Using structural priming to test links between constructions: English caused-motion and resultative sentences inhibit each other

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1 Introduction

Cognitive theories of grammar, among them different strands of Construction Grammar (e.g., Croft 2001; Goldberg 1995) and Cognitive Grammar (Langacker 1987), view speakers' linguistic knowledge as a structured network of form-meaning pairings. This network is assumed to encompass linguistic units at different levels of complexity, ranging from simple lexemes (or even morphemes) to complex phrasal and clausal patterns. Adopting insights from cognitive psychology, grammatical knowledge is conceptualised as a spreading activation network (Collins and Loftus 1975) whose nodes – corresponding to "constructions" in the wide sense of the term employed in most constructionist approaches – are connected by a variety of associative relations.

In current constructionist work, the network is commonly modelled as a two-dimensional structure formed by two main types of links. Early research (e.g., Goldberg 1995) focused mainly on the *vertical* axis of the network, which is defined by the taxonomic or "inheritance" relations between abstract superordinate constructions and their more specific subtypes. These inheritance links are also regarded as the central structuring mechanism of speakers' grammatical knowledge in other cognitive (Hudson 2007) and non-cognitively oriented declarative theories of grammar (Pollard and Sag 1987; Sag 2012). Recent constructionist research (Diessel 2019; Perek 2015; Sommerer and Smirnova 2020), on the other hand, has shown an increased interest in the *horizontal* axis of the network, which encompasses a variety of relations "between semantically or formally similar constructions at the same level of abstraction" (Diessel 2019: 199). These links have been argued to connect, for instance, so-called "allostructions", i.e., formally distinct variants expressing a (near-)identical meaning such as in the English particle placement alternation (*pick up the book* vs. *pick the book up*; Cappelle 2006) and the dative alternation (double-object vs. prepositional dative; Perek 2015). In addition, horizontal links have been posited between formally or semantically contrastive constructions that together form a grammatical paradigm, for example within the family of English demonstratives (*this/that/these/those book(s)*; Smirnova and Sommerer 2020), or among Dutch clause types (verb-initial vs. verb-second vs. verb-final; Van de Velde 2014).

While vertical and horizontal links feature ubiquitously in constructionist analyses, relatively limited psycholinguistic evidence exists so far to support the psychological reality of the proposed relations. Perek (2012) presents evidence from a sentence sorting task suggesting that English speakers are sensitive to the horizontal links between alternating constructions. As the author himself notes (p. 629), however, the metalinguistic task may trigger participants' conscious reasoning about the meaning of the sentences, resulting in the creation of "ad hoc" grammatical categories, rather than tapping into speakers' stored mental representations.

Searching for a more implicit way to study speakers' "on-line" processing of stored constructional relations, structural priming has emerged as a promising experimental paradigm. First demonstrated by Bock (1986), structural priming occurs when processing a construction with particular characteristics facilitates or inhibits subsequent processing of a construction with the same or related characteristics. In the psychological literature, the paradigm has been heralded as a crucial method for studying speakers' linguistic representations (Branigan and Pickering 2017), and in the context of current cognitive-linguistic accounts of the grammatical network, Diessel (2019: 204) comments that "[s]tructural priming provides perhaps the best evidence for constructional relations". However, as will be further outlined below (see Section 3), the application of the method to the study of constructional links has been hindered by several factors: (i) researchers have focused on a small set of target constructions, typically constructional alternations (e.g., the dative alternation); (ii) characteristics of the methodological designs (e.g., the type of outcome measure) impose limitations on the conclusions that can be drawn from the data; and (iii) despite attempts to link up the structural priming literature with cognitive-linguistic research on constructionist networks (Diessel 2019: 202–205; Perek 2015: 165–167), the ways in which the two research strands can mutually inform each other remain underexplored.

The present study marks an attempt to overcome these limitations and illustrate how structural priming can be used to systematically investigate links between clause-level constructions. It applies the method to a new case of related but non-alternating constructions (i.e., constructions that differ in both form and meaning): the English caused-motion construction in (1) and the (adjectival) resultative construction in (2).[1] Studying structural priming in comprehension, using a variant of self-paced reading known as the "maze task" (Forster et al. 2009), allows for an empirical assessment of the widespread theoretical claim (e.g., Goldberg and Jackendoff 2004) that speakers store distinct but related representations for the two constructions. Moreover, priming can help evaluate Goldberg's (1995: 81–89) well-known hypothesis that the constructions are metaphorically related: if the change of location expressed by the caused-motion construction functions as a metaphorical source for the change of state

[1] The two constructions are also included in Johnson & Goldberg's (2013) priming experiment; however, the authors tested the effect of sentential Jabberwocky primes (e.g., *He lorped it on the molp*) on single-verb targets (e.g., *put*), which combines elements of lexical and structural priming and is therefore difficult to compare with the present study.

encoded in the resultative, one would expect asymmetric priming from the former construction to the latter but less so in the opposite direction.

(1) James rolled the ball down the hill. ('X CAUSE Y TO GO Z')

(2) Susan hammered the metal flat. ('X CAUSE Y TO BECOME Z')

Section 2 reviews previous distributional evidence that the two constructions are formally and functionally similar but also distinct. Moreover, existing accounts are shown to disagree over whether the constructions are related via a unidirectional metaphorical link (which could be regarded as a type of vertical inheritance link, in line with Goldberg 1995), or via a bidirectional horizontal link. Section 3 outlines the methodological requirements for applying structural priming to the study of constructional links. It is argued that the paradigm is sensitive to both formal and functional characteristics of constructions, that comprehension methods can overcome some of the limitations of production priming techniques, and that previous findings are equivocal about the role of repeating the same verb in the prime and target (so-called "lexical boost" effects). Section 4 reports a structural priming experiment of the English caused-motion and resultative construction which compares priming between instances of the same construction, between instances of the two different constructions (in both directions), and in the presence and absence of verb repetition. The results are discussed in Section 5, along with an assessment of the wider potential of using structural priming to investigate constructional relations. Section 6 concludes with some implications for future research into the structure of the grammatical network.

2 Linguistic background: the link between the caused-motion and resultative construction

To motivate any representational link between two constructions, it needs to be shown that the patterns are, in terms of their formal and/or functional features, (i) sufficiently different to be regarded as distinct schemas; and (ii) sufficiently similar to be considered as related. In the case of the English caused-motion and resultative construction, some major differences and similarities can be summarised based primarily on Goldberg's (1995) account (for further discussion, see, e.g., Beavers 2012; Boas 2003; Goldberg and Jackendoff 2004).

On the syntactic side, the two constructions display some obvious overlap in the number and order of constituents they contain. It is only at the final phrase that formal differences between the patterns emerge: caused-motion sentences end in a prepositional phrase (see example (3a), repeated from above) or (though less discussed in the literature) an adverb phrase (3b), while resultatives contain either a sentence-final adjective phrase (see (4a), repeated from above), a prepositional phrase (4b) or (rarely) a noun phrase (4c). While prepositional caused-motion and resultative sentences are thus practically indistinguishable on formal grounds, a clear difference

exists between prepositional caused-motion instances and adjectival resultatives, which are the focus of the present study.[2]

(3) a. James rolled the ball down the hill.

b. Mary pushed the chair inside.

(4) a. Susan hammered the metal flat.

b. John broke the bowl into pieces.

c. Claire painted the door a radiant yellow.

On the semantic side, Goldberg (1995: 84–88, 193–197) points out several key differences between the two constructions: first, certain verbs are prototypically associated with only one of the constructions (e.g., *move* for caused-motion, *make* for resultatives).[3] Second, the caused-motion construction encompasses polysemous sub-senses besides the constructional core meaning in (1), for example 'X ENABLE Y TO GO Z' in (5a) and 'X CAUSE Y NOT TO GO Z' in (5b), while resultatives do not display this type of constructional polysemy. Third, resultatives typically encode the end-point of a scale, i.e., they are usually telic, while the caused-motion construction has no such requirement; compare (6a) against (6b).[4]

(5) a. She allowed him into the room.

b. She locked him out of the room. (both from Goldberg 1995: 84)

(6) a. John hammered the metal flat (*for an hour / in an hour). (Wechsler 2001)

b. James rolled the ball down the hill (for an hour / in an hour).

In terms of semantic similarities, Goldberg's (1995: 81–84) account highlights the conceptual resemblance noted above between the change of location expressed by caused-motion sentences and the change of state encoded in resultatives. Based on this similarity, Goldberg suggests that the resultative is a metaphorical extension of the caused-motion construction, with the change along a *metaphorical* path in the former extending the concept of motion along a *literal* path in the latter. Goldberg's main argument for the relatedness of these two types of path expressions is that they are subject to a common "Unique Path" constraint: not more than one distinct path (literal,

[2] Adjectival resultatives are used to create a test case for priming between constructions which are formally *and* semantically distinct.
[3] *Move* can occur in some (idiomatic) prepositional resultatives, e.g., *She moved him to tears*.
[4] But see Goldberg and Jackendoff (2004: 542–543) for counter-examples of atelic resultatives.

metaphorical or a mix of both) can be predicated of the object argument. Sentences that violate this constraint are ill-formed, as illustrated in (7). The postulated metaphorical link draws additional support from the widespread mapping between locations and states observed in lexical expressions (Lakoff 1990) and the pervasive use of spatial metaphors in grammatical and event structure (Jackendoff 1983).

(7) a. *He wiped the table [dry]$_{\text{metaphorical}}$ [clean]$_{\text{metaphorical}}$.

b. *Sam kicked Bill [black and blue]$_{\text{metaphorical}}$ [out of the room]$_{\text{literal}}$.

(both from Goldberg 1995: 81–82)

Crucially, the metaphorical extension hypothesis has implications for the type of link that connects the two constructions in the grammatical network. Specifically, it entails an inherently asymmetric mapping from the caused-motion construction as the metaphorical source to the resultative construction as the metaphorical target. This source-target asymmetry aligns well with the above evidence that the caused-motion is subject to fewer semantic constraints and displays more constructional polysemy than the resultative. Moreover, it motivates Goldberg's (1995) claim that the metaphorical relation between the two construction is a type of inheritance link, i.e., a vertical taxonomic relation between a superordinate (or dominating) and a subordinate (or dominated) construction (see Section 1).[5]

There are, however, also arguments in the literature that the caused-motion and resultative construction may be bidirectionally linked on a horizontal level. Goldberg (1995: 81) herself notes that the two patterns "are often assumed to be instances of a single more abstract construction", which suggests that they may share an abstract supertype (which schematically captures their common features) but are themselves situated on the same horizontal level of the abstraction hierarchy. In a similar vein, Goldberg and Jackendoff (2004) treat the two patterns as "path" and "property" sub-types of an overarching "resultative" family. Interestingly, the authors contrast two alternative interpretations of the relation between the constructions (note 13, p. 542): one view corresponds to the vertical analysis of Goldberg's metaphorical extension account, while the other entails a horizontal analysis, treating the patterns as "parallel instantiations of thematic structure" in line with Jackendoff's work. The latter horizontal view implies that the constructions share a bidirectional (symmetric) link which captures their overlapping formal and/or functional characteristics; this is in line with

[5] The present study leaves open the theoretical question of whether metaphorical links should best be regarded as vertical inheritance links in line with Goldberg (1995), or whether they could be reconceptualised as asymmetric horizontal links (see, e.g., Perek 2020: 161–163). In either case, the link would be asymmetric, which is the crucial point for the experimental predictions regarding priming outlined in Section 4.1.

other accounts of horizontal relations in the literature, where they are usually treated as bidirectional (compare the illustrations in Cappelle 2006; Van de Velde 2014).

To sum up, the existing literature gives rise to two claims and two corresponding empirical questions. First, previous work has established a number of syntactic and semantic similarities as well as differences between the caused-motion and resultative construction, which provide solid theoretical support for the claim that speakers store distinct but related representations for the two constructions. Second, it remains unclear whether the relation between the two constructions should best be conceptualised as a bidirectional horizontal link between formally and functionally similar patterns at the same level of abstraction, or as a unidirectional metaphorical relationship from the caused-motion construction as metaphorical source to the resultative as metaphorical target (which could be regarded as a type of vertical inheritance link, in line with Goldberg 1995). The two resulting empirical questions – whether psycholinguistic evidence can be found which supports the former claim, and which adjudicates between the two possibilities outlined in the latter – will be investigated with the help of a structural experiment in Section 4. Before that, however, some methodological requirements for the application of structural priming to the study of constructional relations need to be considered.

3 Methodological background

3.1 Structural priming is sensitive to the form and function of constructions

As argued in Section 2, constructional links rely on a complex interplay of formal and functional similarities and differences between constructions. Psycholinguistic investigations of such relations must therefore employ an experimental method that is sensitive to both the syntactic and semantic characteristics of clause-level constructions. The evidence that has emerged over the last decades suggests that structural priming fulfils this requirement.

In early structural priming research, it was commonly argued that priming emerges exclusively due to formal-syntactic overlap constructions irrespective of their semantic relatedness. In their classic study, Bock and Loebell (1990) found that passives with *by*-agents as in (8a) were primed by active intransitives with locative *by*-phrases (8b), which have a similar surface form but very different meaning. Recent results by Ziegler et al. (2019) suggest, however, that this effect is driven by the lexical repetition of the preposition *by*; no priming occurs when a different preposition is used (8c) (see also Konradt and Szendrői 2020 for a potential animacy-related confound in Bock and Loebell's original study). Numerous studies have since demonstrated that structural priming effects can be caused by a variety of functional-semantic factors, including thematic roles (Chang et al. 2003; Ziegler and Snedeker 2018), event structure (Bunger et al. 2013; Ziegler et al. 2018) and information-structural properties (Bernolet et al. 2009; Vernice et al. 2012).

(8) a. The 747 was alerted by the airport's control tower.

b. The 747 was landing by the airport's control tower.

c. The 747 has landed near the airport control tower.

Hare and Goldberg (1999) were among the first to present evidence that structural priming can emerge from similarities in the overall *constructional meaning* of clausal patterns rather than their surface-structural form. They compared how often participants produced either member of the dative alternation – the double-object construction illustrated in (9a) and the prepositional dative in (9b) – after exposure to double-object primes, prepositional datives or instances of what they called the "provide-with" construction (9c). They found that double-object and "provide-with" sentences equally primed subsequent double-object productions, while prepositional datives did not. The results suggest that speakers were primed by the semantic similarity between the double-object and the "provide-with" construction and ignored the fact that prepositional datives and "provide-with" sentences share the same phrase structure (NP–V–NP–PP) while double-object sentences are different (NP–V–NP–NP).

(9) a. His editor offered Bob the hot story.

b. His editor promised the hot story to Bob.

c. His editor credited Bob with the hot story.

3.2 Previous studies have focused on constructional alternations

Surveying the structural priming literature, it is striking that most existing studies have focused on a few pairs of alternating constructions: in Mahowald et al.'s (2016) meta-analysis of production priming studies, 291 (85%) out of 343 experimental conditions instantiated either the active/passive or the dative alternation. Within the realm of argument-structure constructions, studies of the dative alternation have dominated the literature (e.g., Bock 1986: Exp. 1; Goldwater et al. 2011; Pickering and Branigan 1998), even though some other alternations have also been investigated, among them the locative alternation in (10) (Chang et al. 2003; Ziegler and Snedeker 2018) and the "fulfilling" alternation in (11) (Ziegler and Snedeker 2018; one member of this alternation is also used by Hare and Goldberg 1999, compare (9c) above). What these three alternations have in common is that their members form "allostructions" in the sense of Cappelle (2006) and Perek (2015), i.e., formally distinct variants with roughly identical meaning (see Section 1).

(10) a. The boy sprayed the plant with the water.

b. The boy sprayed the water on the plant.

(11) a. The woman presented the actor with the award.

b. The woman presented the award to the actor.

(all from Ziegler and Snedeker 2018)

The present study extends the structural priming paradigm beyond such near-synonymous alternating constructions. As was argued in Section 2, the constructional meanings of the caused-motion and resultative construction are related but not (even roughly) identical; in line with this, previous research has not treated them as members of an "alternation". In order to extend the structural priming paradigm to this new class of target phenomena, certain methodological modifications are required, which will now be outlined.

3.3 Comprehension priming affords crucial flexibility

One reason why previous studies have focused on a small set of target phenomena (see Section 3.2) may be that testing priming in production usually requires "structural alternatives" (Branigan and Pickering 2017: sect. 1.4, para. 11). In Bock's (1986) widely used picture description task, for example, participants are presented with a picture which can be described equally felicitously by two semantically near-identical constructions (e.g., a "giving" event that can be described by either of the two dative constructions). This method cannot be applied to related but non-alternating constructions like the caused-motion and resultative construction, which describe markedly different types of events.

Given the limitations of production studies, comprehension priming may offer a more flexible methodology for testing constructional links. Comprehension methods like self-paced reading (e.g., Kim et al. 2014), eye-tracking (e.g., Traxler et al. 2014) or neuroimaging techniques (e.g., fMRI in Segaert et al. 2013) do not require participants to choose between alternating constructions, but simply record their response to a visual or auditory stimulus. In principle, they thus allow structural priming to be applied to any set of target constructions, thereby significantly expanding the possible uses of the method to study constructional relations. While it has been claimed that effects in comprehension may be harder to obtain than in production (Branigan and Pickering 2017: sect. 3.4, para. 3), controlled comparisons between production and comprehension priming have not found a significant difference between the two modalities (Segaert et al. 2013; Tooley and Bock 2014).

Another crucial advantage of comprehension paradigms for the study of constructional links, which has so far received relatively little attention in the literature, lies in the nature of their outcome measure. For comparison, the critical measure in production priming is typically the proportion with which speakers produce one or the other target

construction. Note that the proportions of these two possible outcomes complement each other (i.e., add up to 100%): if one proportion goes up, the other one necessarily goes down.[6] As a result, it is difficult to determine whether priming leads to an increase in the availability of one construction or a decrease in the availability of the alternative construction. Consider the example of a dative priming study in which participants produce more double-object targets after double-object primes than after prepositional dative primes. It cannot be concluded from this result whether the double-object primes facilitated double-object productions, or inhibited prepositional dative productions. Arguably, however, it is only under the latter scenario that a link between the two constructions can be feasibly posited because prime instances of one construction are shown to affect target instances of the other construction.

This methodological limitation is overcome in comprehension paradigms like the one illustrated in Section 4, which typically use non-complementary (i.e., independent) outcome measures such as reaction time and can thus differentiate between the two possible scenarios in the above example. A constructional link between the two dative constructions would only be posited if, for example, double-object primes were shown to affect participants' response times for prepositional dative targets (or vice versa); these responses would be independent from participants' responses to double-object targets.

3.4 The uncertain status of the lexical boost

Pickering and Branigan (1998) first observed what has since been termed "lexical boost" effects, showing that structural priming effects were larger when the same verb was used in both prime and target. According to the authors' explanation, priming is enhanced in these cases because prime and target do not only share their abstract syntactic structure, but also the link between the verb lemma and the construction in which it is used. Subsequent research, however, has produced a much less coherent picture of how the verb's lexical information interacts with the abstract meaning of the construction and whether verb repetition affects priming in production and comprehension differentially.

On the one hand, several studies (e.g., Arai et al. 2007; Branigan et al. 2005; Traxler et al. 2014) have found that comprehension priming does not occur in the absence of verb repetition, suggesting that effects in comprehension may be more strongly lexically

[6] This is not necessarily true in studies which also analyse an additional category of "other" responses, i.e., all target productions that instantiate neither of the critical constructions. For example, Goldwater et al. (2011) found that 4- and 5-year-old children produced more double-object *and* prepositional datives after dative primes compared with a no-prime baseline (while the proportion of "other" responses decreased), suggesting that both critical constructions were facilitated. Note, however, that "other" responses can form a heterogeneous category including interrupted trials and lexical retrieval errors (e.g., Miller and Deevy 2006), which makes their interpretation less straightforward. In addition, Goldwater et al.'s result has not been consistently replicated in dative priming studies with adults, in which proportions of "other" responses usually remain stable across baseline and critical primes (e.g., Bock 1986; Ziegler and Snedeker 2018; but see Pickering et al. 2002: Exp. 3, for some interesting differences).

driven than in production. This contrasts with other experiments (e.g., Giavazzi et al. 2018; Kim et al. 2014; Thothathiri and Snedeker 2008) in which comprehension priming did emerge between sentences with different verbs. Segaert et al. (2013) found that passives were primed both with and without verb overlap, but actives were only primed in the presence of verb overlap; while Fine & Jaeger (2016) found no difference in a direct comparison of conditions with and without verb repetition. Given these inconsistent results, the experiment in Section 4 will directly contrast same-verb and different-verb trials in order to investigate how verb repetition affects comprehension priming between related but distinct constructions.

4 Experiment

4.1 Design and research questions

The experiment reported in this section makes use of structural priming in comprehension to investigate the relation between speakers' mental representations of the caused-motion and resultative construction. To achieve this goal, it will be tested how speakers' processing of the two constructions is affected by previous exposure to instances of (i) the same construction (resultative → resultative, caused-motion → caused-motion); (ii) the (putatively) related construction (caused-motion → resultative, resultative → caused-motion); and (iii) an unrelated construction (the baseline). Comparing (i) against (iii) reveals whether participants are subject to *within-construction* priming, while the comparison between (ii) and (iii) tests for *cross-constructional* priming. In line with the discussion in Section 2, the first research question can thus be formulated as follows:

(Q1) Do speakers show signs of *cross-constructional* priming between instances of the caused-motion and resultative construction, which is distinct from *within-construction* priming between instances of the same construction, thus providing evidence that speakers store *distinct but related* representations for the two constructions?

A second goal of the study is to distinguish between the two possibilities raised in Section 2 that the constructions may be either *asymmetrically* related via a metaphorical link, or *symmetrically* via a horizontal similarity relation. Studies of metaphorical priming in other domains, for example between concepts of space and time in lexical expressions (Boroditsky 2000) and in non-linguistic contexts (Casasanto and Boroditsky 2008), have found that metaphorical sources primed metaphorical targets, but not vice versa. The prediction that metaphorical relations should manifest via priming asymmetries is further strengthened if one assumes that metaphorical links are a type of vertical inheritance link (as proposed by Goldberg 1995; see Section 2): again, one would expect asymmetric priming from the superordinate construction to the

subordinate construction which inherits from it.[7] The directionality of the priming effects in the present study can therefore help address the following question:

(Q2) Does cross-constructional priming only occur from caused-motion primes to resultative targets (providing possible evidence of an asymmetric metaphorical relation), or do the effects emerge in both directions (suggesting the existence of a bidirectional horizontal link)?

Finally, the experiment contrasts prime-target pairs with the same and different verbs in order to contribute to the continuing debate about the influence of verb repetition on structural priming (especially in comprehension, see Section 3.4):

(Q3) Does repeating the same verb across prime and target lead to larger amounts of priming, i.e., is there evidence of a "lexical boost"?

In order to address these three research questions, the experiment employs a variant of self-paced reading known as the "maze" task (Forster et al. 2009), which has been used in at least one recent priming study (Hilpert and Correia Saavedra 2018). In this task, participants choose the correct sentence continuation among two competitor words at every step during reading (see Section 4.4 for details). The technique was applied for three reasons: first, it encourages participants' deep processing of the stimuli since it requires them to integrate each word with the preceding context in order to identify the correct continuation. Second, participants' stepwise choices between competitor words reduce the risk of spillover effects, i.e., delayed manifestations of processing reflexes several words after their source (see the recent evidence by Boyce and Levy 2020). Third, the technical implementation of the method has been facilitated by Boyce et al.'s (2020) "A(uto)-maze", which provides an experimental code for running maze experiments online and automatically generates distractor words for the maze choices using a natural language processing model.

The structural priming effects in this study should manifest themselves in variations of participants' response times at the critical sentence regions. Priming could either have a facilitatory effect on target processing, in which case response times should decrease, or an inhibitory effect, which should lead to longer response times. As illustrated in Figure 1, one region of interest is the final complement phrase: it is at this region that the characteristic meanings of the caused-motion and resultative construction as

[7] See Pappert & Pechmann (2013) for another structural priming study in which this logic was employed: the authors predicted asymmetric priming based on a putative inheritance link from German double-object datives to benefactives (e.g., *The secretary baked her boss a cake*). Interestingly, and in line with the findings of the present study (see Section 5.2), Pappert & Pechmann did not find evidence of an asymmetric inheritance link; instead, their results indicated priming in both directions, supporting a "parallel syntactic analysis" (p. 1317) of the two constructions.

expressing, respectively, a change of location and a change of state are differentiated. The complement of the resultative stimuli consists of a single adjective, while the complement of the caused-motion stimuli encompasses a multi-word prepositional phrase. The critical region will, however, be restricted to the initial preposition of that phrase since it contains the main structural and semantic information which enables participants to recognise the constructional meaning. Once they read *Sarah swept the glass into –,* a resultative interpretation of the sentence becomes implausible.

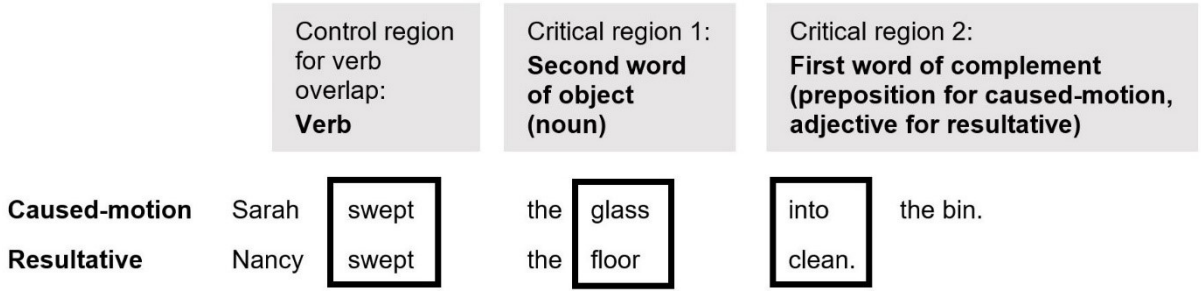


Figure 1: Critical regions for the caused-motion and resultative targets in the experiment.

However, speakers may already become aware of the difference in constructional meaning earlier in the sentence, specifically at the object phrase, which therefore constitutes another region of interest. As the examples in Figure 1 reveal, the two constructions tend to attract distinct semantic types of object which differ in terms of their profiled participant role: in Langacker's (1987) terms, *the glass* in the caused-motion example denotes the "figure" which is brought into motion by the act of sweeping, while *the floor* in the resultative example focuses on the "ground" from which some non-profiled figure is removed. Since the determiner does not disambiguate between the semantic types of the object, the critical region will be restricted to the second word of the object, i.e., the noun.

Finally, response times at the verb are only relevant as a control region to confirm that participants are sensitive to the presence or absence of verb overlap. If verb repetition is found to influence participants' responses at the verb itself, this can be interpreted simply as a *lexical* effect of re-using the same word. In contrast, if verb overlap turns out to modulate response times at the later sentence regions, this can be interpreted as a *structural* effect on speakers' processing of the constructions (a lexical boost).

4.2 Participants

160 self-reported native speakers of English were recruited via Amazon Mechanical Turk. Participation was restricted to workers from the United States who had a 95% or higher HIT acceptance rate. The "Unique Turker" script (https://uniqueturker.myleott.com) was used to prevent multiple participation by the

same worker. One participant's data were not saved due to a technical error; two participants did not complete the experiment; 22 participants were excluded because they made errors in more than 50% of sentences in the maze task. These participants were replaced by 25 new participants. Participants' mean age was 36.3 years (*SD* = 10.6, range 18-68, five unreported); 81 were female and 78 male (one unreported); 142 were right-handed and 17 left-handed (one unreported). The study was approved by the PPLS Research Ethics Committee at the University of Edinburgh (reference number 419-1819/2) and informed consent was obtained from all participants prior to the experiment.

4.3 Materials

Figure 2 provides examples of the stimuli; the full list of experimental items is included in Appendix A. The critical items consisted of 32 caused-motion and 32 resultative sentences, which occurred both as primes and targets in the experiment. The resultatives had the structure "NP [human] – V – NP [human or inanimate] – AP [bare adjective]".[8] The caused-motion items were of the form "NP [human] – V – NP [inanimate] – PP". To create the critical stimuli, 16 verbs were chosen that are compatible with both constructions; there were two sentences for each verb in each construction. To avoid lexical overlap between the prepositions of the caused-motion stimuli, nine different prepositions were used in those items. Similarly, different adjectives were used for the sentence-final phrases of the resultatives where possible, with no adjective occurring more than four times across all materials.[9] To minimise structural variation within the noun phrases, all subject NPs consisted of given names and all object NPs had the form "definite/possessive determiner + common noun".

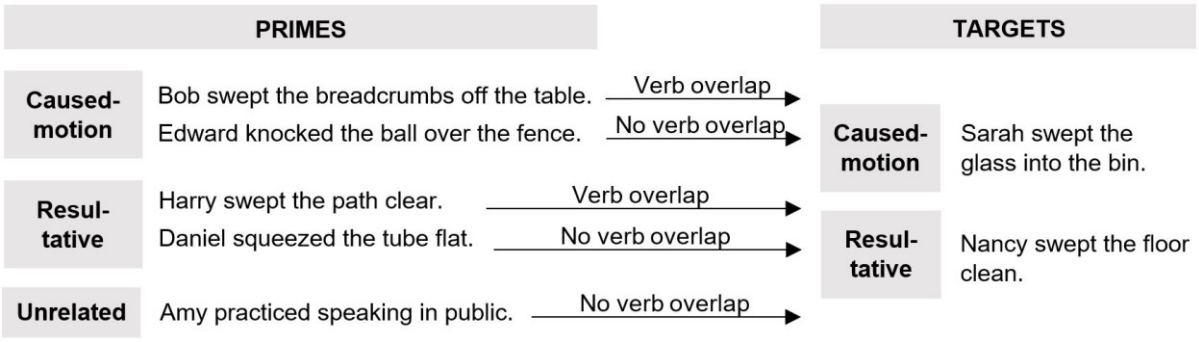


Figure 2: Examples of experimental primes and targets with and without verb overlap.

[8] Object NPs were animate in four of the resultative sentences (examples with the verbs *kick* and *knock*). Including the interaction between prime and target animacy did, however, not significantly improve the statistical models (see Section 4.5). Items with animate and inanimate objects are therefore conflated in the following analyses.

[9] In the experiment, caused-motion and resultative targets never directly followed primes that contained the same preposition or adjective.

Two pre-tests were conducted as judgment tasks on Amazon Turk with 20 participants each to confirm that all caused-motion and resultative stimuli were perceived as highly acceptable instances of their respective constructions. Only items that received median acceptability ratings of 6 or higher on a Likert scale from 1 to 7 were included in the main experiment (with one exception, see footnote).[10]

In addition to the critical items, 96 instances of unrelated constructions were included whose function was twofold: they served as fillers to divert participants' attention from the re-occurring target constructions; and when preceding caused-motion or resultative sentences, they functioned as a baseline condition to test processing of those targets in the absence of priming. They instantiated a variety of unrelated constructions: intransitives with locative or temporal adjuncts, monotransitives (optionally with adjuncts), ditransitives, passives, verb + *to*-infinitive structures, verb + object + *to*-infinitives, verb + prepositional object constructions, verb + *that*-clauses, verb + present participles and sentences containing relative clauses.

For the purposes of the maze task (see Section 4.4), each word of each sentence (except for the first word) was associated with a distractor, i.e., an existing English word which did not form a sensible sentence continuation given the preceding words. Distractors were automatically created using Boyce et al.'s (2020) "A(uto)-maze" to select words from a natural language processing model (Gulordava et al. 2018) which matched their correct counterparts in length and corpus frequency, but had low contextual probability. The automatically chosen distractors were then manually adjusted if they (i) still formed legitimate sentence continuations; (ii) appeared too frequently across the experiment; (iii) were rare or register-specific (e.g., poetic, colloquial); or (iv) had questionable status as correct words of English.

Items were pseudo-randomised to create eight different lists, each distributed to 20 participants. Every participant saw all 160 sentences once during the experiment. For each list, the resultative and caused-motion stimuli were newly combined into prime-target pairs such that, across all lists, each sentence occurred equally often as prime and target, was equally frequently paired with instances of the same and the other construction, and occurred equally often in pairs with and without verb repetition. The lists consisted of four blocks, each of which contained eight resultative and/or caused-motion prime-target pairs in random order, interspersed with two to four unrelated sentences between every critical pair.

Since none of the unrelated (filler) sentences shared the same verb with any of the caused-motion and resultative items, verb overlap could only occur in prime-target

[10] One item (*Maggie licked the bowl empty*) was included in the main experiment despite only receiving a median rating of 5. An additional statistical model indicated a significant difference between the priming behaviour of this sentence compared with the other resultative targets at the first word of the complement. The item, as well as all sentences primed by it, were therefore excluded from the analysis.

pairs that did not contain an unrelated sentence.[11] The experiment therefore had a nested design with 10 conditions, in which 3x2 conditions without verb overlap (caused-motion/resultative/unrelated prime x caused-motion/resultative target) were complemented by an additional 2x2 conditions with verb overlap (caused-motion/resultative prime x caused-motion/resultative target).

4.4 Procedure

The experiment was hosted online on Ibex Farm (Drummond 2013). Participants completed five practice trials before the experiment began. In each trial of the maze task, participants read a sentence word by word; at every step they had to choose between a correct sentence continuation and a distractor word displayed next to each other in the centre of the screen (see Figure 3). The position of the words was randomly determined and participants pressed "e" and "i" for the left and right word respectively. If they chose an incorrect sentence continuation, an error message was displayed and the trial ended immediately. The first word of each sentence was always displayed on the left and accompanied by a dummy distractor "x-x-x" to ensure that participants chose the correct sentence beginning. There were short breaks after 25%, 50% and 75% of the experiment, which were always followed by at least two filler trials.

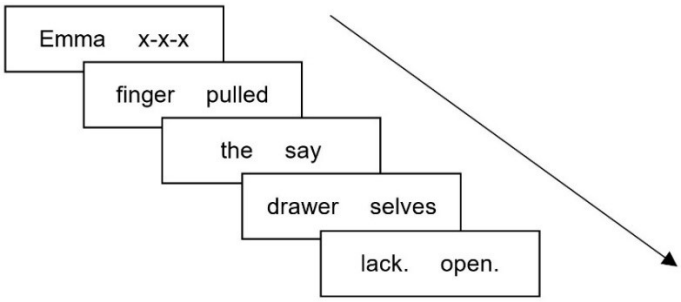


Figure 3: A sample maze task trial.

4.5 Data analysis

Since visual inspection revealed that the response times were right-skewed, they were log-transformed (base 10) to render their distribution more normal (Baayen and Milin 2010). Only the response times at the two critical words – the object noun and the first word of the complement (see Section 4.1) – and at the verb as a control region for the effect of verb repetition were retained for the analysis.

[11] Conditions with verb overlap involving the unrelated sentences were not included because the study investigates a potential *modulatory* effect of verb repetition on structural priming, but the unrelated sentences are not expected to give rise to any priming.

All trials that contained an error, i.e., in which participants had chosen an incorrect sentence continuation, were excluded.[12] Moreover, the trials that immediately followed these trials were also discarded since participants had not been fully primed in those cases. This resulted in the exclusion of 16.4% of the data. For outlier removal, all response times below 200 ms and above 3000 ms were discarded (a further 0.6% of the data). In a second step, all logged response times that were more than 2.5 standard deviations above or below each participant's mean in the respective sentence region within each condition were removed (0.3% of the remaining data). In total, this left 24,798 datapoints for analysis.

The statistical analysis was conducted in R (R Core Team 2019) and consisted of three steps. First, two separate linear mixed-effects models were fitted using the packages *lme4* (Bates et al. 2015) and *lmerTest* (Kuznetsova et al. 2017) to investigate the effect of the priming conditions on response times at each of the two critical words. The fixed effects consisted of target construction (caused-motion vs. resultative), prime construction (caused-motion vs. resultative vs. unrelated) and their interaction. Additional predictors were chosen in a backward stepwise fashion, retaining only those that significantly improved the model fit (using the "bobyqa" optimiser to facilitate model convergence). As a result, the model at the first word of the complement included age and the interaction of age and target construction, while the model at the object noun only included a main effect of age. Gender and handedness did not significantly improve either model and were therefore excluded. For the five participants who did not report their age, the missing age values were replaced by the mean across all other participants (Switzer and Roth 2004). The maximal random effects structure that led to model convergence consisted of intercepts for participant, target sentence and prime sentence as well as a by-participant slope for target construction.

In a second step, two additional models were fitted which tested for the effect of verb overlap (no vs. yes) at the two critical words. These models only compared trials with caused-motion and resultative primes but excluded trials with unrelated primes since the latter never contained the same verb as the targets. The fixed effects consisted of a three-way interaction between prime construction, target construction and verb overlap. Both models included a main effect of age, and the model at the first word of the complement additionally included the interaction with target construction. Maximal random effects which allowed for model convergence consisted of intercepts for participant, target sentence and prime sentence in both models, as well as a by-participant slope for verb overlap at the object noun and a by-participant slope for target construction at the complement.

[12] In addition to the response times, mixed-effects logistic regression analyses were conducted to examine participants' accuracy in the maze task. According to the models, however, error rates did not vary significantly depending on the priming condition, nor on the interaction between priming and lexical overlap. Accuracy results are therefore not further discussed here.

In the final step, a simple model was fitted at the verb to test for a main effect of verb overlap. Priming was not included as a factor since the two target constructions used the same set of verbs and could therefore not be affected differentially by the priming conditions. No further predictors were included as none of them improved the model fit. Maximal random effects comprised intercepts for participant, target sentence and prime sentence.

The crucial effects within the context of this study lay in the interactions between prime and target construction (and verb overlap), which were further investigated via pairwise comparisons using the package *emmeans* (Lenth 2019). The reported *p*-values are adjusted for multiple comparisons using the Tukey method; degrees of freedom are estimated asymptotically.

Section 4.6 only reports the results that are directly relevant to the research questions of this study (see Section 4.1). Main effects of the prime and target construction as well as effects of age are not of particular interest and are therefore not further examined. For the full dataset and the code for the statistical analyses, including test diagnostics for the models, see the data availability statement at the end.

4.6 Results

4.6.1 Priming effects

Across both critical regions, response times varied as a function of priming, i.e., the interaction of prime and target construction. Table 1 contains the output of the pairwise comparisons between the three prime constructions for each of the two target constructions at the noun of the object phrase and the first word of the complement phrase (the preposition in caused-motion sentences and the adjective in resultatives). In the two rightmost columns, the statistically significant results are back-transformed from logged into actual response times; both absolute estimates (in ms) and relative estimates of those differences (in %) are provided. Figure 4 contains a graphical representation of the results which also highlights the statistically significant differences.

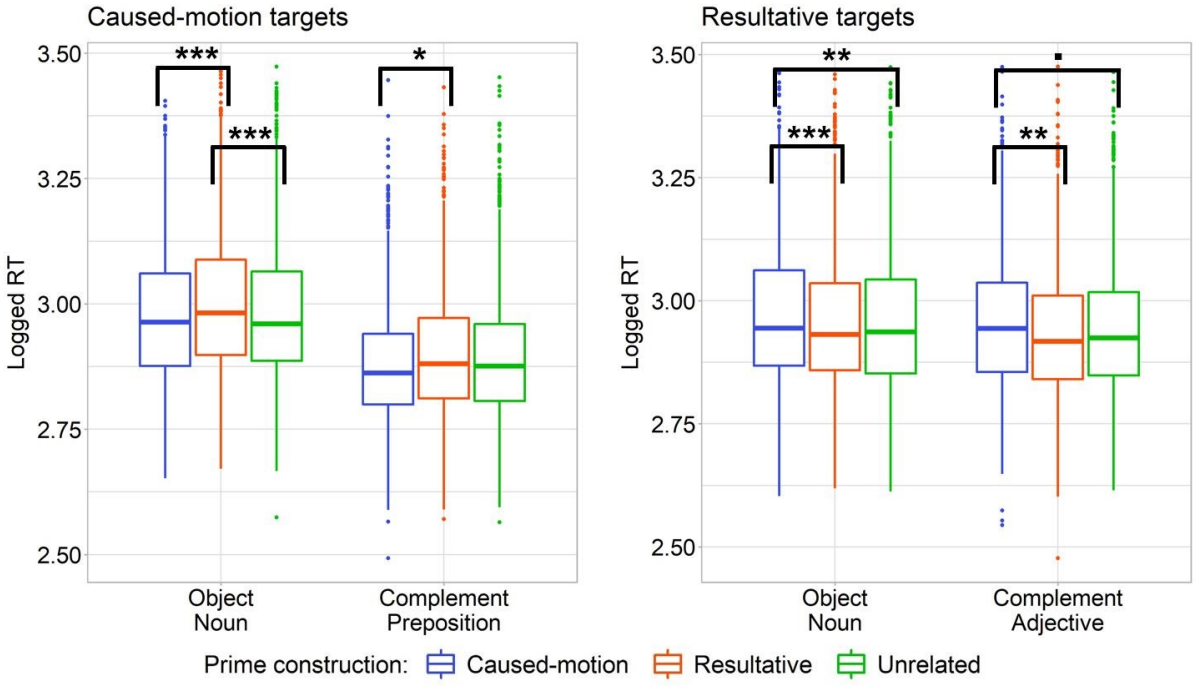
At the object noun, participants responded more slowly to caused-motion targets following resultative primes than after both caused-motion primes (by approx. 57.5 ms) and unrelated primes (by approx. 47.3 ms). Conversely, responses to resultative targets were slower after caused-motion primes than after both resultative primes (by approx. 48.7 ms) and unrelated primes (by approx. 38.5 ms).

At the first word of the complement phrase, participants responded more slowly to caused-motion targets following resultative primes than after caused-motion primes (by approx. 30 ms), but neither of those two conditions differed significantly from unrelated primes. Responses to resultative targets were slower after caused-motion primes than after both resultative primes (by approx. 51.1 ms) and, though only marginally significantly, unrelated primes (by approx. 28 ms).

Table 1: Output from pairwise comparisons of log-transformed response times between prime constructions for each target construction at the two critical words.

Target cxn	Diff. between prime cxns (A minus B)	Estimate	*SE*	*Z*	*p (adjust.)*	Sign.	Diff. in ms	Relative diff.
Second word of object phrase (noun)								
CM	**CM - RES**	**-0.026**	**0.006**	**-4.19**	**<0.001**	***	**-57.5**	**-6.1%**
	CM - UNREL	-0.005	0.005	-0.89	0.647			
	RES - UNREL	**0.021**	**0.005**	**3.94**	**<0.001**	***	**47.3**	**4.7%**
RES	**CM - RES**	**0.023**	**0.006**	**3.73**	**<0.001**	***	**48.7**	**5.1%**
	CM - UNREL	**0.018**	**0.005**	**3.41**	**0.002**	**	**38.5**	**4.1%**
	RES - UNREL	-0.005	0.005	-0.93	0.625			
First word of complement phrase (preposition in CM, adjective in RES)								
CM	**CM - RES**	**-0.017**	**0.007**	**-2.35**	**0.0498**	*	**-30.0**	**-3.9%**
	CM - UNREL	-0.009	0.006	-1.46	0.310			
	RES - UNREL	0.008	0.006	1.29	0.401			
RES	**CM - RES**	**0.025**	**0.007**	**3.51**	**0.001**	**	**51.1**	**5.6%**
	CM - UNREL	0.014	0.006	2.23	0.066	.	28.0	3.1%
	RES - UNREL	-0.012	0.006	-1.88	0.144			

'.' $p < 0.1$; '*' $p < 0.05$; '**' $p < 0.01$; '***' $p < 0.001$; CM = caused-motion; RES = resultative; UNREL = unrelated. Results with $p < 0.05$ in bold.



'.' $p < 0.1$; '*' $p < 0.05$; '**' $p < 0.01$; '***' $p < 0.001$

Figure 4: Log-transformed response times at the two critical words for caused-motion targets (left) and resultative targets (right) depending on the prime construction.

4.6.2 Verb repetition effects

At the object noun, verb repetition did not have a significant main effect, but it was involved in a marginally significant three-way interaction with the prime and target construction. The pairwise comparisons suggest (but only at marginal significance) that when resultative targets were preceded by resultative primes, participants responded approx. 29.2 ms (3.1%) faster in cases in which prime and target shared the same verb than when they contained different verbs ("no overlap" minus "overlap": β = 0.013, SE = 0.008, Z = 1.67, $p_{\text{adjust.}}$ = 0.094). These comparisons also suggest (again, at marginal significance) that when resultative targets were preceded by caused-motion primes, participants responded approx. 26.1 ms more slowly in cases with verb overlap than without overlap ("no overlap" minus "overlap": β = -0.013, SE = 0.007, Z = -1.81, $p_{\text{adjust.}}$ = 0.070).

At the first word of the complement phrase, there was neither a significant main effect of verb overlap nor an interaction between verb overlap and priming.

At the verb, the expected main effect of verb overlap was confirmed, suggesting that participants' responses were approx. 38 ms (4%) faster in conditions with verb overlap than without overlap (main effect of "overlap": β = -0.018, SE = 0.004, $t(3890)$ = -4.95, p < 0.001).

5 Discussion

5.1 Evidence of cross-constructional priming in comprehension

The results of the experiment indicate relatively small (3.1% to 6.1%) but statistically reliable priming effects at both critical words, i.e., the noun of the object phrase and the first word of the complement phrase. In line with the widely held assumption that priming reflects representational similarity (Branigan and Pickering 2017), these effects suggest that speakers' abstract representations of the caused-motion and resultative construction are distinct but related. On the one hand, the fact that participants' processing of the two target constructions varied systematically depending on whether the items were preceded by an instance of the same or the other construction suggests that speakers were sensitive to the difference between the two patterns. On the other hand, the comparisons with the unrelated baseline (which were only significant at the object phrase, see below) reveal that participants' processing of caused-motion targets was slowed down by resultative primes (rather than being speeded up by caused-motion primes), and processing of resultative targets was slowed down by caused-motion primes (rather than being speeded up by resultative primes). This suggests that the observed effects stem from *cross-constructional* priming and thus provide evidence that speakers are sensitive to the relatedness of the constructions. Meanwhile, the results provide no clear evidence of *within-construction* priming (see Section 5.3 for further discussion).

The structural differences and similarities between participants' constructional representations are unlikely to be of a purely formal-syntactic nature. The two constructions were formally identical at their object phrases but differed at the first word of their final complements (prepositional phrase vs. adjective); nevertheless, priming emerged at both sentence regions. For the same reason, the results cannot be attributed to semantic similarities and differences at *one* sentence region only, either at the object phrase (e.g., the semantic type of object noun that the constructions attract) or at the complement phrase (e.g., the specification of a locative path as opposed to a property). Instead, the effects suggest that speakers were sensitive to a more global, clause-level relatedness between the constructions, which can be plausibly captured as a similarity in constructional meaning between the 'CAUSE TO GO' semantics of caused-motion sentences and the 'CAUSE TO BECOME' meaning of resultatives.

The fact that the effects were clearer at the object than at the complement is not particularly surprising considering that the former region temporally precedes the latter, so participants might have already updated their expectations about the construction type by the time they reached the complement. More specifically, the difference between caused-motion and resultative primes was significant at both critical regions, while the difference between the alternative construction and the unrelated baseline was only significant at the object. Nevertheless, the marginally significant result that participants responded more slowly to the complement of resultative targets after caused-motion primes than after unrelated primes suggests that the results at the complement trended in the same direction as at the object.

5.2 The type of link: no evidence of a metaphorical asymmetry

Another question of the study was whether the priming effects would be asymmetric, compatible with the idea of a unidirectional metaphorical link from the caused-motion to the resultative construction (which could be regarded as a type of vertical inheritance link, following Goldberg 1995), or symmetric, hinting at a bidirectional horizontal link capturing the formal and functional similarities of the constructions. The effects in the experiment, which were in fact strikingly symmetric, speak in favour of the second interpretation: as Table 1 and Figure 4 show, cross-constructional priming occurred in both directions at comparable magnitude. The results thus do not provide evidence that speakers' representations of the two constructions are related via an asymmetric metaphorical link. Instead, speakers may be aware of the similarities between the constructional meanings and store them as bidirectionally related members of an overall constructional family (more akin to Goldberg and Jackendoff's [2004] analysis).

One should be careful, however, not to interpret this absence of evidence for a metaphorical link as evidence for the absence of the metaphor. It is still conceivable that speakers represent a metaphorical relation between the caused-motion and resultative construction on some level which was less amenable to the priming methods used in this study. For instance, the asymmetric effects of metaphor priming in Boroditsky's (2000) experiments (see Section 4.1) were facilitatory, while the present study found

inhibitory priming effects. It therefore remains an open question whether the respective priming effects were caused by different processes, and whether the relevant mechanism in this study (e.g., ambiguity resolution; see Section 5.3) may be less affected by the potential metaphorical asymmetry between primes and targets.

5.3 The role of inhibition in structural priming

The fact that participants' responses at the object noun (and, marginally significantly, at the complement of resultative targets) were slowed down by prime instances of the alternative construction but not speeded up by instances of the same construction strongly suggests that speakers were subject to inhibitory rather than facilitatory priming. The results thus differ from most previous structural priming studies, which "have focused so far on facilitatory effects" (Branigan and Pickering 2017: fn. 2) and in which "[i]nhibitory effects have seldom been reported" (Pietsch et al. 2012: 29). Against this background, the present findings may provide relevant evidence towards a re-evaluation of the role of inhibition in structural priming and its use as a diagnostic tool for constructional relations.

Interestingly, many previous studies have in fact been unable to distinguish between facilitatory and inhibitory priming based on their methodological characteristics. As outlined in Section 3.3, production priming studies typically use structure choice proportions as an outcome measure, which do not reveal whether prime exposure leads to increased productions of one target construction or decreased productions of the other construction (or both). In addition, as has been noted before (Miller and Deevy 2006: 393), facilitation and inhibition can only be identified in the presence of a baseline condition against which the critical prime conditions can be compared. Many structural priming studies, including recent experiments on constructional alternations (e.g., Ziegler and Snedeker 2018), do not include such a baseline but merely report the differences between the two critical prime constructions. In contrast to this previous work, the present study demonstrates that a comprehension paradigm combining a non-complementary outcome measure (response time) with an unrelated baseline can successfully distinguish between facilitatory and inhibitory priming.

Using comprehension priming to study inhibitory relations in the constructional network seems particularly attractive as it links up recent connectionist models of structural priming (Malhotra et al. 2008; Segaert et al. 2011), which represent structural alternatives as competing network nodes interlinked by mutually inhibitory connections, with current cognitive-linguistic research into the role of competition as a driving force in language change and the partial productivity of constructions (Berg 2014; Goldberg 2019; Zehentner 2019). Further structural priming experiments may elucidate relevant theoretical questions about the nature of inhibition in speakers' grammatical networks: how do the effects differ depending on the type of constructional relation – for instance between alternating constructions such as in the dative alternation, or related but non-alternating patterns like the caused-motion and resultative construction? Does inhibition of one construction automatically lead to

facilitation of its relatives, or are the effects (partially) independent? Are there systematic differences between production and comprehension?

Follow-up investigations may also help interpret the lack of facilitatory priming between instances of the same construction in the present experiment. Given the novelty of both the target phenomenon (two non-alternating but related constructions) and the method (the maze task, which has so far been rarely used in priming), further experimental evidence is needed to clarify which mechanisms give rise to the observed inhibitory effects. It is possible that specific processes implicated by the maze task – for instance ambiguity resolution, which is frequently discussed in the literature on comprehension priming (Fine and Jaeger 2016; Kim et al. 2014) – are more prone to eliciting inhibitory rather than facilitatory effects. Alternatively, however, the absence of facilitation in the present study could also represent a theoretically relevant finding about the privileged role of inhibition in regulating activation levels within the grammatical network.

5.4 Only marginal evidence of verb repetition effects

As outlined in Section 3.4, previous studies have yielded conflicting evidence as to whether structural priming is strengthened when prime and target share the same verb, and if such verb overlap might even be a prerequisite for observing priming in comprehension. The results of the present study suggest that verb repetition did not have a major influence on priming. Priming emerged consistently at the two critical regions and in both directions, while verb overlap had no effect at the complement and only a marginally significant effect on resultative targets at the object (see below). Combined with the fact that responses at the verb were reliably faster in cases of verb overlap, this suggests that verb repetition had a *lexical* effect on participants' processing of the verb, but little *structural* effect on their processing of the entire constructions. These findings corroborate previous evidence that structural priming can be successfully observed in comprehension studies without verb repetition (Fine and Jaeger 2016; Kim et al. 2014; Thothathiri and Snedeker 2008). This is good news insofar as the freedom to choose prime and target sentences with different verbs may afford researchers the crucial flexibility needed to extend priming to previously understudied constructions while still controlling for lexical features of the stimuli such as the frequencies and collostructional preferences of their elements.

Even though the effects of verb overlap were limited, the marginally significant results at the object suggest that verb repetition may have speeded up participants' responses to resultative targets after resultative primes, and slowed down their responses to resultative targets after caused-motion primes. Interestingly, verb overlap might thus have led to both a "positive" boost – providing some sparse evidence of a potential facilitatory effect between instances of the same construction – and a "negative" boost – strengthening the inhibitory effect between prime and target instances of different constructions. While the latter negative effect has seldom been reported in the literature, both results are in line with the common conception of a lexical boost (see

Section 3.4). On encountering the same verb in the prime and target, participants might form a stronger expectation that the sentences will also coincide structurally. When this expectation is confirmed, i.e., when prime and target instantiate the same construction, processing might be facilitated; when the expectation is contradicted by a different (but related) target construction, speakers' processing might be additionally impeded.

6 Conclusion

This study has been an attempt to extend the structural priming paradigm beyond the relatively small set of alternating constructions targeted by previous experiments, and explore to what extent the method can inform network models of links between clause-level constructions. In a comprehension priming experiment with English caused-motion and resultative sentences, it was found that prime and target instances of the two different constructions gave rise to inhibitory cross-constructional priming, thus providing evidence that speakers store distinct but related representations for the two constructions. The symmetry of the priming effects suggests that the constructions may be bidirectionally related on a horizontal network level. The results do not provide direct evidence of a metaphorical asymmetry underlying the constructional relation (and consequently, also not of a vertical inheritance link). In addition, the effect of verb repetition across prime and target was shown to have at best a marginal effect on priming, supporting recent evidence that comprehension priming can be observed in the absence of a lexical boost.

By providing both methodological explanations and a practical illustration of how comprehension priming can be used to investigate links between non-alternating constructions, the present study raises a number of possibilities and questions for future work. Follow-up experiments could apply similar methods to other pairs (or triplets etc.) of constructions between which representational links have been posited, in order to uncover micro-networks of linking patterns within those constructional families. One key question here would be whether and how different types of links can be differentiated, for example based on differences in the size of the priming effects or the sentence regions at which they occur. Another aspect to be addressed by future work concerns the factors that give rise to facilitation and inhibition in structural priming. The present findings highlight a number of open questions (see also Section 5.3), for example which cognitive processes are reflected by facilitatory and inhibitory priming, to what extent these effects can be observed in a variety of comprehension and production tasks, and how they are modulated by the nature of the prime-target relation (e.g., formal vs. functional vs. distributional similarities and differences).

A final hope of the present research is to bring together cognitive-linguistic theorising about the organisation of the grammatical network with current methodological advances in the psychology of language in a way that can benefit both research communities. On the one hand, cognitive-linguistic accounts of links between clause-level constructions, backed up by detailed linguistic analyses of their formal and functional similarities, can provide a rich framework for the interpretation of structural

priming effects. This is particularly relevant if the scope of priming research is extended to more complex relations between constructions that differ in both form and meaning, posing additional challenges for the interpretation of experimental results (see Branigan and Pickering 2017: sect. 1, para. 6; sect. 3.4, para. 3). On the other hand, structural priming methods provide an extensive empirical testing ground for cognitive-linguistic models of the grammatical network, including core aspects of these accounts such as the types of postulated links (horizontal, vertical, metaphorical, etc.), the mechanisms by which activation spreads through the network (facilitatory vs. inhibitory) and the interaction between lexical and clause-level information (e.g., as evident in lexical boost effects). As suggested by the preliminary evidence provided in this study, an extension of the structural priming paradigm in order to tackle these and other questions is now possible.

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Data availability statement

The dataset generated and analysed during the current study is available in the TROLLing data repository, https://doi.org/10.18710/2YJITD.

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Appendix A. List of experimental items

Verb	Caused-motion construction	Resultative construction
BRUSH	Katie brushed the dirt into the dustpan. Lisa brushed the mud off her coat.	Ellen brushed her hair straight. Sheila brushed the wallpaper smooth.
CUT	Michael cut the cucumber into the salad. Sharon cut the picture out of the magazine.	Jenny cut her hair short. David cut the bread thin.
KICK	Patrick kicked the can onto the street. Maria kicked the key under the sofa.	Judy kicked the man senseless. Ben kicked his opponent unconscious.
KNOCK	Edward knocked the ball over the fence. Susan knocked the vase off the shelf.	Tracy knocked the boxer senseless. Mary knocked the woman unconscious.
LICK	Joe licked the sauce from the plate. Jacob licked the sugar off his fingers.	Maggie licked the bowl empty. Paul licked his hands clean.
PULL	Anna pulled the phone from her pocket. Peter pulled the letter out of the envelope.	Vivian pulled the window shut. Emma pulled the drawer open.
PUSH	Steve pushed the chair into the kitchen. Charles pushed the bicycle up the hill.	Sally pushed the gate closed. Linda pushed the door open.
RINSE	Frank rinsed the soap out of his eyes. Lucy rinsed the ketchup off her hands.	Tim rinsed his sinuses clear. Michelle rinsed the glass clean.
SCRATCH	Terry scratched his name into the rock. John scratched the dirt off the table.	Jane scratched her arm red. Chris scratched his skin raw.
SCRUB	Joan scrubbed the graffiti from the wall. Alice scrubbed the mud off her shoes.	Jeff scrubbed his face red. Adam scrubbed the saucepan clean.
SHOVEL	Will shoveled the soil into the hole. Carol shoveled the sand out of the bag.	Bill shoveled the entrance clear. Kevin shoveled the car free.
SLAM	Richard slammed his schoolbag into the corner. Connie slammed the guitar against the wall.	Sandra slammed the window shut. Helen slammed the door closed.
SPRAY	George sprayed the paint onto the surface. Mark sprayed the water over the plants.	Jason sprayed the fence white. Tom sprayed the truck yellow.
SQUEEZE	Max squeezed the clothes into the suitcase. Rachel squeezed the toothpaste out of the tube.	Karen squeezed her eyes shut. Daniel squeezed the tube flat.
SWEEP	Sarah swept the glass into the bin. Bob swept the breadcrumbs off the table.	Harry swept the path clear. Nancy swept the floor clean.
WIPE	Julia wiped the sweat from her face. Holly wiped the stains off the glass.	Rosie wiped the windshield clear. Allan wiped the table dry.