-CONSTRUCTION is calculated for each theme lemma as in Eq. (2), analogous to Eq. (1), with a again set to 5.

$$\begin{aligned}&\text{SEMANTIC COHERENCE OF THE THEME TO THE } \textit{VERLANG-NAAR}\text{-CONSTRUCTION of theme lemma}_i \\ &= 10\left(\frac{\sum_{n=1}^{a} sim_{cm}\left(\overrightarrow{\text{verlang-naar-}cxn\ collexeme_n}, \overrightarrow{theme\ lemma_i}\right)}{a}\right. \\ &\quad \left. - \frac{\sum_{n=1}^{a} sim_{cm}\left(\overrightarrow{transitive\ \text{verlang-}cxn\ collexeme_n}, \overrightarrow{theme\ lemma_i}\right)}{a}\right) \qquad (2)\end{aligned}$$

Equation 2: Operationalization of the semantic coherence of the theme lemmas of *verlangen* 'desire'.

In sum, a theme lemma has a higher value for SEMANTIC COHERENCE OF THE THEME TO THE *VERLANG-NAAR*-CONSTRUCTION when its vector is closer to the vectors of the 5 most prototypical fillers of the object slot of the *verlang-naar*-construction, and farther from the vectors of the 5 most prototypical fillers of the object slot of the transitive *verlang*-construction. We therefore make the following prediction.

> Prediction a of the Longing Hypothesis: SEMANTIC COHERENCE OF THE THEME TO THE *VERLANG-NAAR*-CONSTRUCTION will have a positive effect on the use of the prepositional variant among the instances of *verlangen* 'desire'.

We now turn to the verb *zoeken* 'search' and the choice between the *zoek-naar*-construction and the transitive *zoek*-construction. As for Step 1, Tables 5 and 6 contains the results of the collostructional analyses. As for Step 2, one possible interpretation of these results is the following. The collexemes *toevlucht* 'refuge', *contact* 'contact', *heil* 'salvation' and *toenadering* 'rapprochement' are theme lemmas that only come into being through the act of searching. That is, they are things that one seeks to make or acquire. Conversely, the collexemes *manier* 'manner', *alternatief* 'alternative', *overlevende* 'survivor' and *oorzaak* 'cause' constitute things that exist independently of the act of searching. That is, they are

Table 5: Top 5 collexemes of the object slot of the transitive *zoek*-construction.

Transitive *zoek*-construction			
Theme lemma	**Freq. in the transitive *zoek*-cxn**	**Total freq.**	**Collostr. strength**
oplossing 'solution'	2324	48,136	24,675
toevlucht 'refuge'	957	2277	14,695
contact 'contact'	1522	54,836	14,416
heil 'salvation'	959	3274	13,871
toenadering 'rapprochement'	561	2171	7944

Table 6: Top 5 collexemes of the object slot of the *zoek-naar*-construction.

***Verlang-naar*-construction**			
Theme lemma	**Freq. in the *zoek-naar*-cxn**	**Total freq.**	**Collostr. strength**
oplossing 'solution'	1822	48,136	22,564
manier 'manner'	484	123,612	3738
alternatief 'alternative'	334	16,441	3677
overlevende 'survivor'	223	4217	2887
oorzaak 'cause'	247	24,415	2372

things that one literally looks for. We hence call this hypothesized distinction the Looking for Hypothesis. The overlapping collexeme *oplossing* 'solution' could arguably be viewed as compatible with either category.

The first prediction of Step 3 then reads: theme lemmas that are more semantically coherent with the meaning of the *zoek-naar*-construction, will more likely appear in the *zoek-naar*-construction, and vice versa. This prediction is operationalized by the variable SEMANTIC COHERENCE OF THE THEME TO THE *ZOEK-NAAR*-CONSTRUCTION, which is calculated analogously to Eq. (2). It thus spells out as follows.

> Prediction a of the Looking for Hypothesis: SEMANTIC COHERENCE OF THE THEME TO THE *ZOEK-NAAR*-CONSTRUCTION will have a positive effect on the use of the prepositional variant among the instances of *zoeken* 'search'.

Meanwhile, the second prediction of Step 3 reads: among the occurrences of one and the same theme lemma, occurrences that are more inclined towards the meaning of the *zoek-naar*-construction, will more likely appear in the *zoek-naar*-construction, and vice versa. To test this prediction, we will have to limit the dataset to only the occurrences of a single verb and a single theme lemma. In other words, we will have to study the alternation at the underlying level with only an open subject slot. We will therefore return to this prediction in Section 3.4.

Section 3.2 mentioned that we also wanted to test the following prediction, based on the Directionality Hypothesis: among the occurrences of one and the same verb, occurrences that are more inclined towards the meaning of the *naar*-construction, will more likely appear in the *naar*-construction. We can now test this prediction on the verbs *verlangen* 'desire' and *zoeken* 'search'. Ideally, that would proceed in a manner that makes it comparable to our other predictions at the current level. To this end, we run collostructional analyses on the object slot of the transitive construction and the *naar*-construction. The results of these can be found in Tables 7 and 8. It is again hard to find a single common denominator among the top 5 collexemes of the transitive construction. Conversely, the top collexemes of the *naar*-construction do have commonality in that they are all places to go to.

Table 7: Top 5 collexemes of the object slot of the transitive construction.

Transitive construction			
Theme lemma	**Freq. in the transitive *zoek*-cxn**	**Total freq.**	**Collostr. strength**
kans 'chance'	57,024	135,665	269,414
rol 'role'	39,802	75,974	210,958
geld 'money'	44,839	143,367	180,223
werk 'work'	49,996	215,372	168,359
probleem 'problem'	41,949	173,833	144,674

Table 8: Top 5 collexemes of the object slot of the *naar*-construction.

***Naar*-construction**			
Theme lemma	**Freq. in the *zoek-naar*-cxn**	**Total freq.**	**Collostr. strength**
huis 'house'	17,423	145,482	139,755
school 'school'	7411	103,469	51,326
plaats 'place'	4794	203,948	22,485
bed 'bed'	2808	26,942	21,597
ziekenhuis 'hospital'	2966	50,606	19,294

We now predict that, among instances of the verb *verlangen* 'desire', theme lemmas that are semantically closer to the top collexemes of the *naar*-construction will more often occur in the prepositional variant, whereas those that are semantically closer to the top collexemes of the transitive construction, will more often occur in the transitive variant. We make the same prediction for the verb *zoeken* 'search'. These predictions are operationalized by the variable SEMANTIC

COHERENCE OF THE THEME TO THE *NAAR*-CONSTRUCTION, which is calculated analogously to Eq. (2). They can be formulated as follows.

> Prediction b of the Directionality Hypothesis: SEMANTIC COHERENCE OF THE THEME TO THE *NAAR*-CONSTRUCTION will have a positive effect on the use of the prepositional variant among the instances of the verb *verlangen* 'desire'.

> Prediction c of the Directionality Hypothesis: SEMANTIC COHERENCE OF THE THEME TO THE *NAAR*-CONSTRUCTION will have a positive effect on the use of the prepositional variant among the instances of the verb *zoeken* 'search'.

3.4 Predictions at the level with only an open subject slot

Section 3.3 mentioned that we also wanted to test whether (i) among the occurrences of one and the same theme lemma, occurrences of *verlangen* 'desire' that are more inclined towards the hypothesized meaning of the *verlang-naar*-construction, will more likely appear in the *verlang-naar*-construction; and (ii) among the occurrences of one and the same theme lemma, occurrences of *zoeken* 'search' that are more inclined towards the hypothesized meaning of the *zoek-naar*-construction, will more likely appear in the *zoek-naar*-construction.

To test (i), we have to limit our dataset to only the instances of the verb *verlangen* 'desire' and a specific theme lemma. This of course severely restricts the number of observations in the dataset. We will look at the theme lemmas *ding* 'thing' and *tijd* 'time', because these theme lemmas yield the most data for their least frequent variant. This means that we investigate the alternation at the level with only an open subject slot, e.g. the choice between the construction *[NP verlang naar ding]* 'NP desire to thing' and the construction *[NP verlang ding]* 'NP desire thing'. Applied to *ding* 'thing' and *tijd* 'time', (i) predicts that if the agent demands things or demands time, the transitive variant will be more probable, whereas when the agent longs for things or longs for time, the prepositional variant will be more probable. For *ding* 'thing', we see no way of operationalizing this distinction in a straightforward manner, so we will attempt to annotate for it directly. That is, we will manually mark each instance as to whether it expresses more of a longing for a thing or more of a demand for a thing. Meanwhile, for *tijd* 'time', we will distinguish between instances where *tijd* 'time' is a mass noun, and those where it is a count noun. The underlying idea is that people may demand more time to perform a certain task, which involves time as a mass noun, while they long for some time period in the past or present, i.e. they long for time as a count noun. This thus leads to the following predictions.

Prediction b of the Longing Hypothesis: The prepositional variant will be more probable when the agent longs for a thing than when the agent demands a thing, among the instances of *(naar) ding verlangen* 'desire thing'.

Prediction c of the Longing Hypothesis: The prepositional variant will be more probable when *tijd* 'time' is used as a count noun than when it is used as a mass noun, among the instances of *(naar) tijd verlangen* 'desire time'.

To test (ii), we have to limit our dataset to only the instances of the verb *zoeken* 'search' and a specific theme lemma. Fortunately, we have a lot of data available for *zoeken* 'search'. This allows us to choose two theme lemmas where the hypothesized distinction between 'seek to make/acquire' and 'look for' can be made in a clear-cut way. The first is *slachtoffer* 'victim'. The meaning 'seeking to make victims' only makes sense if the agent performing the search is an aggressor. Conversely, cases of 'looking for victims' can also involve an agent that intends to help the victims. As such, we make the following prediction.

Prediction b of the Looking for Hypothesis: The prepositional variant will be more probable when the agent is a helper than when the agent is an aggressor, among the instances of *(naar) slachtoffer zoeken* 'search victim'.

The second theme lemma is *woord* 'word'. The meaning 'seeking to make words' can be interpreted to involve an agent trying to utter something, or trying to build a sentence. Conversely, instances of 'looking for words' would involve, say, an agent looking for words in a certain text. To make this distinction in a straightforward manner, we discriminate between those instances where the word(s) in question are non-specific or *de dicto*, and those instances where the word(s) are specific or *de re*. In the first case, any of several words may do, given that they meet particular requirements, e.g. express the correct idea or concept, while the second case will more likely involve looking for one or multiple pre-determined words in a body of text. This leads to the following prediction.

Prediction c of the Looking for Hypothesis: the prepositional variant will be more probable when *woord* 'word' is specific than when it is non-specific, among the instances of *(naar) woord zoeken* 'search word'.

3.5 Overview of the predictions

We now have three hypotheses that each make three predictions. They are listed below.

1. The Directionality Hypothesis: the *naar*-construction expresses directionality, while the transitive construction does not.
   a. Prediction at the level with an open verb slot: SEMANTIC COHERENCE OF THE VERB TO THE *NAAR*-CONSTRUCTION will have a positive effect on the use of the prepositional variant among the instances of the alternating verbs.
   b. Prediction at the level with an open object slot and a fixed verb slot: SEMANTIC COHERENCE OF THE THEME TO THE *NAAR*-CONSTRUCTION will have a positive effect on the use of the prepositional variant among the instances of *verlangen* 'desire'.
   c. Prediction at the level with an open object slot and a fixed verb slot: SEMANTIC COHERENCE OF THE THEME TO THE *NAAR*-CONSTRUCTION will have a positive effect on the use of the prepositional variant among the instances of *zoeken* 'search'.

2. The Longing Hypothesis: the *verlang-naar*-construction expresses a longing, while the transitive *verlang*-construction expresses a demand.
   a. Prediction at the level with an open object slot and a fixed verb slot: SEMANTIC COHERENCE OF THE THEME TO THE *VERLANG-NAAR*-CONSTRUCTION will have a positive effect on the use of the prepositional variant among the instances of *verlangen* 'desire'.
   b. Prediction at the level with only an open subject slot: the prepositional variant will be more probable when the agent longs for a thing than when the agent demands a thing, among the instances of *(naar) ding verlangen* 'desire thing'.
   c. Prediction at the level with only an open subject slot: the prepositional variant will be more probable when *tijd* 'time' is used as a count noun than when it is used as a mass noun, among the instances of *(naar) tijd verlangen* 'desire time'.

3. The Looking for Hypothesis: the *zoek-naar*-construction expresses a literal looking for, while the transitive *zoek*-construction expresses an attempt to make or acquire.
   a. Prediction at the level with an open object slot and a fixed verb slot: SEMANTIC COHERENCE OF THE THEME TO THE *ZOEK-NAAR*-CONSTRUCTION will have a positive effect on the use of the prepositional variant among the instances of *zoeken* 'search'.
   b. Prediction at the level with only an open subject slot: the prepositional variant will be more probable when the agent is a helper than when the agent is an aggressor, among the instances of *(naar) slachtoffer zoeken* 'search victim'.
   c. Prediction at the level with only an open subject slot: the prepositional variant will be more probable when *woord* 'word' is specific than when it is non-specific, among the instances of *(naar) woord zoeken* 'search word'.

4 Data

All instances of the alternating verbs were extracted from the Sonar-corpus (Oostdijk et al. 2013a). Only those observations were taken up for which the country of origin was known and where the theme argument was not extraposed. This placement is only possible for the prepositional variant (Haeseryn et al. 1997: 1225–1400; Zwart 2011: 25–79). To this dataset, the variables THEME COMPLEXITY, VERB-THEME ORDER, COUNTRY, CORPUS COMPONENT, VERB and THEME LEMMA were added. The variable THEME COMPLEXITY corresponds to the natural logarithm of the number of words of the theme, and the variable VERB-THEME ORDER distinguishes between the instances where the theme precedes the verb and those where the verb precedes the theme (as to why these variables was chosen, see Pijpops et al. 2018). COUNTRY differentiates between Belgium and the Netherlands, CORPUS COMPONENT between the corpus components (Oostdijk et al. 2013b: 22), VERB between the verbs and THEME LEMMA between the theme lemmas.

We manually checked for false positives, and removed all instances that were deemed non-interchangeable, following the definition of an alternation as a choice point of an individual language user (cf. Pijpops 2020; Szmrecsanyi et al. 2016: 4–5; Wallis 2012). For a more detailed overview of the data selection procedure, see Pijpops (2019: 107–172). The values of the variables were also corrected where necessary. This yielded a dataset of 93,668 instances. To this dataset, the coherence measures introduced above were added. Finally, we manually added the variables MEANING DESIRE, COUNTABILITY TIME, AGENT TYPE and WORD SPECIFICITY to respectively the data of *(naar) ding verlangen* 'desire thing', *(naar) tijd verlangen* 'desire time', *(naar) slachtoffer zoeken* 'search victim' and *(naar) word zoeken* 'search word'. These variables operationalize the predictions at the level with only an open subject slot, viz. Predictions b and c of the Longing and Looking for Hypotheses.

5 Analysis

5.1 Prediction at the level with an open verb slot

To test Prediction a of the Directionality Hypothesis, a logistic mixed regression model was built with the presence of *naar* as the dependent variable and SEMANTIC COHERENCE OF THE VERB TO THE *NAAR*-CONSTRUCTION as an independent variable. Furthermore, THEME COMPLEXITY, VERB-THEME ORDER and COUNTRY were added as control variables, as well as an interaction between THEME COMPLEXITY and VERB-THEME ORDER

(see Pijpops et al. 2018). The categorical variables were implemented through dummy coding. Random intercepts were added for the variable VERB, because all instances of the same verb have an identical value of SEMANTIC COHERENCE OF THE VERB TO THE *NAAR*-CONSTRUCTION (Speelman et al. 2018: 2), and for the variable CORPUS COMPONENT (Speelman et al. 2018: 3). Multicollinearity was not found to be a problem, with all Variance Inflation Factors (VIFs) well below 5 (Levshina 2015: 160).[9] The specifications of the model are shown in Table 9, and Figure 2 shows the effect plot of SEMANTIC COHERENCE OF THE VERB TO THE *NAAR*-CONSTRUCTION. Effect plots visualize the probability of the success level, i.e. the prepositional variant, estimated by the model as a function of one of the model's predictors while controlling for the other predictors (Fox 2003).

Table 9: Specifications of a regression model at the level with an open verb slot.

AIC:	81,030.2	Transitive observations:	76,138
C-index:	0.696	Prepositional observations (success level):	17,530

Fixed effects	Level	Estimate	Standard error	*Z*-value	*p*-value
	Intercept	−1.04	0.36	−2.87	0.0041
SEMANTIC COHERENCE OF THE VERB TO THE *NAAR*-CONSTRUCTION		−1.11	0.56	−2.00	0.0458
COUNTRY	Belgium	Reference level			
	Netherlands	−0.14	0.02	−5.98	<0.0001
THEME COMPLEXITY		−0.04	0.02	−1.88	0.0601
VERB-THEME ORDER	Theme-verb	Reference level			
	Verb-theme	0.42	0.03	15.31	<0.0001
Interaction THEME COMPLEXITY AND VERB-THEME ORDER	Theme-verb	Reference level			
	Verb-theme	0.30	0.02	12.39	<0.0001

Random effects	Number of levels	Variance	Standard deviation
CORPUS COMPONENT	18	0.07	0.27
VERB	13	4.58	2.14

9 All VIFs reported in this paper were calculated for the same models without the interaction between THEME COMPLEXITY and VERB-THEME ORDER. The used R-packages include *lme4*, *effects* and *Hmisc* (Bates et al. 2013; Fox et al. 2016; Harrell 2017).

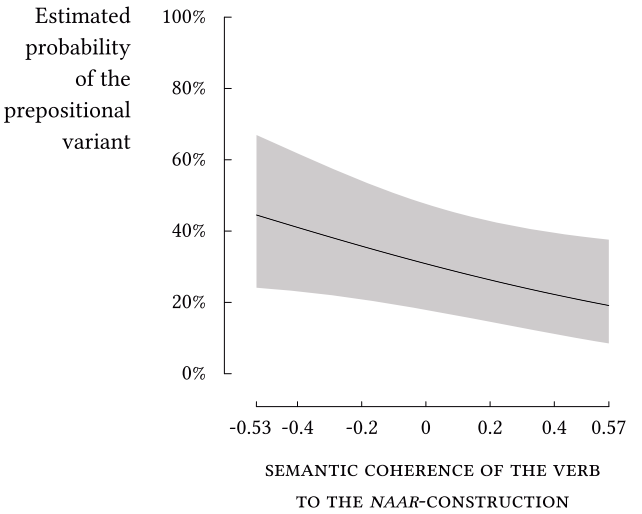

Figure 2: Effect plot of SEMANTIC COHERENCE OF THE VERB TO THE *NAAR*-CONSTRUCTION.

We find that Prediction 1a is not confirmed: the estimate of SEMANTIC COHERENCE OF THE VERB TO THE *NAAR*-CONSTRUCTION in Table 9 and the descending line in Figure 2 show that the variable has a negative effect rather than a positive effect on the use of the prepositional variant. There are various possible reasons for the failure of this prediction. For one, it might be due to some verbs acting as outliers, while the others do conform to the prediction; for another, the verb dispositions might confirm to some other general semantic distinction. To check for this, SEMANTIC COHERENCE OF THE VERB TO THE *NAAR*-CONSTRUCTION was removed from the model, and VERB was implemented as a fixed effect. This enables us to directly assess the verb dispositions. All VIFs are again below 5. The specifications of the new regression model and the effect plot of VERB can be found in Table 12 and Figure 10 in the Appendix. Figure 10 shows that the preferences for each variant do indeed strongly differ from verb to verb, but no general semantic distinction seems apparent.

5.2 Predictions that only pertain to the verb *verlangen* 'desire'

Prediction b of the Directionality Hypothesis and Prediction a of the Longing Hypothesis only pertain to the instances of *verlangen* 'desire'. Hence, we restricted the dataset to only the occurrences of that verb. A regression model was composed with the fixed effects SEMANTIC COHERENCE OF THE THEME TO THE *VERLANG-NAAR*-CONSTRUCTION and SEMANTIC COHERENCE OF THE THEME TO THE *NAAR*-CONSTRUCTION. Since these measures can

only be calculated for full-nominal theme lemmas, all instances with pronominal theme lemmas were removed from the dataset. All instances with theme lemmas that do not appear with any of the 5000 most frequent context features in the corpus were also removed, because no vector could be calculated for them. Finally, the instances of the collexemes themselves or their diminutives were removed to avoid circularity.

The variables COUNTRY, THEME COMPLEXITY, VERB-THEME ORDER and an interaction between THEME COMPLEXITY and VERB-THEME ORDER were again added as control variables, as well as random intercepts for CORPUS COMPONENT and THEME LEMMA. To get the model to converge, its random structure had to be simplified: all theme lemmas that occurred only once were binned in a rest category (cf. Wolk et al. 2013: 399).

Table 10: Specifications of a regression model at Meso-level 2 on the data of the verb *verlangen* 'desire'.

AIC:	1555.8	Transitive observations:	725
C-index:	0.927	Prepositional observations (success level):	914

Fixed effects	Level	Estimate	Standard error	*Z*-value	*p*-value
	Intercept	−1.13	0.73	−1.55	0.1215
SEMANTIC COHERENCE OF THE THEME TO THE *VERLANGNAAR*-CONSTRUCTION		2.26	0.22	10.23	<0.0001
SEMANTIC COHERENCE OF THE THEME TO THE *NAAR*-CONSTRUCTION		0.30	0.16	1.88	0.0608
COUNTRY	Belgium	Reference level			
	Netherlands	−0.26	0.18	−1.40	0.1629
THEME COMPLEXITY		−0.53	0.18	−2.94	0.0033
VERB-THEME ORDER	Theme-verb	Reference level			
	Verb-theme	1.32	0.28	4.72	<0.0001
Interaction THEME COMPLEXITY and VERB-THEME ORDER	Theme-verb	Reference level			
	Verb-theme	0.28	0.22	1.27	0.2043

Random effects	Number of levels	Variance	Standard deviation
CORPUS COMPONENT	12	2.24	1.50
THEME LEMMA	1011	1.34	1.16

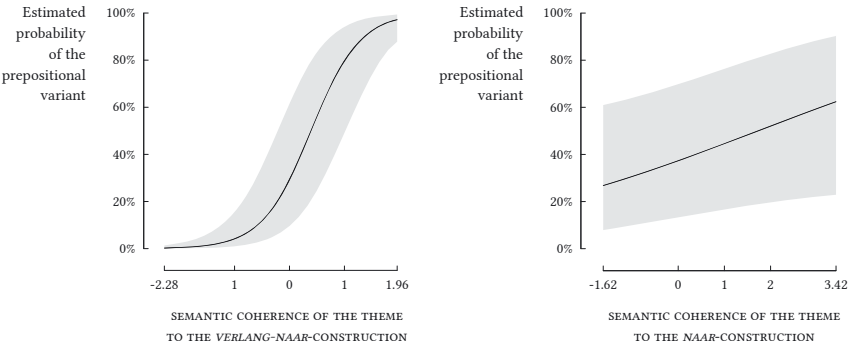

Figure 3: Effect plots of the regression model of *verlangen* 'desire' presented in Table 10.

The model was then fitted to the data. All VIFs were below 5. The specifications of the model can be found in Table 10, and Figure 3 shows the effect plots. We find that Prediction a of the Longing Hypothesis is clearly confirmed: the positive estimate and low *p*-value of SEMANTIC COHERENCE OF THE THEME TO THE *VERLANG-NAAR*-CONSTRUCTION in Table 10 indicates that it has a significant positive effect on the use of the prepositional variant. Meanwhile, Prediction b of the Directionality Hypothesis is not confirmed. The *p*-value of SEMANTIC COHERENCE OF THE THEME TO THE *NAAR*-CONSTRUCTION in Table 10 is non-significant.

5.3 Predictions that only pertain to the verb *zoeken* 'search'

Prediction c of the Directionality Hypothesis and Prediction a of the Looking for Hypothesis only pertain to the instances of *zoeken* 'search'. We hence restricted the dataset to the occurrences of the verb *zoeken* 'search' and built an analogous regression model. Again, all theme lemmas that occur only once had to be binned into a rest category to get the model to converge (cf. Wolk et al. 2013: 399). All VIFs were below 5. The specifications of the model are listed in Table 11, and Figure 4 shows the effect plots. We find that Prediction a of the Looking for Hypothesis is confirmed. The positive estimate and low *p*-value of SEMANTIC COHERENCE OF THE THEME TO THE *ZOEK-NAAR*-CONSTRUCTION in Table 11 indicate that it has a significant positive effect on the use of the prepositional variant. Meanwhile, Prediction c of the Directionality Hypothesis is not confirmed: the negative estimate of SEMANTIC COHERENCE OF THE THEME TO THE *NAAR*-CONSTRUCTION in Table 11 indicates that it does not have a positive effect on the use of the prepositional variant.

Table 11: Specifications of a regression model at Meso-level 2 based on the data of the verb *zoeken* 'search'.

AIC:	39,551.6	Transitive observations:	40,662
C-index:	0.843	Prepositional observations (success level):	8843

Fixed effects	Level	Estimate	Standard error	*Z*-value	*p*-value
	Intercept	−2.18	0.11	−20.09	<0.0001
SEMANTIC COHERENCE OF THE THEME TO THE *ZOEK-NAAR*-CONSTRUCTION		1.39	0.10	13.50	<0.0001
SEMANTIC COHERENCE OF THE THEME TO THE *NAAR*-CONSTRUCTION		−0.39	0.04	−9.20	<0.0001
COUNTRY	Belgium	Reference level			
	The Netherlands	0.35	0.04	9.81	<0.0001
THEME COMPLEXITY		−0.45	0.03	−13.43	<0.0001
VERB-THEME ORDER	Theme-verb	Reference level			
	Verb-theme	0.37	0.05	7.83	<0.0001
Interaction THEME COMPLEXITY and VERB-THEME ORDER	Theme-verb	Reference level			
	Verb-theme	0.56	0.04	14.44	<0.0001

Random effects	Number of levels	Variance	Standard deviation
CORPUS COMPONENT	8,192	0.09	0.30
THEME LEMMA	18	1.16	1.08

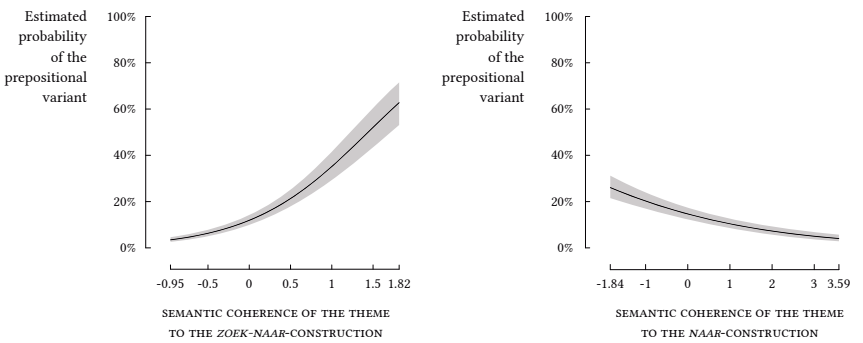

Figure 4: Effect plots of the regression model of *zoeken* 'search' presented in Table 11.

5.4 Predictions at the level with only an open subject slot

Predictions b and c of the Longing Hypothesis only pertain to *(naar) ding verlangen* 'desire thing' and *(naar) tijd verlangen* 'desire time'. Hence, we restricted the data to those instances. The results of are shown in Figures 5 and 6. The datasets are too small for any kind of serious inferential statistics, but the descriptive results are at least in accordance with the predictions. That is, the prepositional variant is more prevalent when the agent longs for a thing than when the agent desires a thing, among instances of *ding* 'thing', and the prepositional variant is more prevalent when *tijd* 'time' is used as a count noun than when it is used as a mass noun, among instances of *tijd* 'time'.

Finally, we turn to the Predictions b and c of the Looking for Hypothesis, which pertain to *(naar) slachtoffer zoeken* 'search victim' and *(naar) woord zoeken* 'search word'. We hence restricted the data to only their instances. Instances that were

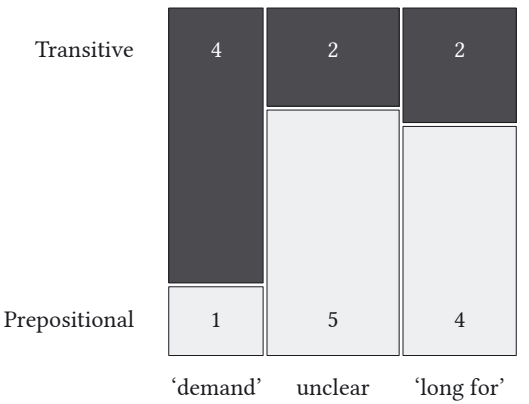

Figure 5: Mosaic plot of MEANING DESIRE for *(naar) ding verlangen* 'desire thing'.

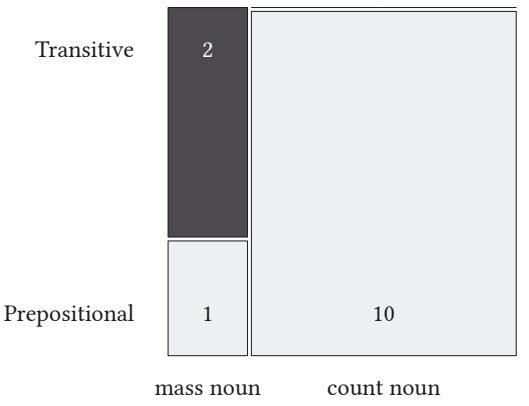

Figure 6: Mosaic plot of TIME COUNTABILITY for *(naar) tijd verlangen* 'desire time'.

unclear for the variables AGENT TYPE and WORD SPECIFICITY, were removed from the datasets. This left us with 68 instances of the least frequent variant for *(naar) slachtoffer zoeken* 'search victims', which is sufficient for a regression model with three parameters (Speelman 2014: 530). We therefore composed a regression model with AGENT TYPE, COUNTRY and THEME COMPLEXITY. All VIFs are well below 5, and the specifications of the model can be found in Table 13 in the Appendix. The effect plot of AGENT TYPE is shown in Figure 7. We find that Prediction 3b is clearly confirmed: the prepositional variant is more probable when the agent is a helper, e.g. (12), than when the agent is an aggressor, e.g. (13).

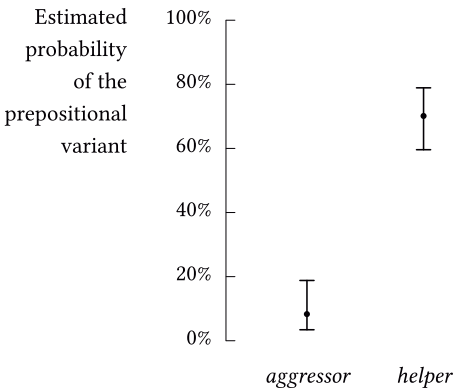

Figure 7: Effect plot of AGENT TYPE in the regression model based on the data of *(naar) slachtoffer zoeken* 'search victim'.

(12) *In* *Albanië* *zijn* *honderden* *hulpverleners (…).* *Ze*
In Albania are hundred relief_workers they
zoeken *naar* *slachtoffers*
search to victims
'In Albania, hundreds of relief workers are (…). They are searching for victims.'
(Sonar-id: WS-U-E-A-0000291696.p.1.s.2)

(13) *De* *potentiële* *zakkenrollers* *zoeken* *waarschijnlijk*
The potential pickpockets search probably
een *nieuw* *slachtoffer.*
a new victim.
'The potential pickpockets are probably searching a new victim.'
(Sonar-id: WR-P-P-G-0000140427.p.33.s.2)

The dataset of *(naar) woord zoeken* 'search word' contained 83 observations of the least frequent variable, which are enough for a regression model with 4 parameters (Speelman 2014: 530). We therefore built a regression model with WORD SPECIFICITY,

COUNTRY, THEME COMPLEXITY and VERB-THEME ORDER. Table 14 in the Appendix shows the specifications of this model, and the effect plot of WORD SPECIFICITY can be found in Figure 8. We find exactly the opposite effect of what was predicted: the prepositional variant is more probable when *woord* 'word' is non-specific than when it is specific.

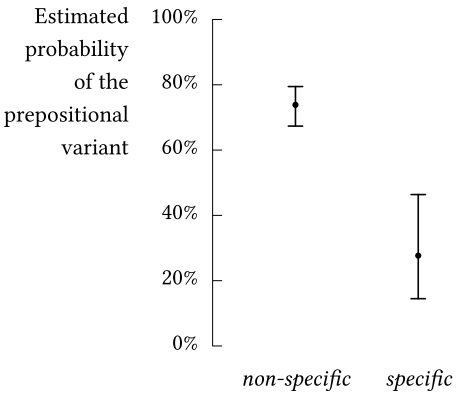

Figure 8: Effect plot of WORD SPECIFICITY in the regression model based on the data of *(naar) woord zoeken* 'search word'.

6 Conclusions

Our hypotheses are repeated below.

1. The Directionality Hypothesis: the *naar*-construction expresses directionality, while the transitive construction does not.
   a. Prediction at the level with an open verb slot: SEMANTIC COHERENCE OF THE VERB TO THE *NAAR*-CONSTRUCTION will have a positive effect on the use of the prepositional variant among the instances of the alternating verbs. Not confirmed.
   b. Prediction at the level with an open object slot and a fixed verb slot: SEMANTIC COHERENCE OF THE THEME TO THE *NAAR*-CONSTRUCTION will have a positive effect on the use of the prepositional variant among the instances of *verlangen* 'desire'. Not confirmed.
   c. Prediction at the level with an open object slot and a fixed verb slot: SEMANTIC COHERENCE OF THE THEME TO THE *NAAR*-CONSTRUCTION will have a positive effect on the use of the prepositional variant among the instances of *zoeken* 'search'. Not confirmed.
2. The Longing Hypothesis: the *verlang-naar*-construction expresses a longing, while the transitive *verlang*-construction expresses a demand.
   a. Prediction at the level with an open object slot and a fixed verb slot: SEMANTIC COHERENCE OF THE THEME TO THE *VERLANG-NAAR*-CONSTRUCTION will have a positive effect on the use of the prepositional variant among the instances of *verlangen* 'desire'. Confirmed.

   b. Prediction at the level with only an open subject slot: the prepositional variant will be more probable when the agent longs for a thing than when the agent demands a thing, among the instances of *(naar) ding verlangen* 'desire thing'. Confirmed.
   c. Prediction at the level with only an open subject slot: the prepositional variant will be more probable when *tijd* 'time' is used as a count noun than when it is used as a mass noun, among the instances of *(naar) tijd verlangen* 'desire time'. Confirmed.
3. The Looking for Hypothesis: the *zoek-naar*-construction expresses a literal looking for, while the transitive *zoek*-construction expresses an attempt to make or acquire.
   a. Prediction at the level with an open object slot and a fixed verb slot: SEMANTIC COHERENCE OF THE THEME TO THE *ZOEK-NAAR*-CONSTRUCTION will have a positive effect on the use of the prepositional variant among the instances of *zoeken* 'search'. Confirmed.
   b. Prediction at the level with only an open subject slot: the prepositional variant will be more probable when the agent is a helper than when the agent is an aggressor, among the instances of *(naar) slachtoffer zoeken* 'search victim'. Confirmed.
   c. Prediction at the level with only an open subject slot: the prepositional variant will be more probable when *woord* 'word' is specific than when it is non-specific, among the instances of *(naar) woord zoeken* 'search word'. Not confirmed.

We have found that our three predictions based on the Directionality Hypothesis have all failed. The reason for these failures becomes apparent when we survey the results of the six predictions based on the Longing and Looking for Hypotheses. These predictions have all but one been successful. When each verb employs the alternation to express its own meaning distinction, this inevitably goes at the cost of a more general, shared semantic contrast. Put concretely, the Directionality Hypothesis required that the distributions of the variants for each verb were dependent on each other. For instance, the prepositional variant was expected to be more dominant for *zoeken* 'search' than for *verlangen* 'desire'. However, the confirmation of the Longing Hypothesis indicates that for the verb *verlangen* 'desire', the alternation expresses a distinction between a desire construed as a demand and one construed as a longing. If language users happen to construe a desire as a demand in approximately 50% of the instances, and as a longing in the other 50%, this results in a 50–50% distribution between the variants for the verb *verlangen* 'desire'. Meanwhile, for the verb *zoeken* 'search', another distinction, viz. between an attempt to make or acquire versus a literal looking for, results in

another distribution. Crucially, the distributions of the variants among the verbs *verlangen* 'desire' and *zoeken* 'search' are independent of one another.

Still, if we consider the Looking for Hypothesis to be confirmed, then the failure of its third prediction is unexpected. We see three possible scenarios that can explain this failure. First, perhaps we misinterpreted the results in Tables 5 and 6 and another semantic distinction is at play for the verb *zoeken* 'search', different from 'seek to make/acquire' versus 'look for'. That distinction would then have to account both for the confirmation of Prediction a and b, and the failure of Prediction c. We currently cannot think of such a distinction, however. Second, the theme *woord* 'word' may be the odd one out. Perhaps *naar woord zoeken* developed as a construction in its own right, meaning 'attempt to express something', while most other objects of *zoeken* 'search' do exhibit a distinction in terms of 'seek to make/acquire' versus 'look for'. Third, perhaps there is no semantic distinction at all for the verb *zoeken* 'search' at the level with an open object slot, and the alternation actually fully operates at a lower level. That is, perhaps all themes use the alternation to express their own idiosyncratic meaning distinctions. In that case, the success of Prediction a of the Looking for Hypothesis would be merely due to chance. We adopt the second scenario for now, because of the confirmation of Predictions a and b of the Looking for Hypothesis. The constructional network according to this scenario is sketched in Figure 9. Given our results, the levels in Figure 9 are good candidates to be cognitively real, or at least, cognitively plausible.

One might wonder how exactly a semantic distinction between two constructions at the level with an open object slot and a fixed verb slot can develop through the lexical origin mechanism, since their verb slot is fixed. Constructions at this level still have other open slots though, which means that the lexical origin mechanism

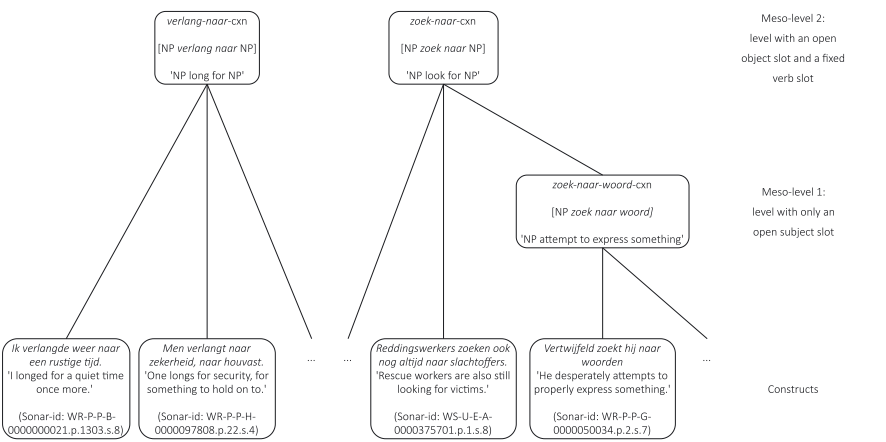

Figure 9: Resulting network after the corpus study, retaining only the nodes necessary to account for the confirmed meaning distinctions.

can operate as follows. First, an ostensible lexical bias emerges in language usage. For instance, in absence of a meaning distinction between the *verlang-naar*-construction and the transitive *verlang*-construction, we would expect the optional preposition *naar* to occur more often in front of complex noun phrases, following the Complexity Principle of Rohdenburg (1996). In addition, particular themes, e.g. *leven* 'life' in (14), would appear more often in complex noun phrases than others. Because of this, the theme *leven* 'life' would more often appear in the prepositional variant than other theme. Now, when the verb *verlangen* 'desire' is combined with the object *leven* 'life', the meaning of the sentence generally tends more towards 'to long for a life' than towards 'to demand a life', as can be seen in (14). As a result, a tendency would exist in language use where the prepositional variant of *verlangen* 'desire' is more often used in instances whose meaning is more inclined towards 'long for' than towards 'demand' – even though strictly speaking, such a semantic distinction between both variants is not yet in place. Language users may then subconsciously interpret this tendency as indicating an actual meaning distinction, and hence start to use the constructions as such.

(14)	*Joost*	*verlangt*	***naar***	*het*	*avontuurlijke*	*fantasierijke*	*leven*
	Joost	desires	to	the	adventurous	imaginative	life
	dat	*hij*	*leidde*	*toen*	*hij*	*nog*	*klein*
	that	he	led	when	he	still	small
	was.	(Sonar-id: WR-P-P-H-0000151970.p.37.s3)					
	was						
	'Joost longs for the adventurous imaginative life that he led when he was still small.'						

The goal of this paper was to tackle the following challenge: how do we hypothesize semantic distinctions that are specific enough to yield clearly falsifiable and successful predictions regarding language variation, while only relying on general mechanisms? We have shown that the key to dealing with this challenge is to incorporate the multi-level nature of the constructicon into hypothesis testing. This can be done by (i) taking a general mechanism, such as the lexical origin mechanism; (ii) sketching out the various levels of the constructional network at which the alternation may operate; and (iii) systematically applying that mechanism at various levels.

If we would have taken the alternation at face value, and only applied the lexical origin mechanism at the level with an open verb slot, then all our predictions would have failed. We would have been confronted with the exact same problem as Lenci (2012: 14) and Perek (2014: 64). That is, the notion of directionality is too vague to explain the specific meaning distinctions found for the *naar*-alternation in our corpus study. Still, the underlying lexical origin mechanism is in fact perfectly able to explain and predict these distinctions. It just needs to be applied at the proper level. That is the crucial point of this paper: if

there are no clear indications at which level in the constructicon an alternation operates, then it is advisable to systematically formulate and test hypotheses at various levels. Doing so allows us to substantially increase the descriptive coverage of cognitive linguistics, without incurring a loss in theoretical simplicity: no additional theoretical mechanisms are needed.

Our results indicate that the Dutch *naar*-alternation primarily operates at the level with an open object slot and a fixed verb slot. This could be interpreted as supporting a lexical approach to argument structure (e.g. Müller and Wechsler 2014) in contrast to a phrasal approach (e.g. Goldberg 2013). Such an interpretation would miss the point, however. For one, other studies have shown that other alternations do operate at a more schematic level (e.g. Colleman 2009; Pijpops and Speelman 2017). For another, we fully expect diversity in the levels at which alternations operate, based on usage-based theory. According to usage-based theory, one of the primary reasons that variation exists is to answer a functional need of the language user (Diessel 2015; Van de Velde 2014). This functional need may manifest itself at any level of in the vertical dimension. For instance, it is rather convenient for the language user to be able to express the semantic distinction between 'demand' and 'long for' for the verb *verlangen* 'desire' – but this distinction is useless for other verbs, such as *zoeken* 'search'. Similarly, the semantic distinctions that Lenci (2012) observed for the Italian verbs *decidere* 'decide' and *rimproverare* 'reproach' are very useful distinctions to be able to express – but only for these specific verbs. By contrast, in the English dative alternation, it is convenient to be able to express the same semantic distinction between 'transfer of possession' versus 'physical movement' for a whole number of alternating verbs. In sum, since a functional need may manifest itself at any level of in the vertical dimension, some alternations operate at a low level in the constructional network, while others operate at a higher level (cf. Boas 2014; Croft 2003; Pedersen 2019). The proposed multi-level procedure can be used to find out at which level it operates.

This procedure is obviously still in need of refinement. For one, there are still serious practical difficulties in investigating an alternation at low levels in the vertical dimension. At the lower levels, the number of potential constructions increases exponentially, as can be seen in Figure 1 (cf. Iwata 2008: 212). Meanwhile, as we add restrictions to our dataset, e.g. by restricting it to particular verbs and themes, the number of observations in a dataset goes down, and data scarcity becomes a problem. Still, these practical difficulties should not keep us from testing hypotheses at these lower levels, when doing so is theoretically desirable and practically feasible.

Acknowledgments: Funding by the Research Foundation Flanders (Grant No. 11ZZO16N) is gratefully acknowledged. We owe thanks to the editors of Cognitive Linguistics and several anonymous reviewers for useful comments that have

improved this article. In addition, we are grateful to Timothy Colleman, William Croft, Florent Perek and Remi van Trijp for various fruitful and stimulating discussions on the topic of this paper. We also thank Kris Heylen for much appreciated help with calculation of the distributional vectors. All remaining errors are of course our own.
Research funding: This project is funded by Research Foundation Flanders (Grant No. 11ZZO16N).

Appendix

Table 12: Specifications of a regression model at the level with an open verb slot with VERB as a fixed effect.

AIC:	80,965.0	Transitive observations:	76,138
C-index:	0.696	Prepositional observations (success level):	17,530

Fixed effects	Level	Estimate	Standard error	*Z*-value	*p*-value
	Intercept	−1.93	0.08	−22.76	<0.0001
VERB	*zoeken* 'search'	Reference level			
	opbellen 'phone'	−5.54	0.80	−6.92	<0.0001
	jagen 'hunt'	−0.44	0.48	−0.91	0.3618
	schoppen 'kick'	−0.16	0.21	−0.76	0.4463
	bellen 'phone'	0.12	0.03	4.67	<0.0001
	grijpen 'grab'	0.69	0.04	16.57	<0.0001
	vissen 'fish'	1.10	0.22	5.07	<0.0001
	grabbelen 'scramble'	1.57	0.29	5.39	<0.0001
	verlangen 'desire'	1.81	0.04	47.61	<0.0001
	peilen 'gauge'	2.00	0.06	33.85	<0.0001
	telefoneren 'phone'	2.00	0.14	14.44	<0.0001
	graaien 'grasp'	3.35	0.30	11.30	<0.0001
	happen 'snap'	3.98	0.12	32.37	<0.0001
COUNTRY	Belgium				
	The Netherlands	−0.14	0.02	−5.98	<0.0001
THEME COMPLEXITY		−0.04	0.02	−1.87	0.0611
VERB-THEME ORDER	Theme-verb				
	Verb-theme	0.42	0.03	15.26	<0.0001
Interaction THEME COMPLEXITY and VERB-THEME ORDER	Theme-verb				
	Verb-theme	0.30	0.02	12.36	<0.0001

Random effect	Number of levels	Variance	Standard deviation
CORPUS COMPONENT	18	0.07	49.40

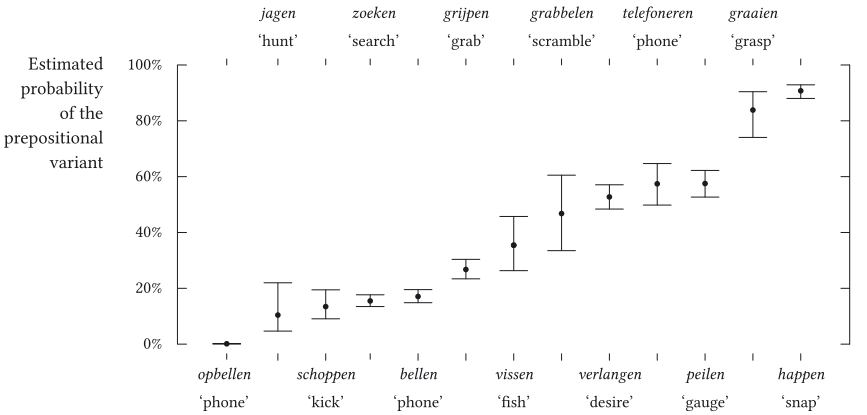

Figure 10: Effect plot of VERB in the regression model presented in Table 12, with the verbs ordered according to increasing estimated probability of the prepositional variant.

Table 13: Specifications of a regression model for *(naar) slachtoffer zoeken* 'search victim'.

AIC:	147.4	Transitive observations:	81
C-index:	0.846	Prepositional observations (success level):	68

Fixed effects	Level	Estimate	Standard error	*Z*-value	*p*-value
	Intercept	−2.35	0.56	−4.17	<0.0001
AGENT TYPE	Aggressor	Reference level			
	Helper	3.26	0.54	6.03	<0.0001
COUNTRY	Belgium	Reference level			
	The Netherlands	1.13	0.59	1.93	0.0537
THEME COMPLEXITY		−0.32	0.30	−1.07	0.2863

Table 14: Specifications of a regression model for *(naar) woord zoeken* 'search word'.

AIC:	283.2	Transitive observations:	83
C-index:	0.731	Prepositional observations (success level):	166

Fixed effects	Level	Estimate	Standard error	*Z*-value	*p*-value
	Intercept	0.62	0.31	2.00	0.0460
WORD SPECIFICITY	Non-specific	Reference level			
	Specific	−2.00	0.44	−4.51	<0.0001
COUNTRY	Belgium	Reference level			
	The Netherlands	0.82	0.30	2.68	0.0075
THEME COMPLEXITY		−0.37	0.18	−2.10	0.0356
VERB-THEME ORDER	Theme-verb	Reference level			
	Verb-theme	0.34	0.31	1.10	0.2695

References

Adler, Julia. 2011. *Dative alternations in German. The argument realization options of transfer verbs*. Jerusalem: Hebrew University Dissertation.

Bates, Douglas, Martin Maechler, Ben Bolker and Steven Walker. 2013. lme4: Linear mixed-effects models using Eigen and S4. R package version 1.4.

Boas, Hans. 2014. Lexical and phrasal approaches to argument structure: Two sides of the same coin. *Theoretical Linguistics* 40(1–2). 89–112.

Broccias, Cristiano. 2001. Allative and ablative at-constructions. In Mary Adronis, Christopher Ball, Elston Heide & Sylvain Neuvel (eds.), *CLS 37: The Main Session. Papers from the 37th Meeting of the Chicago Linguistic Society*, 67–82. Chicago: Chicago Linguistic Society.

Broekhuis, Hans. 2004. Het voorzetselvoorwerp. *Nederlandse Taalkunde* 9. 31–97.

Colleman, Timothy. 2009. Verb disposition in argument structure alternations: a corpus study of the dative alternation in Dutch. *Language Sciences* 31(5). 593–611.

Croft, William. 2003. Lexical rules vs. constructions. A false dichotomy. In Hubert Cuyckens, Thomas Berg, René Dirven & Klaus-Uwe Panther (eds.), *Motivation in language: studies in honor of Günter Radden*, 49–68. Stanford: CSLI Publications.

Dąbrowska, Ewa. 2017. *Ten lectures on grammar in the mind*. Leiden: Brill.

Davies, Mark. 2008. *The corpus of contemporary American English (COCA): One billion words, 1990–2019*. Available at: https://www.english-corpora.org/coca/.

Diessel, Holger. 2015. Usage-based construction grammar. In Ewa Dąbrowska & Dagmar Divjak (eds.), *Handboek of cognitive linguistics*, 296–322. Berlin: De Gruyter Mouton.

Diessel, Holger. 2019. *The grammar network: How linguistic structure is shaped by language use*. Cambridge: Cambridge University Press.

Dixon, Robert. 1991. *A new approach to English grammar, on semantic principles*. Oxford: Clarendon.
Dowty, David. 1991. Thematic proto-roles and argument selection. *Language* 67(3). 547–619.
Fox, John. 2003. Effect displays in R for generalised linear models. *Journal of Statistical Software* 8. 1–27.
Fox, John, Sanford Weisberg, Michael Friendly, Jangman Hong, Robert Andersen, David Firth & Steve Taylor. 2016. *Effect displays for linear, generalized linear, and other models* R package version 3.2.
Geeraerts, Dirk. 2006. Introduction. A rough guide to cognitive linguistics. In DirkGeeraerts (ed.), *Cognitive linguistics. Basic readings*, 1–28. Berlin: Mouton de Gruyter.
Geeraerts, Dirk. 2010. Schmidt redux: How systematic is the linguistic system if variation is rampant? In Kasper Boye & Elisabeth Engberg-Pedersen (eds.), *Language usage and language structure*, 237–262. Berlin/New York: De Gruyter Mouton.
Goldberg, Adele Eva. 1995. *Constructions: a construction grammar approach to argument structure*. Chicago: University of Chicago Press.
Goldberg, Adele Eva. 1999. The emergence of the semantics of argument structure constructions. In Brian Macwhinney (ed.), *Emergence of language*, 197–212. Hillsdale: Lawrence Earlbaum Associates.
Goldberg, Adele Eva. 2006. *Constructions at work: the nature of generalization in language*. Oxford: Oxford University Press.
Goldberg, Adele Eva. 2013. Argument structure constructions versus lexical rules or derivational verb templates. *Mind & Language* 28(4). 435–465.
Goldberg, Adele Eva, Devin Casenhiser & Nitya Sethuraman. 2004. Learning argument structure generalizations. *Cognitive Linguistics* 15(3). 289–316.
Gries, Stefan Thomas. 2007. *Coll.analysis 3.2a*.
Gries, Stefan Thomas & Anatol Stefanowitsch. 2004. Extending collostructional analysis: A corpus-based perspective on "alternations". *International Journal of Corpus Linguistics* 9(1). 97–130.
Haeseryn, Walter, Kirsten Romijn, Geerts Guido, Jaap de Rooij & Maarten van den Toorn. 1997. *Algemene Nederlandse Spraakkunst*. Groningen: Nijhoff.
Harrell, Frank Junior. 2017. *Hmisc: Harrell Miscellaneous*. R package version 4.0-3.
Hilpert, Martin. 2019. *Construction grammar and its application to English*, 2nd edn. Edinburgh: Edinburgh University Press.
Huber, Judith. 2013. Caused-motion verbs in the Middle English intransitive motion construction. In Juliana Goschler & Anatol Stefanowitsch (eds.), *Variation and change in the encoding of motion events*, 203–222. Amsterdam/Philadelphia: John Benjamins.
Iwata, Seizi. 2008. *Locative alternation. A lexical-constructional approach*. Amsterdam: John Benjamins.
Langacker, Ronald Wayne. 1988a. A usage-based model. In Brygida Rudzka-Ostyn (ed.), *Topics in cognitive linguistics*, 127–161. Amsterdam/Philadelphia: John Benjamins.
Langacker, Ronald Wayne. 1988b. An overview of cognitive grammar. In Brygida Rudzka-Ostyn (ed.), *Topics in cognitive linguistics*, 3–48. Amsterdam/Philadelphia: John Benjamins.
Langacker, Ronald Wayne. 1991. *Foundations of cognitive grammar: descriptive application*. Stanford: Stanford University Press.
Langacker, Ronald Wayne. 2000. A dynamic usage-based model. In MichaelBarlow & Suzanne Kemler (eds.), *Usage-based models of language*, 1–63. Stanford: CSLI Publications.

Lenci, Alessandro. 2012. Argument alternations in Italian verbs: a computational study. In Valentina Bambini, Irene Ricci & Pier Marco Bertinetto (eds.), *Linguaggio e cervello-Semantica/Language and the Brain-Semantics. Atti del XLII Congresso Internazionale di Studi della Societ`a di Linguistica Italiana*, 1–26. Rome: Bulzoni.

Lenci, Alessandro. 2018. Distributional models of word meaning. *Annual Review of Linguistics* 4. 151–171.

Levshina, Natalia. 2011. *Doe wat je niet laten kan [do what you want]: A usage-based analysis of Dutch causative constructions*. Leuven: University of Leuven Dissertation.

Levshina, Natalia. 2012. Comparing constructicons: A usage-based analysis of the causative construction with doen in Netherlandic and Belgian Dutch. *Constructions and Frames* 4(1). 76–101.

Levshina, Natalia. 2015. *How to do linguistics with R: Data exploration and statistical analysis*. Amsterdam: John Benjamins.

Levshina, Natalia & Dirk Geeraerts. 2010. Constructing the constructicon empirically: Experiments with Dutch causatives. In International Conference on Construction Grammar, Prague, September 5.

Levshina, Natalia & Kris Heylen. 2014. A radically data-driven construction grammar: Experiments with Dutch causative constructions. In Ronny Boogaart, Timothy Colleman & GijsbertRutten (eds.), *Extending the scope of construction grammar*, 17–46. Berlin: Mouton de Gruyter.

Müller, Stefan & Stephen Wechsler. 2014. Lexical approaches to argument structure. *Theoretical Linguistics* 40(1–2). 1–76.

Oostdijk, Nelleke, Martin Reynaert, Véronique Hoste & Ineke Schuurman. 2013a. The construction of a 500-million-word reference corpus of contemporary written Dutch. In Peter Spyns & Jan Odijk (eds.), *Essential speech and language technology for Dutch, theory and applications of natural language processing*, 219–247. Heidelberg: Springer.

Oostdijk, Nelleke, Martin Reynaert, Véronique Hoste & Ineke Schuurman. 2013b. *SoNaR user documentation*.

Padó, Sebastian & Mirella Lapata. 2010. Dependency-based construction of semantic space models. *Computational Linguistics* 33(2). 161–199.

Pedersen, Johan. 2019. Verb-based vs. schema-based constructions and their variability: On the Spanish transitive directed-motion construction in a contrastive perspective. *Linguistics* 57(3). 473–530.

Perek, Florent. 2014. Rethinking constructional polysemy: The case of the English conative construction. In Dylan Glynn & Jus Robinson (eds.), *Polysemy and synonymy: Corpus methods and applications in cognitive linguistics*, 61–85. Amsterdam/Philadelphia: John Benjamins.

Perek, Florent. 2015. *Argument structure in usage-based construction grammar: Experimental and corpus-based perspectives*. Amsterdam/Philadelphia: John Benjamins.

Perek, Florent. 2018. Recent change in the productivity and schematicity of the way-construction: A distributional semantic analysis. *Corpus Linguistics and Linguistic Theory* 14(1). 65–97.

Perek, Florent & Adele Eva Goldberg. 2015. Generalizing beyond the input: The functions of the constructions matter. *Journal of Memory and Language* 84. 108–127.

Perek, Florent & Maarten Lemmens. 2010. Getting at the meaning of the English at-construction: The case of a constructional split. *CogniTextes* 5. Association française de linguistique cognitive (AFLiCo).

Pijpops, Dirk. 2019. *How, why and where does argument structure vary? A usage-based investigation into the Dutch transitive-prepositional alternation*. Leuven: University of Leuven Dissertation.
Pijpops, Dirk. 2020. What is an alternation? Six answers. *Belgian Journal of Linguistics* 34. 283–294.
Pijpops, Dirk & Dirk Speelman. 2017. Alternating argument constructions of Dutch psychological verbs. A theory-driven corpus investigation. *Folia Linguistica* 51(1). 207–251.
Pijpops, Dirk, Dirk Speelman, Stefan Grondelaers & Freek Van de Velde. 2018. Comparing explanations for the complexity principle. Evidence from argument realization. *Language and Cognition* 10(3). 514–543.
Rohdenburg, Günter. 1996. Cognitive complexity and increased grammatical explicitness in English. *Cognitive Linguistics* 7(2). 149–182.
Speelman, Dirk. 2014. Logistic regression: A confirmatory technique for comparisons in corpus linguistics. In Dirk Speelman, Kris Heylen & Dirk Geeraerts (eds.), *Corpus methods for semantics: Quantitative studies in polysemy and synonymy*, 487–533. Amsterdam: John Benjamins.
Speelman, Dirk, Kris Heylen & Dirk Geeraerts. 2018. Introduction. In DirkSpeelman, Kris Heylen & Dirk Geeraerts (eds.), *Mixed-effects regression models in linguistics*, 1–10. Cham: Springer.
Steels, Luc. 2000. Language as a complex adaptive system. In Marc Schoenauer, Kalyanmoy Deb, Günter Rudolph, Xin Yao, Evelyne Lutton, Juan Julian Merelo & Hans-PaulSchwefel (eds.), *Proceedings of PPSN VI: Lecture notes in computer science*, 17–26. Berlin: Springer.
Steels, Luc. 2011. Modeling the cultural evolution of language. *Physics of Life Reviews* 8(4). 339–356.
Stefanowitsch, Anatol & Susanne Flach. 2016. The corpus-based perspective on entrenchment. In Hans-Jörg Schmid (ed.), *Entrenchment and the psychology of language learning: How we reorganize and adapt linguistic knowledge*, 101–127. Berlin: Mouton de Gruyter.
Stefanowitsch, Anatol & Stefan Thomas Gries. 2003. Collostructions: Investigating the interaction of words and constructions. *International Journal of Corpus Linguistics* 8(2). 209–244.
Szmrecsanyi, Benedikt, Biber Douglas, Jesse Egbert & Karlien Franco. 2016. Toward more accountability: Modelling ternary genitive variation in Late Modern English. *Language Variation and Change* 28(1). 1–29.
Thompson, Sandra Annear. 1990. *Information flow and dative shift in English discourse. Development and diversity: Language variation across time and space. A Festschrift for Charles-James N. Bailey*, 239–253. Arlington: The Summer Institute of Linguistics and the University of Texas.
Traugott, Elizabeth Closs. 2007. The concepts of constructional mismatch and type-shifting from the perspective of grammaticalization. *Cognitive Linguistics* 18(4). 523–557.
Turney, Peter & Patrick Pantel. 2010. From frequency to meaning: Vector space models of semantics. *Journal of Artificial Intelligence Research* 37. 141–188.
Van de Velde, Freek. 2014. Degeneracy: The maintenance of constructional networks. In Ronny Boogaart, Timothy Colleman & Gijsbert Rutten (eds.), *Extending the scope of construction grammar*, 1, 141–179. Berlin: Mouton de Gruyter.
van Hout, Anna Maria Henrica. 1996. *Event semantics of verb frame alternations: a case study of Dutch and its acquisition*. Tilburg: Tilburg University Dissertation.
van Noord, Gertjan. 2006. At last parsing is now operational. In Piet Mertens, Cédric Fairon, Anne Dister & Patrick Watrin (eds.), TALN 2006. Verbum Ex Machina. Actes de la 13e

conference sur le traitement automatique des langues naturelles, 20–42. Louvain-la-Neuve: Cental.
van Trijp, Remi. 2015. Cognitive vs. generative construction grammar: The case of coercion and argument structure. *Cognitive Linguistics* 26(4). 613–632.
van Trijp, Remi and Luc Steels. 2012. Multilevel alignment maintains language systematicity. *Advances in Complex Systems* 15(3–4). https://doi.org/10.1142/s0219525912500397.
van Voorst, Jan. 1996. Some systematic differences between the Dutch, French and English transitive construction. *Language Sciences* 18(1–2). 227–245.
Wallis, Sean. 2012. That vexed problem of choice. In Paper presented at ICAME33, 30 May–3 June 2012. Leuven: University of Leuven. Available at: www.ucl.ac.uk/english-usage/statspapers/vexedchoice.pdf.
Weeds, Julie, David Weir & Diana McCarthy. 2004. Characterising Measures of Lexical distributional similarity. *COLING '04: Proceedings of the 20th international conference on Computational Linguistics*, 1015–1021.
Wible, David & Tsao Nai-Lung. 2020. Constructions and the problem of discovery: A case for the paradigmatic. *Corpus Linguistics and Linguistic Theory* 16(1). 67–93.
Wolk, Christoph, Joan Bresnan, Anette Rosenbach & Benedikt Szmrecsanyi. 2013. Dative and genitive variability in Late Modern English: Exploring cross-constructional variation and change. *Diachronica* 30(3). 382–419.
Zwart, Jan-Wouter. 2011. *The syntax of Dutch*. Cambridge: Cambridge University Press.