

**Structural priming in the grammatical network:
A study of English argument structure constructions**

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Abstract

Recent cognitive-linguistic approaches view grammar as a mental network of stored knowledge. The present study investigates to what extent psycholinguistic evidence from structural priming can inform one of the crucial linking mechanisms in this network: similarity relations between formally and/or functionally related constructions. Structural priming occurs when processing a multi-word unit affects speakers' subsequent processing of the same or a similar construction. Focusing on a range of English argument structure constructions, it is shown that priming can help address theoretical claims about the structure of the grammatical network, and that the network-based view in turn motivates reinterpretations of previous priming results as well as novel extensions of the paradigm.

Chapter 1 introduces the topic and outlines the goals of the investigation. It is proposed that structural priming can provide a rich source of evidence for cognitive-linguistic models of the grammatical network, but that the ways in which the two research areas can inform each other have not yet been sufficiently explored.

Chapter 2 outlines the central role of similarity relations in cognitive-linguistic network models, combining elements from Construction Grammar, Cognitive Grammar, Word Grammar and other related frameworks. Different types of similarity relations between argument structure constructions are illustrated with detailed linguistic analyses, including functionally similar (alternating) constructions (e.g., the double-object and the *to*-dative construction) and formally similar constructions (e.g., the resultative and the depictive construction). It is shown that previous theoretical accounts raise questions about the nature and degree of these similarities, which can be addressed with the help of the priming evidence provided in the later chapters. Moreover, the discussion provides an overview of corpus-based and experimental methods that can be used to investigate constructional similarities.

Chapter 3 describes how structural priming can be used to study similarity relations in the grammatical network via their implicit effects on speakers' processing. Evidence is provided that priming is sensitive to both formal and functional similarities between constructions. Based on an overview of production and comprehension priming methods, it is argued that different methods are needed to study different types of similarity relations. In addition, the discussion outlines three relevant distinctions for the interpretation of structural priming effects: the difference between within-construction and cross-constructional

priming; between symmetric and asymmetric priming; and between facilitatory and inhibitory priming.

Chapter 4 reinterprets previous structural priming findings about alternating constructions in the context of a cognitive-linguistic network model of grammar. First, based on within-construction priming effects between instances of the same construction, it is suggested that speakers' grammatical networks comprise both abstract argument structure constructions and verb-specific representations. Second, it is shown that the evidence for cross-constructional priming between members of the same alternation (e.g., the double-object and the *to*-dative construction) is weaker than previously assumed, casting doubt on the central role that alternations play in some grammatical theories. Third, varying degrees of cross-constructional priming are observed between members of different alternations (e.g., the dative and the benefactive constructions) and related to previous theoretical claims about their respective similarities.

Chapter 5 reports novel comprehension experiments that extend structural priming to previously understudied non-alternating argument structure constructions. In two experiments, a variant of self-paced reading known as the 'maze task' is used to investigate priming between the resultative and the object-oriented depictive construction. The results indicate that depictives facilitate both depictive targets (within-construction priming) and resultative targets (cross-constructional priming), but that resultatives do not give rise to priming. Frequency-related and other possible explanations for the asymmetric effects are provided. The discussion then addresses another recent experiment that tests priming between the caused-motion and the resultative construction. The observed symmetric priming effects do not support previous claims about an asymmetric metaphorical relation between the constructions. Moreover, an explanation is offered for the occurrence of inhibitory priming in the experiment, which has seldom been observed in structural priming.

Finally, Chapter 6 summarises the key findings of the study and outlines three implications that merit further investigation. These concern the source ambiguity of priming effects, the use of priming for investigating other types of network relations, and a novel view of 'constructionhood' as a gradient rather than a categorical property. Together, the discussions and remaining questions illustrate that cognitive-linguistic theory and structural priming research complement each other in their efforts to uncover the structure of the grammatical network.

Lay summary

Grammar has traditionally been viewed as a system of abstract rules that define the structure of sentences but have no meaning in themselves. More recently, however, researchers working in cognitive linguistics, who are particularly concerned with the psychological processes involved in language use, have proposed a different view of grammar. On this view, grammatical constructions are assumed to form a complex network of knowledge stored in speakers' minds. All units in this network have a form and a meaning, including abstract grammatical constructions: for example, the English double-object construction *The X gives the Y the Z* (e.g., *The librarian gave the customer the book*) expresses a transfer of possession. Moreover, constructions are linked to each other in the network via the similarities that they share. The double-object construction, for instance, has nearly the same meaning as the *to*-dative construction (e.g., *The librarian gave the book to the customer*), even though the two patterns differ in their syntactic structure.

This thesis investigates to what extent the above model of grammar as a network of similarity relations is supported by evidence from psychological experiments. The focus is on a specific psychological effect known as *priming*. Priming occurs when people, after encountering a stimulus (e.g., an object, a word or a sound), react differently to another stimulus of the same or of a similar type. Applied to grammar, speakers tend to react differently to a sentence when they have previously read or heard an instance of the same or of a similar construction. Priming effects thus provide evidence for two things: first, that abstract grammatical constructions exist (because speakers recognise when two sentences belong to the same construction); and second, that these constructions share different degrees of similarity with each other (because the stronger the priming effect, the more similar the constructions).

At a more specific level, the thesis combines the results of previous priming studies with new experiments to test the strength of the network relations among a particular class of constructions, known as 'argument structure constructions'. These include the double-object and the *to*-dative construction mentioned above, but also other patterns like the benefactive construction (e.g., *The students baked their teacher a cake*), the resultative construction (e.g., *Susan hammered the metal flat*) and the depictive construction (e.g., *Richard ate the steak raw*). The priming effects indicate that speakers recognise different

degrees of similarity between these constructions, ranging from almost identical constructions to quite distinct and potentially unrelated patterns. Moreover, the experimental results help address a range of other questions about the grammatical network, for example how abstract speakers' knowledge of grammar is, and why speakers find it sometimes easier and sometimes harder to process similar constructions. As the discussions illustrate, these questions can only be approached when theoretical linguists and cognitive psychologists work hand in hand with each other.

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1 Introduction

Over the last decades, grammatical theory and psycholinguistic research on language processing have become increasingly intertwined. This is a natural process considering that detailed linguistic analyses typically generate the hypotheses that are then tested experimentally, and that the empirical findings illustrate aspects of speakers' processing system that motivate and constrain theoretical claims. Recently, a new research area has emerged in which such collaboration between linguists and psychologists seems more feasible and more urgently needed than ever. In a range of cognitive-linguistic frameworks, the traditional view of grammar as a system of computational rules has been replaced by a model of grammar as a mental network of stored declarative knowledge. This network-based view of grammar is shared by a number of theories, including Construction Grammar (Goldberg 1995; Hilpert 2014), Cognitive Grammar (Langacker 1987) and Word Grammar (Gisborne 2020; Hudson 2007). Several recent publications (Diessel 2019; Goldberg 2019; Schmid 2020; Sommerer and Smirnova 2020) have laid out detailed proposals of what the architecture of the grammatical network could look like, and by what (socio-)cognitive processes it may be shaped.

The network-based view distinguishes itself from mainstream generative grammar by its potential to account for a wide range of phenomena – including grammatical descriptions, processing effects, acquisition timelines and diachronic changes – within a single unified framework. This framework is, in line with the central 'cognitive commitment' (Lakoff 1990: 40) endorsed by cognitive linguists, constructed such that it "accord[s] with what is generally known about the mind and brain from disciplines other than linguistics". To make this possible, lexemes, phrases and clause-level units (all subsumed under a wide notion of 'constructions' in Construction Grammar) are regarded as parts of a single network whose structure is determined by the complex linking patterns between its nodes. The connectivity patterns are assumed to be shaped by a number of (socio-)cognitive, most likely domain-general, mechanisms such as (joint) attention, categorisation, automatisisation and spreading activation (Diessel 2019; Schmid 2020). Moreover, while individual accounts vary in some of the network relations they posit, they all recognise a few core linking mechanisms. One linking type that has attracted particular attention concerns similarity relations between constructions (also known as 'paradigmatic', 'taxonomic' or 'inheritance' links). Similarity

relations are what gives rise to the schemas, or generalisations, at different levels of abstraction that allow speakers to organise their previous linguistic experience, categorise newly witnessed input, and extend familiar patterns in productive ways.

The tight interrelation between these accounts of the grammatical network and the psychological factors by which the network is shaped raises the question of what empirical support the cognitive-linguistic models are based on. One psycholinguistic paradigm that has been discussed as a particularly rich source of evidence in this context is priming. Priming effects occur when previous exposure to a stimulus affects speakers' subsequent response to the same or a similar stimulus (Lashley 1951; Meyer and Schvaneveldt 1971). A widely accepted explanation for these effects is that when processing a 'prime', speakers co-activate their representations of other related units, thus facilitating their response to those units when they subsequently occur as 'targets'. In this way, priming effects provide a natural tool to probe the strength of similarity relations between constructions in speakers' grammatical networks.

Priming effects above the word level are known as 'structural priming' (Branigan and Pickering 2017; Pickering and Ferreira 2008). The importance of such effects for investigating network relations between clause-level constructions has been highlighted by several cognitive-linguistic authors (e.g., Diessel 2019: 202–205; Goldberg 2006: 120–125; Perek 2015: 165–166). Diessel (2019: 204) goes as far as to propose that "[s]tructural priming provides perhaps the best evidence for constructional relations". Despite this emphasis on priming as a key method for probing the grammatical network, however, a detailed and systematic interpretation of the structural priming evidence in the context of cognitive-linguistic network models does not yet exist. Previous discussions like the ones mentioned above have been brief: they span only a few pages; they examine a small number of constructions based on a limited sample of studies; and they do not address many of the more fine-grained insights that priming provides about speakers' representations and processing of constructional relations.

The present study will go beyond these previous attempts by presenting in-depth interpretations of previous structural priming findings as well as novel experimental evidence from a theoretically informed network-based perspective. Given the scope of the structural priming literature, which to date comprises several hundreds of studies, the investigation will focus on a particular type of clause-level constructions that have been widely discussed in

cognitive-linguistic research: argument structure constructions. These constructions are used to encode ‘humanly relevant’ scenes through the combination of a verb and its arguments (Goldberg 1995). Examples of English argument structure constructions, which are the focus of the present investigation, include: the double-object and the *to*-dative construction, both of which express transfer of possession; the caused-motion construction, which encodes a change of location; and the resultative construction, which denotes a change of state.

The primary goal of the discussions will be to illustrate the wealth of evidence that structural priming provides about similarity relations between instances of the same and of different constructions. It will be investigated to what extent priming supports key features of cognitive-linguistic network models, such as the assumption that speakers encode multiple formal and functional similarities between constructions, and that they represent similarity relations simultaneously at different levels of schematicity. Moreover, it will be shown that cognitive-linguistic analyses of network relations between constructions provide an explanatory framework for the (re)interpretation of a diverse range of structural priming effects. Beyond that, the present work also aims at highlighting the methodological challenges that researchers face when designing and interpreting priming experiments. A clear understanding of these challenges, and their potential solutions, is an important condition for evaluating realistically the potential of priming to inform theoretical models of the grammatical network. A final and overarching goal of this study is to illustrate that the relationship between cognitive-linguistic theory and structural priming research can be one of fruitful collaboration, in which each field makes use of the conceptual and empirical tools provided by the other.

The structure of this investigation is as follows: Chapter 2 outlines the theoretical underpinnings of cognitive-linguistic models of the grammatical network. After situating these approaches within the wider advancement of network models across disciplines, the chapter describes a number of common assumptions shared by cognitive-linguistic accounts of grammar. Following that, the role of similarity relations as a primary linking mechanism in the grammatical network is examined. The discussion addresses the multi-dimensional nature of similarities, the relationship between similarity links at multiple levels of schematicity, and the ways in which similarities can be captured via ‘horizontal’ and ‘vertical’ representations. The chapter then provides a classification of similarity relations which includes, among others, functional similarities (between alternating constructions) and formal similarities (between

polysemous or homonymous constructions). Each type is illustrated with specific argument structure constructions, and it is shown that further empirical evidence is needed to assess conflicting theoretical views about the nature and strength of their similarities. The chapter also provides an overview of different corpus-based and experimental methods that can be used to probe constructional similarities. Finally, the unresolved aspects identified during the discussion are condensed into four ‘theory-related’ research questions that are addressed in the later empirical chapters.

Chapter 3 introduces structural priming, covering its key characteristics, commonly used methods and examples of previously studied phenomena. The discussion outlines the specific advantages that the paradigm brings to the study of similarity relations, and illustrates that structural priming is sensitive to both the formal and functional characteristics of constructions. Moreover, it is highlighted that the choice of a specific production or comprehension priming method depends crucially on the type of similarity relation that is investigated. Beyond that, the chapter outlines three key distinctions involved in the interpretation of priming effects: the difference between within-construction and cross-constructional priming; between symmetric and asymmetric priming; and between facilitatory and inhibitory priming effects. The previous literature only provides partial answers to how these different effects can be identified and interpreted; the resulting research gaps are summarised as four ‘methods-related’ questions for the following empirical analyses.

Chapter 4 comprises the first half of these analyses; it focuses on a reinterpretation of previously observed priming effects between alternating constructions within a cognitive-linguistic network model of grammar. The first part of the discussion targets ‘within-construction’ priming effects between instances of the same construction. It is examined whether priming supports the existence of both abstract argument structure constructions and verb-specific representations, and whether the network-based view can account for ‘lexical boost effects’ (Pickering and Branigan 1998) as well as ‘inverse frequency effects’ (Ferreira and Bock 2006). The other two parts of the chapter focus on ‘cross-constructional’ priming effects between different constructions. First, it is discussed whether priming effects between members of the same alternation (for example, between the double-object and the *to*-dative construction) support the status of alternations as important generalisations over speakers’ grammatical knowledge. Given that previous interpretations of the results are

subject to limitations, new analysis techniques are applied to reveal a more nuanced picture. Second, it is assessed whether priming supports the existence of similarity relations between members of different alternations (the dative and benefactive constructions) and with an additional construction outside the alternation (the locative caused-motion construction).

Chapter 5 forms the second half of the empirical analyses, reporting new experiments that extend structural priming to non-alternating argument structure constructions. It is suggested that these constructions can be studied with the help of comprehension priming methods, thus overcoming the limitations of previously used production techniques. One such comprehension method, a variant of self-paced reading known as the 'maze task' (Forster et al. 2009), is applied in two novel experiments that test priming between the resultative and the object-oriented depictive construction. The discussion addresses both theoretical and methodological implications of the results, regarding the degree of similarity between the constructions and the processing effects through which this similarity manifests itself. It is then investigated whether another recent experiment provides evidence of a metaphorical asymmetry between the caused-motion and the resultative construction. Moreover, an attempt is made to explain the occurrence of inhibitory priming in comprehension and to relate it to previous findings in the structural and lexical priming literature.

Finally, Chapter 6 summarises the key findings and readdresses the question of how cognitive linguistics and structural priming can mutually inform each other. In addition, the discussion outlines three implications of the present work that could motivate further research in both areas.

2 Similarity relations in the grammatical network

This chapter outlines the theoretical background for the empirical analyses in the later chapters. It introduces the network-based view of grammar advocated by cognitive linguists, and illustrates the crucial role that similarity relations play in shaping the structure of the grammatical network. Through a critical evaluation of previous accounts, the discussion puts forward some innovative proposals about the nature of similarity relations, for example by using multi-level network diagrams to illustrate similarities at different levels of schematicity (see Section 2.3.3), by distinguishing different ways of representing similarities (see Section 2.3.4), and by suggesting a classification of similarity links between argument structure constructions that unifies a number of previously discussed phenomena (see Section 2.4). Moreover, the chapter provides detailed theoretical analyses of the specific constructions that will be investigated in the later analysis chapters.

Section 2.1 situates network models in linguistics within the wider context of the increasing use of network representations across various disciplines. Section 2.2 outlines six common features shared by different cognitive-linguistic models of the grammatical network. Section 2.3 characterises the cognitive functions of similarity relations as a primary linking mechanism in the grammatical network. It outlines how multi-dimensional similarities at multiple levels of schematicity are related to each other, and how they can be represented alternatively via ‘horizontal’ or ‘vertical’ links. Section 2.4 illustrates different types of similarity relations between argument structure constructions, depending on whether they primarily encode functional similarities, formal similarities or both. Section 2.5 provides an overview of corpus-based and experimental methods for testing similarity relations, which will be later compared with the structural priming paradigm introduced in Chapter 3. Finally, Section 2.6 summarises the discussion and highlights four theory-related research questions that will guide the empirical analyses in Chapters 4 and 5.

2.1 Networks across disciplines: from sociology to cognitive linguistics

Over the last 150 or so years, networks have become an indispensable tool for the analysis of complex systems. Networks consist of *nodes* (also called vertices), which represent the components of a system, and *links* (or edges), which describe the interactions between those components. While the mathematical foundations for the description of networks have

been developed since the 18th century within the field of graph theory, it is only since the 20th century that network models have been increasingly applied to real-world phenomena across the empirical sciences (Barabási 2016). Networks are now studied in a wide range of disciplines, including sociology (e.g., social networks of friendship, kinship or professional ties); communication studies (e.g., the internet, scholarly citations); economics and management (e.g., trade relations, organisational structures); biology, biochemistry and epidemiology (e.g., ecological networks, genetic structures, virus spread); as well as neuroscience and artificial intelligence (neural networks and their artificial counterparts). Over the last two decades, these endeavours have been unified within the newly emerging field of 'network science', which investigates the common organising principles of networks across domains and has been heralded by some as the 'science of the 21st century' (Barabási 2016; Watts 2007). In particular, network science has uncovered a number of recurring characteristics of real-world networks, such as their 'small-world' and 'scale-free' properties, which have gained popular attention beyond the scientific community (Buchanan 2002).

In linguistics, too, networks have been widely used to model aspects of speakers' knowledge of language. Several research directions can be distinguished here. One area of work has focused on building large encyclopaedic networks of linguistic items by manually annotating the relations between them. Among the best-known examples of this approach for English are WordNet (Fellbaum 1998), a database of interrelated word senses, and FrameNet (Baker et al. 1998), a network of the semantic frames associated with lexical units, based on Fillmore's (1982) Frame Semantics. Another research strand has taken a more formal approach to studying the structure of linguistic networks, using the mathematical tools of network science to analyse, for instance, the degree of connectivity in these networks, as well as their community structure and growth over time. These methods have been applied to a range of linguistic subdomains, including speakers' lexical networks (Steyvers and Tenenbaum 2005), phonological networks (Vitevitch 2008) and orthographic networks (Siew 2018) as well as networks of linear word co-occurrences (Ferrer i Cancho and Solé 2001) and syntactic dependencies (Ferrer i Cancho et al. 2004). A third long-standing research programme has made use of connectionist networks, a class of computational models that are inspired by biological mechanisms in the human brain. These artificial neural networks have been used to simulate the processing and acquisition of a variety of linguistic structures, including English past tense morphology (Rumelhart and McClelland 1986), lexical categories

such as nouns and verbs (Elman 1990), recursive syntactic structures (Christiansen and MacDonald 2009) and syntactic dependencies in general (Manning et al. 2020).

In cognitive linguistics, too, researchers have made widespread use of network architectures to characterise speakers' grammatical knowledge on all levels, from phonemes to morphemes and words to complex phrasal and clause-level units. In line with the 'cognitive commitment', i.e., the endeavour to "make one's account of human language accord with what is generally known about the mind and the brain, from other disciplines as well as our own" (Lakoff 1990: 40), cognitive linguists are particularly concerned with the psychological (and social) underpinnings of the grammatical network. Some of their key questions are: how this network is shaped by speakers' individual and collective experiences in concrete instances of language use; how it is affected by psychological (and neurally based) mechanisms such as spreading activation, memory consolidation and priming (which are the particular focus of the present investigation); and how its structure develops dynamically during processes of language acquisition and individual- as well as community-level diachronic change. As the discussion in Section 2.2 will show, network models lie at the heart of all current cognitive-linguistic theories of grammatical knowledge, and they play a central role in distinguishing these frameworks from mainstream generative approaches which treat grammar as a system of derivational rules.

2.2 Six characteristics of cognitive-linguistic network models

Since their conception, the cognitive-linguistic theories that emerged in the 1980s and 1990s in opposition to mainstream generative grammar have placed the notion of the grammatical network at centre stage. In his foundational work, Langacker (1987: 57) defined grammar as "a structured inventory of conventional linguistic units" and analysed its elements in terms of (schematic) networks. Around the same time, Hudson (1984: 1) proposed the 'network postulate' according to which "[l]anguage is a conceptual network". Based on Lakoff's (1987) idea that constructions 'motivate' each other to the degree that they are interrelated, Goldberg (1995) was among the first to posit a network of 'inheritance' relations (see Section 2.3.4) not only between lexical units, but also between clause-level constructions. In the three decades since, the network view of grammatical knowledge has become a core tenet of all major cognitive-linguistic frameworks. A non-exhaustive list of these theories includes: (i) different strands of Construction Grammar (grouped under this

umbrella term in the following), such as Cognitive Construction Grammar (Goldberg 1995; Goldberg 2006; Hilpert 2014), Radical Construction Grammar (Croft 2001) and Fluid Construction Grammar (Steels 2011), as well as approaches that combine elements from several of these frameworks (Diessel 2019; Traugott and Trousdale 2013); (ii) Cognitive Grammar (Langacker 1987; Langacker 2008); (iii) Word Grammar (Gisborne 2020; Hudson 1984; Hudson 2007); (iv) Relational Morphology (Jackendoff and Audring 2020), an extension of the Parallel Architecture (Jackendoff 2002); and (v) a variety of other approaches, including exemplar-based network models (Ambridge 2020a; Bybee 2010) and Schmid's (2020) socio-cognitively oriented 'Entrenchment-and-Conventionalisation Model'.¹

The importance of the network postulate across this diverse range of approaches has been acknowledged in cross-theory comparisons (Croft 2007; Croft and Cruse 2004: Chapters 9-11; Goldberg 2013; Hudson 2008; Langacker 2005). In addition, these overviews highlight a number of key assumptions about the nature, structure and psychological basis of the grammatical network that are shared by all of the above frameworks. These commonalities of cognitive-linguistic network models are summarised in the following under six broad aspects.

2.2.1 A declarative non-derivational network

A key advantage of the network model of language is that it explicitly characterises all the elements that are assumed to be stored in speakers' long-term memory, rather than following generative approaches in deriving patterns from other structures on distinct representational levels via rule-based computational procedures (e.g., transformations). Goldberg (2006: 10) stresses this notion of 'surface structure' in a "what you see is what you get" approach, which treats semantically similar but formally distinct patterns as separate (though potentially related) constructions, rather than regarding one of them as the underlying structure from which the other is generated (see Section 2.4.1 for further discussion). Modelling language as a large declarative knowledge network rather than as a

¹ Not all the frameworks listed here explicitly adopt the label 'cognitive-linguistic': for example, proponents of the Parallel Architecture do not. Nevertheless, the latter framework is included because it shares many of its cognitively oriented assumptions with the other theories, as outlined in the rest of this section. On the other hand, the above list does not include some further variants of Construction Grammar, such as Berkeley Construction Grammar (Fillmore et al. 1988) and Sign-Based Construction Grammar (Boas and Sag 2012). These approaches also posit constructional networks, but they differ from the above theories in other core respects (e.g., they are not usage-based; see Hoffmann 2017) and are thus not the focus of the following discussions.

system of cost-intensive computational rules aligns well with the psychological evidence that humans' long-term memory capacity is vast while their working memory resources are quite limited (Goldberg 2019: 139; see also Bresnan 1978).

2.2.2 A psychologically plausible network

In line with the 'cognitive commitment' (see Section 2.1), cognitive linguists emphasise the need to construct models of language use and representation that are compatible with, and informed by, the available psychological and neuroanatomical evidence. Adopting Collins and Loftus' (1975) concept of 'spreading activation' (which builds on Quillian's [1968] work on semantic memory), speakers' grammatical knowledge is modelled as a network of associative links through which activation flows from one node to another. Schmid (2020: 43), following Langacker, defines 'associations' in broad terms as "the ability of 'one kind of experience ... to evoke another'". The notion of an associative network thus embodies the view that linguistic knowledge consists of a web of interrelated memory traces in which activating one stored experience triggers the co-activation of other, related memories. Associative links may be of different kinds, and specific accounts vary in the number and types of network links that they posit. Nevertheless, certain types of network connections feature in all cognitive-linguistic frameworks: in particular, this applies to the similarity relations that will be introduced in Section 2.3 (see Section 2.3.1 for a discussion of other potential linking mechanisms).²

The grammatical network is extended by the integration of new experiences with prior knowledge and the consequent updating of the connections between existing nodes. In this regard, the associative model receives neurological support from the rich auto-associative connectivity of the human brain cortex, i.e., its tendency to form strong local connections between similar patterns of experience (Pulvermüller and Knoblauch 2009). On the neural level, linguistic units are in fact not represented by single 'nodes' but by "fleeting patterns of associations" (Schmid 2020: 44). Frequently repeated activation of these patterns leads to the routinisation (or automatisisation) of the associative links of which they consist, resulting in increasing levels of entrenchment. Langacker (1987: 162) consequently identifies linguistic

² Hudson (2007: 10) avoids the term 'associative network', which to him suggests that "all links have the same status and the same meaning". Other researchers, however, assume that associative links, while sharing a single underlying neural basis, can be classified into different types of relations (see also Gisborne's [2020] Word Grammar account, which uses the term 'associative links').

units, and concepts in general, with “entrenched cognitive routines”. Well-entrenched patterns serve as ‘attractors’ in the network, i.e., relatively stable states that the network gravitates towards when confronted with a novel stimulus (Langacker 2016).

These psychological and neural underpinnings of the grammatical network also form the basis for a number of processing effects that are commonly observed in language. Such effects include (for overviews, see Diessel 2019: 201–202; Schmid 2020: 53–55): frequency effects (more frequent units are recognised faster and more accurately due to their higher degree of routinisation); recency effects (more recently activated units are recognised faster due to residual activation in the network); and neighbourhood effects (units in denser network neighbourhoods and with more frequent neighbours are recognised more slowly due to competition between similar activation patterns). Related to recency effects, another pervasive processing effect is priming, which forms the focus of the present investigation and will be introduced in detail in Chapter 3.

2.2.3 A multi-dimensional network of form and meaning

A fundamental tenet that distinguishes cognitive-linguistic from generative approaches to grammar is that the units of the grammatical network are not characterised primarily in terms of their formal characteristics (e.g., phrase structure), but that they are assumed to combine features of form and meaning (or function). In Construction Grammar, constructions are therefore defined as ‘form-meaning pairings’; likewise, they are characterised as ‘symbolic units’ in Cognitive Grammar, i.e., associations between a semantic and a phonological pole (Langacker 1987: 58).³ This means that network nodes can be linked along at least two dimensions, each of which can in turn be analysed as a combination of several more fine-grained elements. The ‘meaning’ pole of grammatical units is thus assumed to encompass not only semantic information but also pragmatic and discourse-functional properties. The ‘form’ pole is more controversial: while Construction Grammarians (Croft 2001; Goldberg 1995) entertain a wide understanding of the term, including syntactic constituents (e.g., noun phrases, prepositional phrases), syntactic functions (e.g., subject,

³ Word Grammar does not allow form-meaning pairings as single nodes in the grammatical network (Hudson 2008). Nevertheless, the theory resembles the other frameworks in assuming that “[s]yntactic patterns are intricately bound to semantic ones” and that “syntactic and semantic information is represented within a single feature structure” (Holmes and Hudson 2005: 243).

object) and grammatical categories (e.g., case), Cognitive Grammar restricts grammatical form to phonological structure only (Langacker 2005).

Of course, these categories provide only a coarse classification of the numerous features and dimensions by which constructions are integrated into the grammatical network. As Langacker (1987: 163) suggests, humans' encyclopaedic knowledge should be regarded "as an interlocking set of networks [...], or alternatively, as a single vast network of almost unimaginable proportions" (see also Hudson 1984: 1–4). More recently, Goldberg (2019: 27) has stressed that grammatical knowledge forms a "vast" network situated within the "hyper-dimensional conceptual space" of human memory. This means that grammatical units may not only be related to a handful of other network nodes along a few shared dimensions, but that they may simultaneously be linked to myriads of other nodes along a vast array of formal and functional dimensions. An idea of the extent to which such possible linkages could be stored in speakers' brains is provided by the neuroanatomical evidence that the human cortex includes between 10^{10} and 10^{11} neurons, which are connected via an estimated 10^{14} or more synapses (Pulvermüller 2002). Given that neuroanatomy is taken to constrain and inform cognitive-linguistic network models (see Section 2.2.2), it seems reasonable to assume that speakers may represent linguistic units and their interrelations at a tremendous level of detail (Lamb 1999).⁴

2.2.4 A network along the syntax-lexicon continuum

All cognitive-linguistic approaches to grammar deny the sharp distinction made by traditional generative approaches between the lexicon, seen as the domain of idiosyncratic contentful units, and syntax, defined as a limited set of formal rules. Instead, all grammatical knowledge is assumed to be part of a "uniform representation" (Croft and Cruse 2004: 255), i.e., a single network architecture. The main motivation for this view comes from the fact that words and complex constructions alike constitute pairings of form and meaning, and that the boundary between the two is blurred by the abundance of idiomatic constructions which

⁴ Representing the complexity of the grammatical network in models that still remain interpretable and explanatorily useful continues to be a challenge for current cognitive-linguistic work. Compare, for instance, Ibbotson et al.'s (2019: 671) critique of cognitive-linguistic network theories: "Precisely what this inventory looks like is often not specified in any detail, and where it is, the proposals are often static, highly schematized (viz. hierarchical abstraction) and only partial visualizations of the complete grammatical system." To address some of these concerns, the present study aims to show how previous theoretical claims about speakers' grammatical representations can be corroborated with the help of concrete psycholinguistic evidence from priming.

combine lexically fixed elements with open slots and thus fall in between lexical and grammatical units. As a consequence, cognitive linguists assume a ‘syntax-lexicon continuum’ (e.g., Croft 2001: 17): lexical and grammatical items are not categorically different, but only vary in terms of their degree of schematicity (from specific/substantive to abstract/schematic) and their degree of complexity (from atomic to complex). This is illustrated in Table 2.1, which shows the range of construction types included in the grammatical network, spanning mono-morphemic words, inflectional morphology and idiomatic phrases as well as item-specific and abstract clause-level constructions.⁵

Table 2.1. The syntax-lexicon continuum (from Croft and Cruse 2004: 255)

Construction type	Traditional name	Examples
Complex and (mostly) schematic	syntax	[SBJ <i>be</i> -TNS VERB <i>-en</i> by OBL]
Complex, substantive verb	subcategorization frame	[SBJ <i>consume</i> OBJ]
Complex and (mostly) substantive	idiom	[<i>kick</i> -TNS <i>the bucket</i>]
Complex but bound	morphology	[NOUN-s], [VERB-TNS]
Atomic and schematic	syntactic category	[DEM], [ADJ]
Atomic and substantive	word/lexicon	[<i>this</i>], [<i>green</i>]

The claim that the whole of language can be described via this multi-dimensional but uniform continuum of linguistic units is captured by Goldberg’s (2006: 18) programmatic statement that “it’s constructions all the way down”. In a variant of this slogan, Hudson (2015: 692) stresses the fact that the sole burden for representing this diverse inventory of constructions rests on the grammatical network: “it’s networks all the way down”. The discussion of how the network structure can incorporate constructions at varying levels of schematicity will be continued in Section 2.3.3.

⁵ Word Grammar does not recognise ‘constructions’ above the word level, but instead represents phrasal and clausal structures as linking patterns between words (Gisborne 2008; Holmes and Hudson 2005). This view, however, appears to be compatible with a Construction Grammar position in which complex constructions are not treated as encapsulated and unanalysable units, but as clusters that emerge from the syntagmatic links between their parts (similar to how schemas emerge from paradigmatic links between their subtypes; see Section 2.3.3).

2.2.5 A usage-based network

Cognitive-linguistic models of the grammatical network are fundamentally shaped by the usage-based view that “experience with language creates and impacts the cognitive representations for language” (Bybee 2013: 49). Usage-based approaches (e.g., Barlow and Kemmer 2000; Langacker 1988; Tomasello 2003) refute the structuralist distinction between knowledge of language and language use, and instead assume that speakers’ linguistic knowledge arises from concrete usage events. According to this view, the structure of the grammatical network is governed by the properties of the utterances that speakers have witnessed, and in particular by the frequency of occurrence of particular linguistic units. The usage-based perspective is part of a wider view of language as a ‘complex adaptive system’ according to which “[t]he structures of language emerge from interrelated patterns of experience, social interaction, and cognitive mechanisms” (Beckner et al. 2009: 2), leading to a dynamic network that is constantly evolving as a result of speakers’ past and present interactions (see also Gell-Mann 1992; Larsen-Freeman 1997).

The usage-based stance often goes hand in hand with an ‘emergent’ view of grammar according to which speakers’ knowledge of grammatical categories and generalisations ‘emerges’ in a bottom-up fashion from instances of use (Bybee 1998; Hopper 1987; MacWhinney and O’Grady 2015). This view contrasts with an account under which grammar consists simply of a set of abstract principles that are not learned from concrete usage events but may instead be part of speakers’ innate linguistic endowment. On the emergent view, speakers infer more abstract regularities by generalising over recurring patterns in the input. Moreover, they do not necessarily ‘forget’ the individual instances once they have formed a generalisation; rather, they may store these instances alongside the more schematic representations (see Section 2.3.3 for further discussion). The view that speakers’ grammatical knowledge encompasses a multitude of such concrete instances of use, also known as ‘exemplars’, has been endorsed by a variety of cognitive linguists (Abbot-Smith and Behrens 2006; Ambridge 2020a; Bybee 2010; Goldberg 2006; Langacker 2016).

2.2.6 A network of socially conventionalised units

Langacker’s (1987) characterisation of grammar as an inventory of ‘conventional’ linguistic units (see above) highlights the fact that the grammatical network cannot be solely analysed as a structure situated in an individual’s mind, but that it is subject to a variety of

social forces operating within a speech community. Similarly, Schmid (2020) views the psychological factors (grouped under the term ‘entrenchment’) and the social factors (subsumed under ‘conventionalisation’) that shape speakers’ linguistic systems as two mutually interacting feedback loops. Under this view, the psychological and the social dimension are partially independent from each other. This is illustrated by previous evidence that grammatical patterns may be well-entrenched in the mind of an individual speaker but not conventionalised in the wider community; and conversely, that a pattern may have spread across a community despite being entrenched to varying degrees in the minds of individual speakers (Barlow 2013; Dąbrowska 2015).

Distinguishing between individual-level and group-level grammars is a challenge for many psycholinguistic frameworks, in which experimental results are commonly aggregated across a larger sample of speakers. The same is true for many corpus studies, even though there have recently been increasing attempts to analyse corpus data at the level of the individual speaker (Schmid 2020: 217). When empirical studies rely on aggregate data, they cannot clearly distinguish between entrenchment in an individual’s mind and conventionalisation within the speech community. Instead, they provide an approximation of the *average* speaker’s grammatical knowledge (note that this ‘average’ speaker is quite different from Chomsky’s [1965] ‘ideal’ speaker-hearer who knows their language ‘perfectly’ and is unaffected by processing limitations). The present study will also largely rely on this construal of an average speaker, given that most of the structural priming results discussed in Chapters 4 and 5 are based on aggregate data and do not explicitly test for individual variation (but see Section 4.1.3 for an exception). While keeping in mind the above caveats, the obtained results can still be interpreted as an approximation of the social and psychological reality of speakers’ grammatical networks.

2.3 The role of similarity in the network: categorisation, schematicity and inheritance

As the previous section has outlined, cognitive-linguistic approaches highlight the fact that speakers’ grammatical knowledge does not comprise an unstructured list of idiosyncratic items, but that it forms an organised network in which constructions motivate each other via their mutual relations. While different types of links have been suggested (see Section 2.3.1),

one linking mechanism has received particular attention across all cognitive-linguistic frameworks: *relations of similarity*.

Under the guise of different labels, similarity relations lie at the heart of all cognitive-linguistic network models. They correspond to Schmid's (2020) 'paradigmatic' links between units that can fill the same position in a sentence. They also parallel the 'relational' links that Relational Morphology posits between words with partially overlapping structure (Jackendoff and Audring 2020). Moreover, given that similarities are what allows constructions to be classified as part of the same taxonomic category, similarity links are closely connected to Diessel's (2019) 'taxonomic' relations, which connect schemas and their subtypes. By the same token, similarity relations provide the basis for the 'categorising' relations proposed by Cognitive Grammar (Langacker 1987), as well as the 'inheritance' links posited by Construction Grammar (Croft 2001; Goldberg 1995) and Word Grammar (Hudson 2007). The latter label stems from the fact that subtypes of the same category are assumed to adopt, or 'inherit', their common features from the schema. Inheritance links are so central to Construction Grammar and Word Grammar that their proponents have characterised the entire grammatical network as an "inheritance network" (Goldberg 2013: 21; Hudson 2007: 11). The relationship between similarity, taxonomy and inheritance will be addressed in more detail in Sections 2.3.3 and 2.3.4. Before that, however, Sections 2.3.1 and 2.3.2 will characterise the function of similarity relations, as well as their multi-dimensional nature.

2.3.1 The function of similarity relations

There are a number of reasons why similarity relations can be regarded as a fundamental structuring mechanism not only within the grammatical network, but within the whole of speakers' conceptual knowledge. First and foremost, similarities form the basis for the human ability to categorise previous experiences and integrate novel stimuli with existing knowledge (Bybee 2013; Diessel 2019: 31–33; Langacker 1987: Chapter 10). The study of how conceptual categories arise from the perceived similarities between physical objects and abstract concepts has a long history in psychology and philosophy. It goes back to the Gestalt psychologists' 'Law of Similarity' (Wertheimer 1923); it features prominently in Wittgenstein's (1953) work on 'family resemblances'; and it plays a central role in Rosch's (1973) Prototype theory. All of these frameworks have had a crucial influence on cognitive-linguistic theory (Taylor 2003).

More specific to speakers' linguistic knowledge, cognitive linguists have suggested that similarity relations lie at the core of what constitutes *motivation* in language (e.g., Booij 2017; Lakoff 1987; Radden and Panther 2004). Based on the structuralist insight that the elements of a system mutually define each other, linguistic units are not fully arbitrary but partially predictable to the extent that their features overlap with those of other items (Saussure 1916). According to Goldberg's (1995: 67) "Principle of Maximised Motivation", speakers seek to increase the amount of motivation in the linguistic system by inferring similarities and generalisations whenever possible. This drive towards grouping similar units together can be related to the auto-associative character of the human brain cortex, whose tendency to link up similar experiences provides the basis for humans' remarkable abilities to detect recurring patterns in the input (see Section 2.2.2).

The role that similarity relations play in the grammatical network can be further broken down into three functions (following Jackendoff and Audring 2020: Chapters 3 and 7). First, it seems feasible that similarities make new constructions easier to learn. When encountering a novel item that is partially similar to familiar units, the familiar components of the new item should already have a certain 'resting activation' level in the network, which facilitates the processing and acquisition of the new item. On the morphological level, for instance, Jackendoff and Audring (2020: 221) suggest that a word like *purpleness*, which consists of two morphemes that speakers are likely to be already familiar with, should be easier to learn than a monomorphemic word like *tarpaulin*, which displays no similarities with other units. Under this view, the more similarity relations that can be established between a new unit and already existing network structures, the larger the learning advantage should be.

Second, newly learned constructions should subsequently be easier to retain in memory if they share similarities with other members of the network. As suggested already by Jackendoff (1975), the storage cost of an item can be modelled as a function of the item's *independent* information content plus the cost of relating it to other network units. Crucially, whatever information can be captured by a similarity link between two items need no longer be stored as part of each item's independent content, but can instead be represented more efficiently in the form of 'redundant' or 'shared' information (see also Goldberg 1995: 74). As a result, establishing similarity links between grammatical items should reduce the overall storage load in the network (assuming that the cost of storing the additional similarity link is

smaller than the cost of storing the information content of the two units independently). The ‘redundancy rules’ that capture the similarities between constructions in Jackendoff’s (1975) original proposal can thus be restated in terms of similarity relations between network units.

Third, similarity relations should make stored items easier to retrieve and thus facilitate processes of language production and comprehension. As Jackendoff and Audring (2020) note, stronger similarity links (which the authors subsume under ‘relational’ links) provide faster pathways for spreading activation in the network, thus speeding up speakers’ response to patterns that resemble their previous linguistic experience. Similarly, Goldberg (2006: Chapter 6) argues that the generalisations that speakers form over similar units have crucial *predictive value* during processing. On the comprehension side, both corpus and experimental evidence suggest that knowledge of abstract constructional schemas helps speakers understand the meanings of upcoming sentences, especially in cases in which the verbs are novel or display flexible argument linking patterns. On the production side, Goldberg argues that speakers’ ability to generalise over similar patterns is what enables them to be primed by their own as well as their interlocutor’s utterances, thus facilitating their subsequent productions (see Chapter 3 for the role of similarity relations in priming).

Finally, while similarity relations are the focus of the present investigation, and while they play a particularly important role in structuring speakers’ grammatical knowledge, they are certainly not the only potential linking mechanism in the grammatical network. Most cognitive-linguistic accounts of grammar feature at least two other types of network links. One of these consists of ‘symbolic’ relations that connect the form and meaning poles of constructions (Diessel 2019; Langacker 1987; Schmid 2020; compare also Jackendoff and Audring’s [2020] ‘interface’ links, which relate the three levels of phonology, semantics and syntax). The other linking type concerns ‘syntagmatic’ relations between linearly co-occurring units (Budts and Petré 2020; Schmid 2020), which are also known as ‘sequential’ relations (Diessel 2019), ‘meronymic’ links (Barðdal and Gildea 2015), or relations of ‘integration’ and ‘composition’ (Langacker 1987). Further types of links have been proposed, such as ‘pragmatic’ relations (Schmid 2020) or ‘quantity’ and ‘identity’ links (Hudson 2007), but these remain so far restricted to individual accounts. Given the scope of the present investigation, the following sections and chapters will focus exclusively on similarity relations. Chapter 6 will, however, briefly return to the question of whether priming can also provide psycholinguistic evidence about other linking types, such as syntagmatic relations.

2.3.2 Multi-dimensional similarities

Having introduced the overall functions of similarity relations, the discussion can now focus on the similarities that hold among the specific class of constructions investigated here. Especially in Construction Grammar, a primary research focus has been on similarity relations between abstract clause-level constructions. One class of such constructions has received particular attention in the cognitive-linguistic literature: argument structure constructions, which encode the arguments of predicates, determine the basic clause types in all languages, and express ‘humanly relevant’ event types such as (caused) motion, transfer of possession, and change of state (Croft 2001; Goldberg 1995). Examples of some commonly studied English argument structure constructions are provided in (1) to (6).

- (1) *The children broke the window.* (transitive construction)
- (2) *The librarian gave the customer the book.* (double-object construction)
- (3) *The librarian gave the book to the customer.* (to-dative construction)
- (4) *James rolled the ball down the hill.* (caused-motion construction)
- (5) *Susan hammered the metal flat.* (resultative construction)
- (6) *Richard ate the steak raw.* (depictive construction)

As with any other type of construction, argument structure constructions can display varying degrees of similarity with each other. Based on their putative formal and functional similarities, the constructions in (1) to (6) could, for example, be arranged in a hypothetical network that might look like the one depicted in Figure 2.1. The thickness of the links indicates the strength of the similarity relation between the patterns. The diagram is merely intended as an illustration of the network representation; the link strengths are based on intuition and are in need of empirical corroboration (see below).⁶

⁶ While boxes are used to delineate constructions in this and all the following diagrams, this is not meant to indicate that constructions form fixed categories with clearly defined boundaries. Rather, cognitive linguists view constructions as prototypically structured categories with fuzzy boundaries that contain more central and more peripheral members (Lakoff 1987).

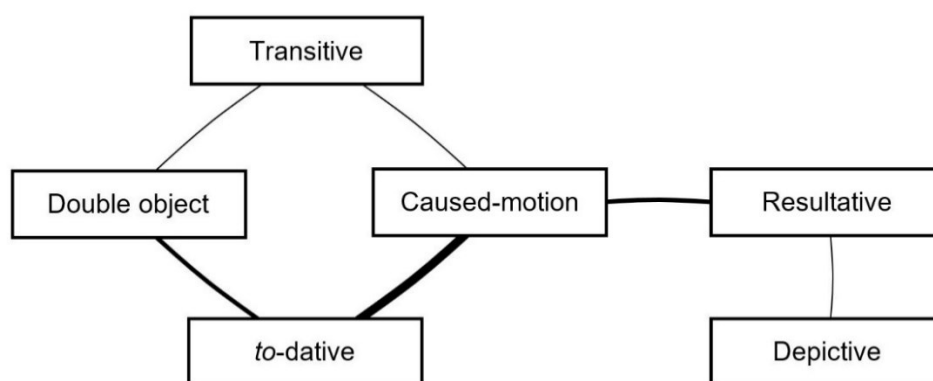


Figure 2.1. A (hypothetical) network of abstract argument structure constructions

The varying strengths of the similarity relations depicted in Figure 2.1 derive from the fact that constructions are similar (and different) along various formal and functional dimensions (Trijp 2020). The diagram thus provides a summary view of a much more fine-grained reality in which constructions display numerous specific similarities, comprising phonological, semantic, syntactic, information-structural, social and other contextual-pragmatic properties. Goldberg (2019: 6) makes this particularly clear when she argues that constructions exist in a “hyper-dimensional conceptual space” in which they can be compared along a vast number of potential parameters (see Section 2.2.3). The overall strength of the similarity between two constructions is thus determined by the number of features they share within this complex conceptual space.

To illustrate this point, Figure 2.2 zooms in on a specific link from the above network: the similarity relation between the caused-motion and the (adjectival) resultative construction, illustrated in examples (4) and (5) above. Using a notation common in Construction Grammar work (e.g., Croft 2001), the diagram depicts the constructions as symbolic pairings of a formal and a functional pole, characterised in the two smaller boxes within each constructional representation. As the diagram shows, the single similarity relation between the constructions can, at a more fine-grained level of analysis, be broken down into multiple shared features, each of which is represented as a separate link.

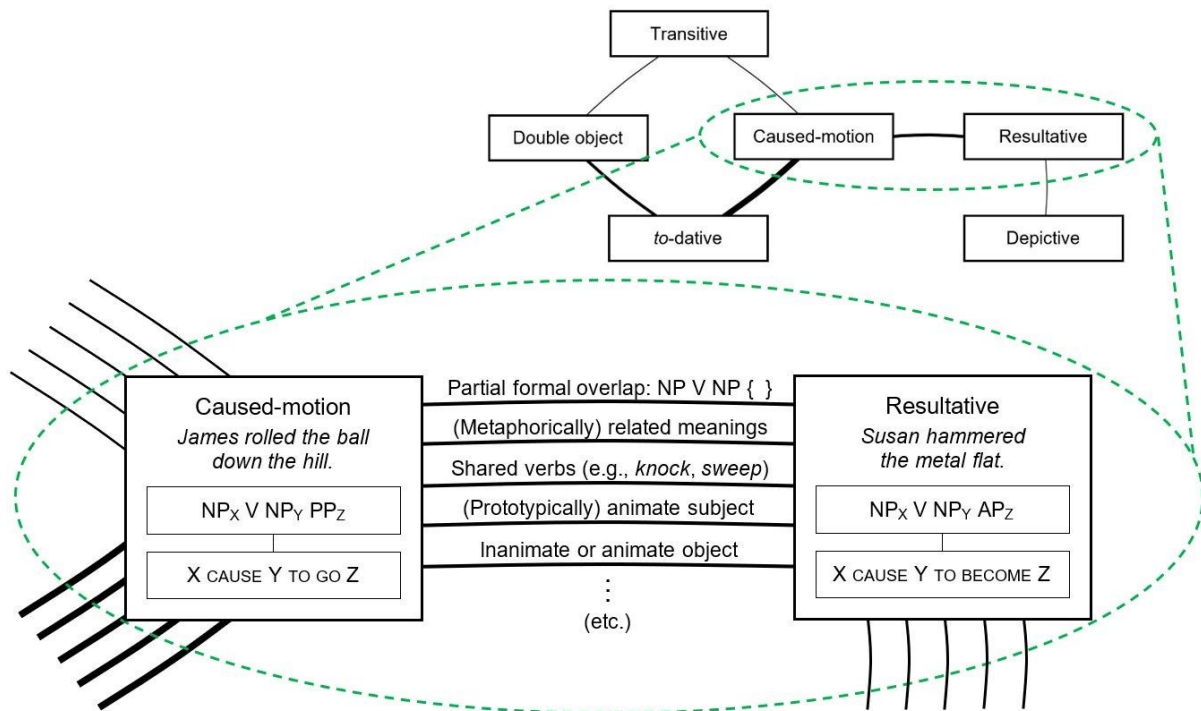


Figure 2.2. Zooming in on a network link: multi-dimensional similarities between the caused-motion and the resultative construction

One similarity consists in the partial syntactic overlap between the constructions up to their final constituent, where they differ between a prepositional phrase in the caused-motion construction and an adjective phrase in the resultative. A second similarity concerns the potential relatedness of the constructional meanings: according to Goldberg (1995), the ‘change of state’ meaning encoded by the resultative forms a metaphorical extension of the ‘change of location’ meaning of the caused-motion construction (see Section 2.4.5 for a detailed discussion of this metaphorical link, and Section 5.3 for an empirical assessment). Yet another commonality lies in the fact that a certain set of verbs can occur in both constructions, such as *knock* (*the ball over the fence / the boxer unconscious*) or *sweep* (*the glass into the bin / the floor clean*). Finally, various other features can be identified that are shared by the constructions, especially regarding the characteristics of their component parts: for instance, the fact that their subjects are (prototypically) animate while their objects can be either animate or inanimate. As Figure 2.2 suggests, the list of these further similarities is potentially open-ended, highlighting the notion of multi- (or hyper-) dimensional similarities discussed above.

Two conclusions can be drawn from the above discussion. First, the overall network representation in Figure 2.1 uses links of varying strengths to capture the *degree of similarity* between argument structure constructions, which can be broken down into multiple shared features at a more detailed level of analysis, as shown in Figure 2.2. The grammatical network, at least as far as its similarity links are concerned, can thus be regarded as a *weighted* network, a type of network architecture that is also appropriate for the description of many other real-world phenomena (Barabási 2016). While these considerations justify the use of summary notations such as Figure 2.1, it is nevertheless crucial to keep track of the fine-grained formal and functional similarities of constructions in order to generate predictions about their degree of relatedness. This will be illustrated in Section 2.4, where multiple similarities (and differences) between constructions are used to motivate empirically testable hypotheses about the nature of their relationship (which are then assessed in Chapters 4 and 5).

Second, it was noted above that both the summary network in Figure 2.1 and the more detailed analysis in Figure 2.2 rely purely on theoretical intuition. Empirical evidence is needed in order to test network models like the ones above and quantify the actual degree of similarity between constructions. As the detailed discussion in Chapter 3 will show, structural priming may provide a particularly suitable experimental paradigm for determining the strength of constructional similarities. The first theory-related research question (Q_T) for the empirical part of the present investigation is therefore:

Q_T 1: Can structural priming provide evidence about the degree of similarity between argument structure constructions?

This question will provide an overall frame for the discussion of the experimental evidence in Chapters 4 and 5.

2.3.3 Similarities at multiple levels of schematicity

The previous section addressed the similarity relations that are assumed to relate abstract argument structure constructions in speakers' grammatical networks. In recent years, however, scholars have increasingly debated at what level of schematicity constructional similarities are most likely represented. A number of researchers (Boas 2003; Dąbrowska 2008; Herbst 2014; Langacker 2000; Schmid 2020) have expressed doubt about

the psychological reality of highly abstract argument structure constructions, and have instead argued that speakers may form more specific generalisations at lower levels of schematicity.

The following discussion will outline a network model in which similarities are assumed to exist simultaneously at several levels of schematicity. On this account, higher-level similarities between abstract constructional schemas and lower-level similarities between their subtypes are not represented independently from each other; rather, it is argued that the higher-level links are ‘immanent’ in the lower-level connections. This provides a natural explanation for how the network of abstract argument structure constructions ‘emerges’ from the previous experience that speakers have had with specific instances of these constructions. While the theoretical underpinnings of this view are not new (see the discussion of emergentist approaches below), they are combined with innovative network diagrams that illustrate the relationship between similarities and schemas at different levels of abstraction.

Evidence that speakers not only store abstract argument structure constructions, but that they also encode lower-level regularities between more specific patterns, has been provided abundantly over the last two decades of cognitive-linguistic research (e.g., Boas 2003; Dąbrowska 2008; Hartmann 2019; Hilpert 2015; Newman and Rice 2006; Perek 2014). For example, Boas (2003) proposes that English resultatives, introduced in Section 2.3.2, cannot be subsumed under a single abstract schema, but that they give rise to multiple verb-specific (or even verb-sense-specific) generalisations at lesser degrees of schematicity. Positing these lower-level schemas is necessary to explain the various more fine-grained formal and functional constraints that resultatives display depending on the specific sense of their verb. For instance, the verb *drive* occurs with a specific meaning in the resultative, describing a negative change in a person’s mental state, typically towards a state of ‘craziness’ (see also Bybee 2010; Goldberg 1995). As a result, the *drive*-‘crazy’ resultative only combines with final adjectives denoting such mental states, as in (7a), but does not accept adjectives denoting other mental or physical states, as illustrated by the examples in (7b).

- (7) a. *Chris drove Pat mad / bonkers / bananas / crazy.*
b. **Chris drove Pat silly / dead / angry / happy / sick.*
(both from Goldberg 1995)

Croft (2001), among others, has made a similar case for lower-level subschemas, positing for instance verb-specific subtypes of the transitive construction such as [SUBJECT *kick* OBJECT] or [SUBJECT *kiss* OBJECT]. Crucially, the higher-level schemas (e.g. the resultative or the transitive construction) and the lower-level schemas (e.g., the ‘*drive* resultative’ or the ‘*kick* transitive’) are not mutually exclusive. As Goldberg (2006: 63) argues, “there is solid evidence that both item-specific knowledge and generalizations coexist”. Under an ‘emergent’ view of grammar (e.g., Bybee 1998; Hopper 1987; see Section 2.2.5), speakers form abstract constructions by generalising over the shared features of their instances; higher-level schemas thus ‘emerge’ from lower-level similarities. This process can be repeated at increasing levels of schematicity: after forming a certain set of generalisations, speakers may recognise similarities among these schemas which give rise to an even higher-level generalisation that subsumes the lower-level schemas.

Figure 2.3 provides a novel way for capturing such similarity relations at varying levels of abstraction diagrammatically. Returning to the above example of verb-specific subschemas of the resultative and the caused-motion construction, similar to the ones discussed by Boas (2003), the diagram illustrates a multi-level network in which the two abstract argument structure constructions emerge from the similarities among their verb-specific subtypes at a lower level of schematicity.

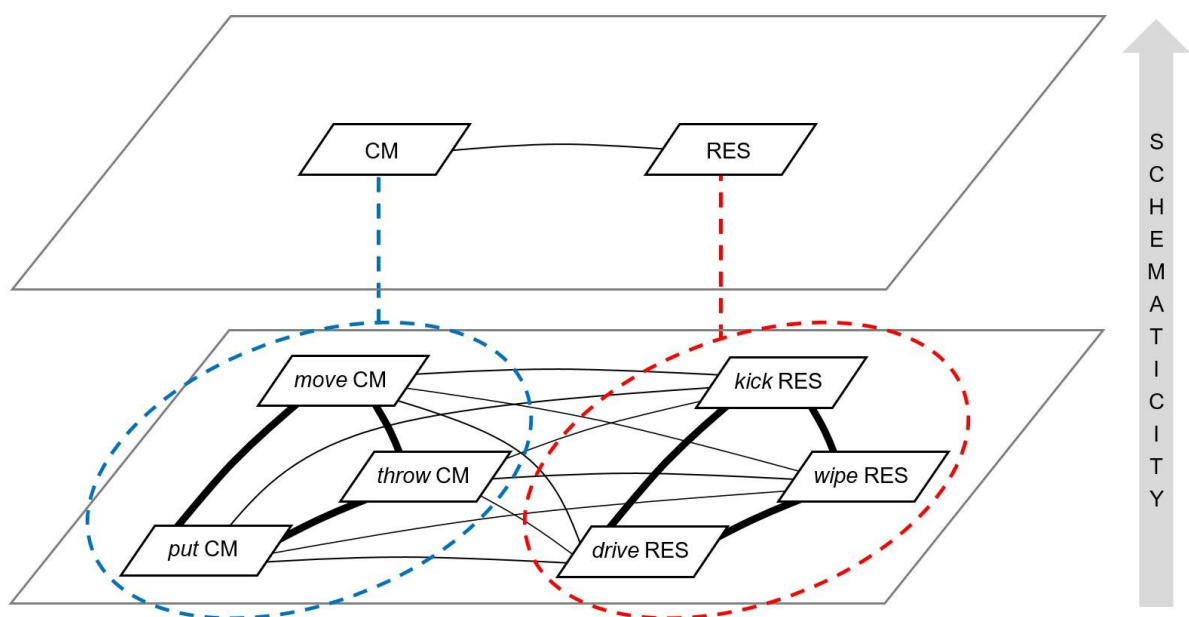


Figure 2.3. The caused-motion (CM) and resultative (RES) construction emerge from clusters of similar subpatterns at lower levels of schematicity

The thickness of the links in Figure 2.3 represents the degree of similarity, which is expected to be higher among subtypes of the same construction than between subtypes of different constructions. As a result, subtypes of the same construction (e.g., ‘*put* CM’ and ‘*move* CM’) form clusters of strongly linked units, which for visual convenience are highlighted by a dotted coloured oval. Each lower-level cluster forms a generalisation that can be represented as a single node at the higher level of schematicity (as shown by the dotted coloured lines that connect the two levels). In contrast, subtypes of different constructions (e.g., ‘*put* CM’ and ‘*drive* RES’) are related by weaker similarity links (see Section 2.3.2 for the similarities between the two constructions). At the higher level of schematicity, they are therefore not subsumed under a common generalisation; instead, the lower-level similarity relations are translated into a single similarity link at the higher level that connects the two abstract schemas. In total, then, the top-level representations in Figure 2.3 constitute a ‘short-hand’ or ‘summary’ version of the bottom-level representations. Crucially, the strength of the similarity links between the lower-level units determines whether they form part of a single higher-level generalisation (in the case that they are strongly similar), or whether they form part of distinct generalisations (in the case that they are less similar).⁷

Figure 2.3 only provides a simple example of the correspondences that hold between similarity relations at two different levels of abstraction. The same mechanism can be extended to various other levels of schematicity. In the same way that similarities among verb-specific schemas can give rise to abstract schemas such as the caused-motion or resultative construction, these abstract schemas may, in virtue of their similarities, give rise to an even higher-level schema that encompasses all their shared features. This superschema is represented as a single node at the top level of Figure 2.4, which forms an extension of the previous diagram. In the absence of a better label, the superschema is referred to as

⁷ In network science terms, Figure 2.3 highlights the *community structure* of the grammatical network, i.e., its organisation into more densely connected clusters of nodes (Barabási 2016: Chapter 9). Communities can be *nested* within each other, thus giving rise to the hierarchical network structure illustrated in the diagram. In this way, Figure 2.3 provides a more explicit illustration of Diessel’s (2019) view that grammar forms a nested network. The representation of network clusters as nodes at a higher level is inspired by Ibbotson et al.’s (2019) model of emergent grammatical patterns in child speech (see their Appendix 3 for a similar ‘layered’ network diagram). The computational algorithm used by Ibbotson et al. to detect network communities (the ‘Louvain method’; Blondel et al. 2008) resembles the logic of the theoretical argument outlined above. The algorithm constructs a series of networks, each of which treats the communities of the previous network as the nodes of the new network, and continues this process until no further sufficiently similar communities can be found.

‘resultative in the wide sense’ (or ‘RES_{wide}’; compare Goldberg and Jackendoff [2004], who use the term ‘resultative’ in a broad sense that subsumes caused-motion sentences).

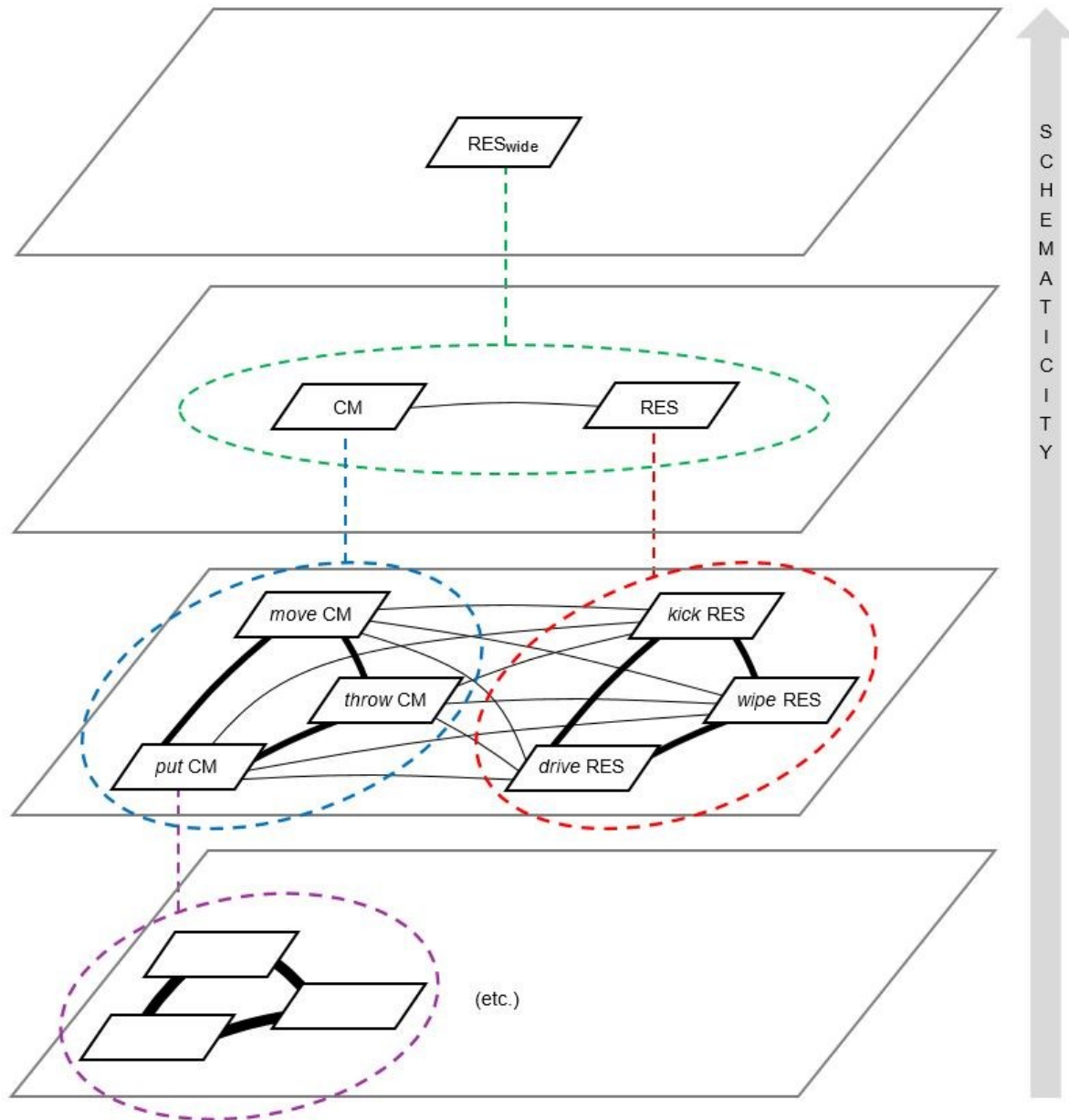


Figure 2.4. Similarities at higher and lower levels of schematicity may give rise to additional sub- and superschemas (RES_{wide} = ‘resultative in the wide sense’)

By analogy, the same logic can also be applied to the lower end of the schematicity continuum, where the verb-specific schemas discussed above can in turn be regarded as generalisations that emerge from similarities at even lower degrees of abstraction. This is indicated by the additional bottom layer in Figure 2.4, which illustrates how the ‘*put CM*’

schema arises from similarities among its instances. While the network quickly becomes too complex for visualisation, it is clear that this process of relating schemas back to the clusters of more specific units from which they emerge can be continued across various lower levels of schematicity. There is evidence that speakers' grammatical knowledge includes highly specific regularities even below the level of individual lexemes. Newman and Rice's (2006) corpus results, for example, suggest that inflected forms of *eat* and *drink* differ in their argument linking patterns. Among other things, the authors observe that the proportions of transitive and intransitive uses of *eat* vary depending on the grammatical person and number, with intransitive uses being more common in the first and third person plural.⁸ In addition, many cognitive linguists endorse the view that speakers must also store units at the lowest levels of schematicity, referred to as 'exemplars', or individual instances of use (e.g., Abbot-Smith and Behrens 2006; Ambridge 2020a; Bybee 2010; see Section 2.2.5). Under this view, the representation in Figure 2.4 could be continued downwards until the level of exemplars, which cluster together based on similarities of varying strengths and thus ultimately give rise to all higher-level schemas.⁹

Together, the above network diagrams illustrate two important points about the role of similarity relations in the grammatical network. First, the present network model assumes that higher-level units (both schemas and the similarity links between them) are not stored independently from lower-level units, but that the former are crucially dependent on the latter. This follows naturally from an emergentist view according to which generalisations emerge from similarities among more specific subpatterns. In Langacker's (1987: 438) terminology, schemas are thus "immanent" in their subtypes: they reside in the similarities that speakers encode among their instances. This perspective aligns with Elman's (2004: 304) view of the mental lexicon as a connectionist network in which types are assumed to be "implicit" in their tokens rather than being represented separately. It is also echoed by Ambridge's (2020b: 641) exemplar-based account (in its revised version based on extensive

⁸ Note, however, that Newman and Rice (2006) do not conduct a full statistical analysis of their results. In addition, the authors point out that the differences they found may be a result of speakers' "experiential realities" (p. 239): for example, speakers may have fewer opportunities to use *eat* transitively in the plural because groups of people tend to eat a variety of food items that are difficult to capture exhaustively. As a result, it is worth considering whether speakers' inflection-specific preferences really need to be stored explicitly as part of their *linguistic* knowledge.

⁹ Figure 2.4 could, of course, also incorporate various intermediate levels of schematicity – for example, verb-class-specific schemas (Croft 2003), which would be situated on an additional level between the verb-specific and the abstract constructional schemas in the diagram.

peer commentary), where the author proposes that abstractions are “made of” exemplars and that “exemplars are re-represented in such a way as to constitute abstractions”. Finally, viewing abstractions as immanent in their subtypes also seems to link up with Goldberg’s (2019: 7) most recent definition of ‘constructions’, which “are understood to be emergent clusters of lossy memory traces that are aligned within our high- (hyper!) dimensional conceptual space on the basis of shared form, function, and contextual dimensions”. The phrasing of this passage suggests that generalisations are directly equated with clusters of similar lower-level units (which on this view are assumed to be ‘lossy’, i.e., already partial abstractions over usage events).

It is important to note that this view does not deny the existence of abstract representations. Quite to the contrary, the nature of speakers’ generalisations is of central concern for the theoretical and empirical parts of the present investigation. Rather, the above remarks refer to the *format* in which schemas are represented in the grammatical network: namely, not as independent units that are stored separately from their subtypes, but *via the similarities among their subtypes*. As will be shown in Section 2.3.4, this emphasis on the mutual dependence of schemas and their subpatterns has further theoretical consequences, for instance when comparing ‘horizontal’ and ‘vertical’ models of similarity relations.

The second important feature illustrated by the above network diagrams is that the question of how feasible it is to posit a schema depends on the degree of similarity among the instances of that schema. It is only when a group of linguistic units are sufficiently similar to each other that speakers are likely to subsume them under a common schema. As outlined in Section 2.3.2, determining the degree of similarity among abstract argument structure constructions is an empirical question. By extension, then, the present discussion demonstrates that the question of whether those abstract constructions exist in the first place is also an empirical concern, as has been noted repeatedly in the literature (e.g., Croft 2001: 57; Diessel 2019: 16; Hilpert 2019: 261). The answer to this question relies on how strong the similarities are that speakers encode between the instances of each construction.

For example, the above network model suggests that abstract schemas like the ‘caused-motion construction’ or the ‘resultative construction’ are only feasible if their instances are sufficiently similar to each other. In contrast, if speakers were to perceive only weak similarities between resultative instances that contain different verbs, as opposed to strong similarities between resultatives with the same verb, then it would be more plausible

to describe their knowledge of these patterns in terms of verb-specific representations and to avoid positing abstract verb-general constructions. At the same time, if the abstract caused-motion and resultative schemas are shown to be feasible, this raises the follow-up question of whether they are sufficiently similar to be subsumed under a single, even more schematic construction, such as the ‘resultative in the wide sense’ schema depicted in Figure 2.4. That the latter question is of theoretical interest to researchers is illustrated by a comparison of Boas’ (2003) view, who questions the distinction between caused-motion and resultative sentences, and Goldberg (1995), who regards the two constructions as metaphorically related but still dissociable (see Section 2.3.2).¹⁰

As these examples illustrate, the question of which higher-level schemas can be feasibly posited as part of speakers’ grammatical knowledge requires an empirical assessment of the strength of the similarity relations between grammatical units. In this context, structural priming may again provide a crucial tool for determining the degree of constructional similarity. A second theory-related research question can therefore be formulated to guide the empirical analyses in Chapters 4 and 5:

Q_T 2: Can structural priming help determine at what level of schematicity speakers form constructional generalisations?

In response to this question, the later Section 4.1 will review structural priming evidence that speakers simultaneously encode similarities at the level of both abstract and verb-specific argument structure constructions. Moreover, Section 4.3 will provide examples of priming effects which suggest that two constructions are perceived as so similar that they can be possibly subsumed under a common schema, and of other effects which indicate that the constructions are sufficiently dissimilar to be treated as distinct patterns.

2.3.4 Representing similarity: horizontal and vertical (inheritance) links

To round off this introduction to similarity relations in the grammatical network, the following discussion will address how individual similarity links can be represented

¹⁰ Note, however, that Boas (2003) also questions the existence of abstract constructional schemas in the resultative family (see the earlier discussion). As a result, a network model that follows his account would need to represent strong similarity links between caused-motion and resultative instances that contain the *same* verb, and weak links among instances with *different* verbs.

diagrammatically. Previous work has suggested two main ways of capturing similarity relations, which make use of ‘vertical’ and ‘horizontal’ links, respectively. Contrary to the popular view, however, that these two types of representations encode qualitatively distinct types of cognitive structures, it is argued below that they may merely form notational variants for capturing the same notion of constructional similarity. Nevertheless, it is suggested that as notational devices, horizontal and vertical representations are each associated with specific advantages and limitations. Finally, the discussion outlines which type of notation is used in the remainder of this investigation given the specific purposes of the study.

Horizontal representations of similarity relations were already introduced as part of the network diagrams in Section 2.3.3. An excerpt from these earlier diagrams is provided in Figure 2.5, consisting of a single network layer that depicts the (putative) horizontal links between verb-specific subpatterns of the caused-motion and the resultative construction. As the representation shows, horizontal links connect patterns at the same degree of schematicity. Differences in the degree of similarity between subpatterns are captured via the strength of the links (depicted by the varying thickness of the lines). For instance, the two caused-motion subpatterns ‘*put CM*’ and ‘*move CM*’ are shown to be strongly related, i.e., more similar, whereas subpatterns of different constructions such as ‘*put CM*’ and ‘*drive RES*’ are weakly connected, i.e., less similar.¹¹

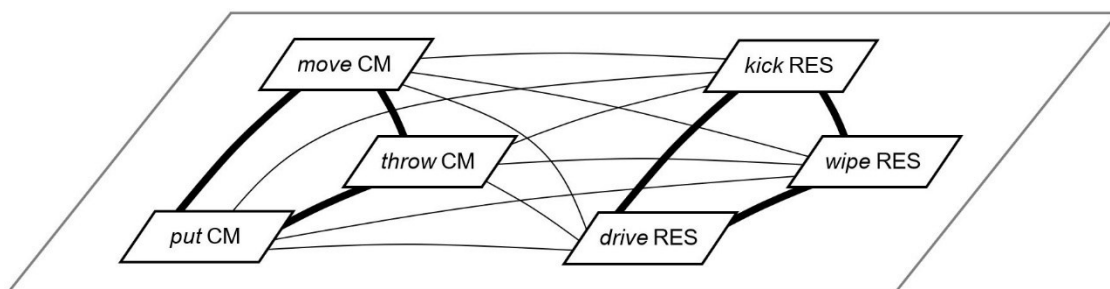


Figure 2.5. Horizontal representation of the similarities between caused-motion (CM) and resultative (RES) subtypes

The exact same information can be alternatively represented via a configuration of vertical links, thus giving rise to a taxonomic hierarchy, as shown in Figure 2.6. In contrast to

¹¹ It should be noted that the horizontal links discussed here refer exclusively to similarity relations that connect units at the same level of a taxonomic hierarchy. These relations are thus associated with the *paradigmatic* level of analysis and are fundamentally distinct from *syntagmatic* relations between linearly co-occurring units. The latter relations are also sometimes referred to as ‘horizontal’ (e.g., Budts and Petr  2020), but this involves a different understanding of the term which concerns the spatial arrangement of units in a sentence.

the ‘direct’ horizontal links between subpatterns, vertical representations capture their similarities ‘indirectly’ by relating them vertically to a common schema that encompasses all their shared features. The degree of similarity between subpatterns is captured by the path distance in the taxonomic tree: for example, ‘*put CM*’ and ‘*move CM*’ are closer to each other, i.e., more similar, than ‘*put CM*’ and ‘*drive RES*’, which are only related by the abstract ‘resultative in the wide sense’ schema (see Section 2.3.3) and are thus separated by an additional step in the hierarchy.¹² Compared to the horizontal representation of Figure 2.5, the vertical notation represents schemas and their subtypes as separate nodes, but as noted by Langacker (2009: 247) and further discussed below, this use of separate nodes is merely intended “for analytical convenience”. It should not obscure the fact that the schematic nodes in the vertical representation encode the same similarities among their subtypes that can alternatively be captured via the horizontal links above.

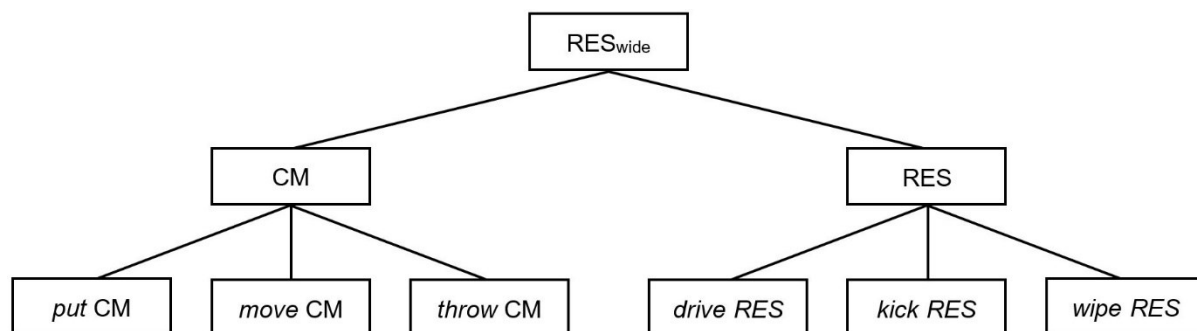


Figure 2.6. Vertical representation of the similarities between caused-motion (CM) and resultative (RES) subtypes (RES_{wide} = ‘resultative in the wide sense’)

In this way, the horizontal representation in Figure 2.5 and the vertical representation in Figure 2.6 encode the same configuration of similarity relations via different notational mechanisms. In fact, revisiting the multi-level network diagrams in Section 2.3.3, it becomes clear that the two representations can be fruitfully combined for the sake of explanatory clarity. Each network layer in these earlier diagrams contains a configuration of horizontal links; at the same time, the vertical links between the network layers make the hierarchical

¹² In addition, lines and boxes of varying thickness could be used in the diagram to represent the fact that the more abstract ‘RES_{wide}’ schema is potentially less well-entrenched than its lower-level subtypes (compare the varying degrees of entrenchment at different taxonomic levels in Langacker’s [2005: 145] diagrams).

community structure of the network explicit (see below for further advantages and limitations of the two notations).

In the cognitive-linguistic literature, vertical representations have for a long time been the dominant mode of representing similarity relations across different theoretical frameworks. In particular, as noted at the beginning of Section 2.3, vertical links are used to construct the ‘inheritance’ hierarchies that feature prominently both in Construction Grammar (Croft 2001; Goldberg 1995; Hilpert 2014) and Word Grammar (Gisborne 2020; Hudson 1984; Hudson 2007). The concept of ‘inheritance’ was originally borrowed from computer science and the literature on formal knowledge representation (Fahlman 1979; Touretzky 1986; see Daelemans et al. 1992 for a review of this early literature). To capture similarities between constructions, it invokes the notion that these constructions adopt, or ‘inherit’, their shared features from a common superordinate schema.

It is only more recently that constructionist researchers have proposed horizontal links as an alternative to vertical inheritance relations (Diessel 2015; Perek 2015; Sommerer and Smirnova 2020; Van de Velde 2014; Zehentner 2019). Interestingly, the two types of links are usually assumed to encode fundamentally different types of relations: in Smirnova and Sommerer’s (2020: 25) words, “[m]ost scholars differentiate between ‘taxonomic links’ (symbolizing relatedness through inheritance) and ‘horizontal links’ (symbolizing partial similarity but non-inheritance)”. The distinction appears questionable, however, given the above argument that both horizontal and taxonomic inheritance links encode partial similarities (see also Diessel 2019: 16). This is also reflected by the fact that several researchers have struggled to distinguish between vertical and horizontal links: Zehentner and Traugott (2020: 194) note that “the distinction [...] is difficult to uphold”; Gyselinck (2020: 135) observes that horizontal links may be “actually reinterpretations of the vertical links in another possible configuration of the network”; and Perek (2015: 153) acknowledges that “in essence, the semantic relatedness of constructions could as well be captured by direct relations [i.e., horizontal links, T.U.] between constructions”. These comments seem to provide implicit support for the above proposal that ‘direct’ horizontal links between constructions and ‘indirect’ vertical links to a common schema do not encode distinct

cognitive structures, but instead constitute notational variants for representing constructional similarities.¹³

As with any other notational system, however, each of the two representational types has specific advantages and limitations that makes it more or less suitable for the analysis of particular phenomena. The following discussion addresses three aspects in which horizontal and vertical representations potentially differ: (i) the compactness of the representations; (ii) their explicitness; and (iii) the psychological plausibility of the mechanisms that are thought to underlie the two representations.

With regard to the first of these aspects, horizontal representations provide a more compact and arguably more flexible way of capturing similarity relations. Comparing Figure 2.5 and Figure 2.6 above, it can be seen that a single horizontal link between grammatical units corresponds to a more elaborate vertical constellation in which each unit shares a vertical link with a schema that is represented as a separate node. In Langacker's (1987: 75) terms, the horizontal notation can be regarded as a "compacted" representation, while the vertical notation instantiates an "exploded" representation.¹⁴ As a practical consequence, vertical representations of a particular similarity relation tend to require more space than their horizontal equivalents. This can become a challenge especially when the same grammatical unit is shown to display different kinds of similarities with several other network units. Using a vertical notation, each of these similarities needs to be stated via a separate schema, and the same unit is then vertically related to each schema. In theories that treat vertical links as inheritance links, this is known as 'multiple inheritance' (Goldberg 1995; Sommerer 2020). The higher the number of schemas that a network unit inherits from, however, the more convoluted the representation becomes. Horizontal representations

¹³ An additional attempt to draw a distinction between vertical and horizontal links is made by Zehentner (2019: 324), who argues that only very strong horizontal links result in the formation of vertical links to a common schema. But a more plausible view is to assume that both horizontal and vertical links can vary in strength (or degree of entrenchment): weak horizontal/vertical links encode a low degree of similarity (which gives rise to only weakly entrenched schemas), while strong horizontal/vertical links encode a high degree of similarity (which gives rise to strongly entrenched schemas).

¹⁴ Note that Langacker (1987) makes this distinction in his discussion of syntagmatic hierarchies, but that the idea can be transferred to taxonomic hierarchies. Langacker argues that in a 'compacted' representation of a syntagmatically complex unit, "the content of the composite structures is given only implicitly, as a function of their components and the lines of integration connecting them" (p. 75). This is comparable to a horizontal representation of similarity relations, in which the schematic category is implicit in the horizontal link between its members.

provide a simpler alternative in these cases because each similarity is only represented as a single link without the need for additional schematic nodes.

With respect to the second point, one of the primary advantages of vertical representations is that by depicting schemas as separate nodes, they *explicitly* state the nature of the similarity between linguistic units (see Perek [2015: 153] for a similar argument). While some vertical representations use only simple constructional labels to capture schematic generalisations (e.g., the label ‘caused-motion construction’ in Figure 2.6), other diagrams specify in detail which formal and functional features the schema comprises, and which are thus shared by its subtypes. In horizontal representations, on the other hand, the generalisation is usually only *implicit* in the horizontal links between units. As a result, the exact nature of the similarity is often not specified, and the horizontal links merely indicate that two units are similar in some regard. Still, this limitation may be overcome if horizontal links are annotated with more explicit information about the type of similarities they represent (see Section 2.4 for the use of this strategy).

An additional advantage of the vertical notation is that vertical links are better suited for making the hierarchical structure of similarities at different levels of schematicity explicit. The higher up a schema is positioned in the taxonomic hierarchy, the more schematic the similarity it captures (i.e., the weaker the strength of the similarity among its instances, and the larger their number). In horizontal representations, on the other hand, the hierarchical structure is implicit in the different weights of the links (indicated by the thickness of the lines in Figure 2.5 above), but it is less clearly visible than in vertical representations (compare with Figure 2.6 above).

The third and final aspect concerns not so much a difference between horizontal and vertical representations, but it is rather a criticism of one particular interpretation of vertical links. There is a recurring view in the literature according to which schemas and their subtypes are treated as “independent” (Croft 2001: 25) nodes in a vertically organised network. On this account, it is assumed that generalisations over linguistic units are stored separately from these units themselves. It can be easily seen how this view arises from a specific interpretation of vertical representations: namely, if the nodes at higher taxonomic levels are not only understood as *notational* devices that make the hierarchical structure of the network explicit (as was argued above), but if they are instead interpreted ‘literally’ as *the psychological structures themselves*. This view is particularly common in the context of inheritance models,

in which lower-level instances are assumed to inherit features from separately stored higher-level nodes. This view is, however, at odds with the model of the grammatical network outlined in Section 2.3.3, according to which schemas emerge from the similarities among their subtypes and are therefore not regarded as independently stored, but as ‘immanent’ or ‘implicit’ in their subtypes (Ambridge 2020b; Elman 2004; Langacker 1987).

Treating schemas and their subtypes as separately stored units gives rise to several problems. It should, however, be emphasised that the following remarks are not directed against vertical representations *per se*, but only against their specific interpretation in terms of separately represented schemas. One challenge for this view is that if schemas and their subtypes are stored independently, this raises the question in what direction information is exchanged along the vertical links between those units. Inheritance is by definition a unidirectional relationship, with most researchers interpreting it as a top-down relation from more abstract to more specific nodes (Hilpert 2014; Smirnova and Sommerer 2020; but see Hudson [2007] for a bottom-up account of inheritance). This top-down orientation, however, runs counter to the direction of language acquisition assumed by usage-based approaches, in which higher-level schemas are thought to emerge from specific usage events (see Jackendoff and Audring [2020: 69] for this argument). It could potentially be argued that speakers initially acquire schemas in a bottom-up fashion from the input they witness, but that once the higher-level categories (i.e., constructions) are established, information is subsequently inherited downward to classify new instances as members of the category. The problem with this view is that there is no discrete point at which schemas have ‘fully’ formed, at which acquisition ‘stops’ and where the bottom-up process consequently turns into a top-down process. Rather, speakers’ schematic representations are consistently updated based on the incoming input, and speakers consistently draw inferences about newly witnessed instances based on their previous knowledge. In this sense, establishing similarities between new instances and stored categories is necessarily a bidirectional process.

Note that the issue of unidirectionality does not arise if schemas are regarded as being immanent in their subtypes. In this case, the vertical network layers are merely understood as notational devices for making the hierarchical structure of the network explicit and ‘top-down’ and ‘bottom-up’ are metaphors for what are actually bidirectional similarity relations that speakers establish between new instances and clusters of stored units. This perspective seems compatible with Jackendoff and Audring’s (2020: 68–74) view, who take issue with the

directionality of inheritance links and abandon the concept in favour of representing similarities via symmetric 'relational' links.

A second problem with regarding schemas and their subtypes as independent cognitive units concerns the question of storage load. One type of inheritance approach assumes that shared information is stored only at the level of the superordinate node and then inherited by the subordinate nodes whenever they are activated (so-called 'complete inheritance' or 'impoverished-entry' models; e.g., Boas and Sag 2012). This view, however, conflicts with neuropsychological evidence that humans' storage capacity is vast while their online processing resources are very limited (Goldberg 2019: 139; see Section 2.2.3). In another class of inheritance models, shared information is assumed to be stored redundantly both within the superordinate and the subordinate nodes ('normal inheritance' or 'full-entry' models; e.g., Hilpert 2014). This account, however, clashes with the intuition that establishing similarities between units should facilitate their storage and retrieval, rather than increasing memory load (Jackendoff and Audring 2020: 81). Again, these problems do not arise when schemas are regarded as immanent in their subtypes: in this case, the shared information is stored only once as part of the overlapping representations of the subtypes (Goldberg 1995: 74; see also the discussion of Jackendoff's [1975] redundancy rules in Section 2.3.1).

Based on the respective advantages and limitations of horizontal and vertical representations, it can finally be outlined which of the two notational systems will be used in the following sections. Since the remainder of this investigation focuses on similarity relations between individual constructions, it will not be necessary to use vertical links in order to highlight the hierarchical structure of larger network sections. Instead, horizontal representations will be preferred for the sake of their compactness. At the same time, the horizontal links will be annotated with detailed information about the similarities (and differences) between the respective constructions. This provides for an explicit yet flexible way to characterise different types of constructional similarities. Finally, the horizontal notation will avoid any unwarranted interpretations of vertical representations as described above, and instead underscore the notion that schemas of varying strengths emerge from the similarities among their subtypes.

2.4 Types of similarity relations and empirically testable hypotheses

Building on the model of the grammatical network outlined in the preceding sections, in which constructions can be related via both formal and functional similarities, the current section pursues two goals. First, it is argued that similarity relations between argument structure constructions can be distinguished into several broad types, depending on whether they primarily encode functional overlap (Section 2.4.2), formal overlap (Section 2.4.3), or partial formal *and* functional overlap (Section 2.4.4). In addition, Section 2.4.5 introduces metaphorical relations as a special type of functional similarity links. While relatively coarse, this classification of similarity relations provides a unifying frame for the analysis of phenomena that have been previously discussed in isolation from each other under labels such as ‘alternating constructions’ (or ‘allostructions’), ‘polysemous constructions’ and ‘homonymous constructions’ (see Sections 2.4.2 and 2.4.3). This analytical frame will then serve as a basis for the empirical investigations in Chapters 3 to 5, where it will be shown that different structural priming methods are necessary to test different types of similarity relations, and that the interpretations of priming effects are also influenced by the linking type. In addition, the current section introduces all key constructions that will be investigated in the empirical chapters, and provides theoretical analyses of their major similarities and differences.¹⁵

The second goal of this section is to outline examples of the differing predictions that previous researchers have made about the *degree of similarity* encoded by specific constructional relations. For certain similarities, it is shown that opinions diverge over whether these links form a crucial part of speakers’ grammatical knowledge, or whether they are only weakly represented in the grammatical network (see Section 2.4.2). For other similarities, it has been suggested that the respective patterns are so strongly related that they can be subsumed under a single construction (see Section 2.4.3 and 2.4.4). Finally, the relation between some constructions has been suggested to display special properties, such as a metaphorical asymmetry (see Section 2.4.5). All of these predictions rely largely on theoretical arguments (and selective distributional evidence). To what extent the different

¹⁵ The constructions examined here merely serve as examples of more general linking mechanisms in speakers’ grammatical networks. As a result, the following analyses provide a sufficient level of detail to motivate the interpretations of the experimental evidence in the later chapters, but they may not capture all of the fine-grained properties of the constructions discussed in previous theoretical work.

claims match the psychological reality of speakers' mental networks is a question that can only be addressed in the light of further empirical evidence (see Section 2.5 for discussion). Each of the following discussions is therefore accompanied by a reference to a later section in the empirical chapters in which the respective claim is assessed with the help of structural priming evidence.

Before starting the discussion of the different linking types, however, one hypothesis needs to be addressed that features particularly prominently in the rest of this section. Goldberg's (2002) 'Surface Generalisation Hypothesis' gives rise to a series of predictions about the degree of similarity between argument structure constructions. After introducing the general nature of the hypothesis in Section 2.4.1, the following sections will contrast its specific predictions about specific types of similarity relations with other competing accounts.

2.4.1 Goldberg's Surface Generalisation Hypothesis

Goldberg (2002: 329) states the 'Surface Generalisation Hypothesis' as follows (see also Goldberg [2006: Chapter 2] for a detailed discussion):

There are typically broader syntactic and semantic generalizations associated with a surface argument structure form than exist between the same surface form and a distinct form that it is hypothesized to be syntactically or semantically derived from.

On a general theoretical level, the hypothesis forms a critique of the concept of derivations or transformations used in generative approaches to derive one grammatical pattern from another pattern with similar meaning. This mechanism has, in particular, been applied to so-called constructional 'alternations', i.e., pairs of constructions that can be used interchangeably with little difference in meaning, such as the two dative constructions illustrated in (8), repeated from Section 2.3.2 above. While previous generative accounts (e.g., Baker 1997) have identified one member of these alternations as the underlying form from which the other can be derived, Goldberg proposes that each construction should be considered in its own right. Her main argument is that the members of the alternation often display stronger formal and functional similarities with constructions outside the putative alternation, which cannot be accounted for by the derivational approach.

- (8) Dative alternation:¹⁶
- a. *The librarian gave the customer the book.* (double-object construction)
 - b. *The librarian gave the book to the customer.* (*to*-dative construction)

What is not at issue here is Goldberg's general point about the role of 'surface structure' in grammatical representation, i.e., the focus on the 'visible' formal and functional properties of constructions, and the consequent eschewal of derivational operations and underlying 'deep' levels of syntactic structure. The recognition of surface structure is shared by all other cognitive-linguistic frameworks and forms a core assumption of the present investigation (see Section 2.2.1). Besides this overall theoretical view, however, Goldberg proposes a number of specific, empirically testable predictions in support of the Surface Generalisation Hypothesis, which crucially concern the degree of similarity between certain types of argument structure constructions. Two main sets of these predictions are relevant to the constructions discussed in the following sections.

First, Section 2.4.2 elaborates on Goldberg's claim that speakers' representations of alternating constructions, for example the members of the dative alternation illustrated in (8) above, may be less similar than previously assumed, thus raising doubts about the psychological reality of the concept of 'alternations'. As discussed below, this view has met with opposition by other cognitive-linguistic researchers, who have reasserted that alternations play an important role in generalising over constructions with similar meanings. Second, Sections 2.4.3 and 2.4.4 address Goldberg's suggestion that the constructions traditionally grouped under the dative alternation and the distinct 'benefactive' alternation (Levin 1993; see Section 2.4.3 for examples) are better analysed as part of other constructional generalisations. On this account, the double-object members of the two alternations are regarded as sufficiently similar to be subsumed under a single construction (see Section 2.4.3). In contrast, the prepositional members of the alternations (the *to*-dative and the *for*-dative) are assumed to be less strongly related and instead form part of other

¹⁶ The double-object construction is also known as the 'ditransitive construction' (e.g., Goldberg 1995); but sometimes both dative constructions are called 'ditransitives' (e.g., Zehentner and Traugott 2020). The *to*-dative is alternatively referred to as the 'prepositional dative' or 'prepositional object construction'. Note also that whenever the label 'double-object construction' is used in the following, it refers more specifically to the 'transfer double-object construction', which differs from the 'benefactive double-object construction' discussed further below.

constructions, with the *to*-dative, for instance, instantiating the caused-motion construction (see Section 2.4.4).

2.4.2 Similar functions, different forms: constructional alternations (or allostructions)

Having introduced Goldberg's (2002) Surface Generalisation Hypothesis, which will feature repeatedly in the following analyses, the discussion can now move on to outlining a broad classification of similarity relations. The first recurring type of link to be addressed here concerns the constructional alternations mentioned above, i.e., pairs of constructions that differ in their form but express highly similar meanings and can therefore often be used interchangeably. The term 'alternation' has long been used in other linguistic domains to characterise substitution patterns in phonology (e.g., vowel changes in English irregular past tense forms) and morphology (e.g., analytic versus synthetic adjective comparison). Applied to clause-level constructions, it has given rise to an extensive literature on argument structure alternations (also known as 'valency' or 'diathesis' alternations; see Levin 1993; Levin and Rappaport Hovav 2005; Pinker 1989). Some well-known examples of alternating constructions include the dative alternation (see the examples in (8) above) as well as the benefactive and locative alternations illustrated in (9) and (10).

(9) Benefactive alternation:

- a. *The students baked their teacher a cake.* (benefactive double-object construction)
- b. *The students baked a cake for their teacher.* (*for*-dative construction)

(10) Locative alternation:¹⁷

- a. *The cleaner sprayed water on the plant.* (theme-first locative construction)
- b. *The cleaner sprayed the plant with water.* (theme-second locative construction)

Despite the apparent similarity between the meanings of alternating constructions, there is an ongoing debate among cognitive linguists, especially in Construction Grammar, about how strongly speakers' representations of the constructions are related. On one side of the discussion, a number of researchers have endorsed the view that alternations

¹⁷ An alternative label for the locative alternation is '*spray/load* alternation' (Levin 1993). Its theme-second variant has also been referred to as the '*with*-applicative construction' (Perek 2015).

represent important generalisations over functionally similar constructions (Cappelle 2006; Perek 2015; Zehentner 2019). While they share this general stance with earlier transformational accounts (Emonds 1972; Hall 1965) and lexicalist accounts of alternations (Jackendoff 1975; Pinker 1989; Rappaport and Levin 1988), they differ from both of these paradigms in important respects. In contrast to transformational approaches, cognitive linguists assume that speakers store both alternating constructions as separate (but related) units within their declarative knowledge, rather than deriving one pattern from the other via a computational procedure. In contrast to lexicalist approaches, which capture the relationship between alternating patterns by assuming that speakers store two distinct entries for each verb, related via lexical rules, Construction Grammarians posit a more abstract similarity link at the level of the constructional schema, which generalises over the common alternating behaviour of individual verbs (for a more detailed comparison of the approaches, see Levin and Rappaport Hovav 2005).

Under this constructionist view, the similarity link between alternating constructions can be schematically captured as in Figure 2.7, which displays the main features in which two alternating patterns (here denoted as A and B) typically overlap and differ. In terms of similarities, the diagram indicates the characteristic overlap in constructional meaning (marked as ‘function A’ in both representations), corresponding to the view that alternating constructions are “essentially synonymous” (Perek 2015: 156) or “near-synonymous” (Zehentner and Traugott 2020: 173). Another similarity lies in the fact that alternating patterns typically combine with a shared set of verbs, which can be interpreted as overlap in the event types that they denote (but see below for verb-specific preferences towards one alternating variant).¹⁸ In terms of differences, alternating constructions are primarily characterised by their distinct syntactic forms (marked as ‘form A’ and ‘form B’ in the diagram). In addition, however, they also tend to differ in certain of their functional properties, including semantic, pragmatic or discourse-functional features, as will be illustrated for the example of the dative constructions below.

¹⁸ The fact that alternating constructions combine with similar verbs is related to their similarity in constructional meaning, but not identical with it. There are constructions that express highly similar meanings, but are each associated with a distinct set of verbs, for instance the double-object construction (*The TV host gave the actress her award*) and what Ziegler and Snedeker (2018) refer to as the ‘theme-second fulfilling construction’ (*The TV host presented the actress with her award*). Notably, the latter pair of constructions is usually not regarded as an alternation.

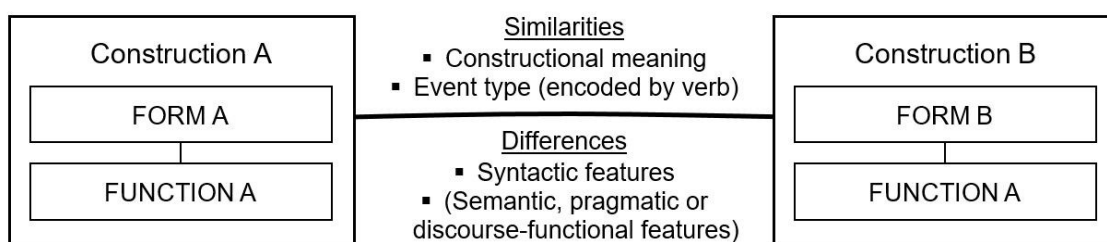


Figure 2.7. Schematic representation of similarities and differences between alternating argument structure constructions

To highlight the functional similarity between alternating constructions, Cappelle (2006) suggests treating them as ‘allostructions’, a term that has since been adopted by other researchers (De Vaere et al. 2020; Hartmann 2019; Zehentner and Traugott 2020).¹⁹ While Cappelle’s original example concerns the English verb-particle alternation (e.g., *pick up the book* versus *pick the book up*), Perek (2015) applies the concept explicitly to argument structure alternations such as the dative alternation. In analogy to allophones and allomorphs, which constitute alternative structural instantiations of a more abstract linguistic unit, allostructions are assumed to denote “variant structural realizations of a construction that is left partially underspecified” (Cappelle 2006: 18). By positing a partially underspecified schema – or ‘constructeme’ – that contains the shared functional features of the alternating variants but is underspecified in form, the allostruction model favours a ‘vertical’ representation of similarity relations. As argued in Section 2.3.4, however, this representation is equivalent to a ‘horizontal’ analysis that represents the similarity directly via a single link between the constructions. This horizontal link is illustrated in Figure 2.7, which therefore forms a notational variant of the vertical diagrams provided, for instance, by Perek (2015: 156, 162).²⁰

While some cognitive linguists thus endorse the view that similarity links between alternating constructions (reconceptualised as allostructions) play a significant role within speakers’ grammatical networks, other researchers have called the status of alternations into

¹⁹ Even though the term ‘allostructions’ highlights more explicitly the functional similarity between the constructions, the following chapters will continue to use the term ‘alternating constructions’, which is more common across different theoretical frameworks.

²⁰ Also note that Cappelle’s (2006: 18) and Zehentner’s (2019: 324) diagrams of the similarity relation between alternating constructions contain both vertical *and* horizontal links (or at least a horizontal arrow, in Cappelle’s case).

question. As introduced in Section 2.4.1, one prediction of Goldberg’s (2002) Surface Generalisation Hypothesis is that speakers perceive alternating constructions as less similar than previously assumed, and that some researchers, especially in the generative tradition, may have overemphasised the role of alternations as part of speakers’ grammatical knowledge. The main argument for this view is that alternating constructions, besides differing in their syntactic form, display additional functional differences, as will be illustrated in the following using the example of the dative alternation.

The double-object construction and the *to*-dative are among the most frequently discussed examples of alternating argument structure constructions; some of their key similarities and differences are summarised in Figure 2.8. In line with the earlier schematic representation in Figure 2.7, the diagram captures the fact that the two dative constructions share their constructional core meaning of ‘transfer of possession’ and combine with similar verbs, but that they differ in the syntactic form of their postverbal arguments (two noun phrases in the double-object construction versus a noun phrase and a prepositional phrase in the *to*-dative).

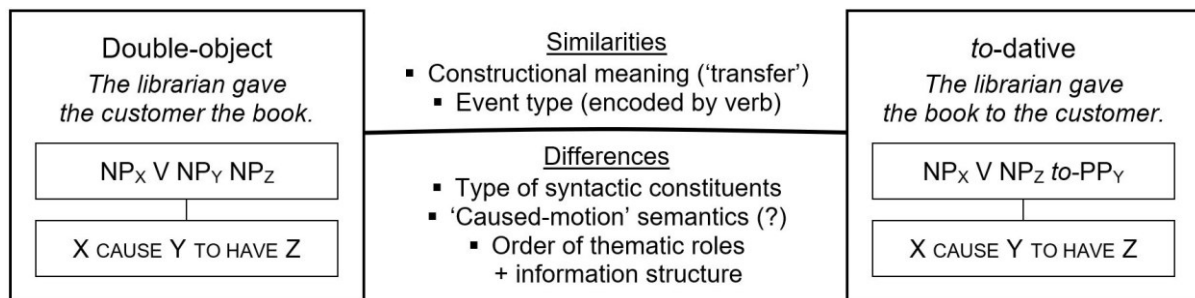


Figure 2.8. Similarities and differences between the double-object and the *to*-dative construction

Beyond the formal difference, however, Figure 2.8 also indicates several potential divergences between the functional characteristics of the constructions.²¹ First, some researchers have argued that the constructions display subtle semantic differences, with only the double-object construction expressing ‘caused possession’ and the *to*-dative instead

²¹ Besides the factors discussed here, Goldberg (2006: 30–32) outlines some further differences between the two dative constructions, including the fact that the recipient argument of the double-object construction is more resistant to appearing in long-distance dependencies than the *to*-dative recipient. Goldberg illustrates this with the example of *wh*-questioning, where the double-object question *Who did she give the towel?* appears less natural than the *to*-dative *To whom did she give the towel?*

encoding ‘caused motion’ (Harley 2003; Pinker 1989). One piece of evidence for this comes from the fact that the double-object construction does not allow successful transfer to be denied as in (11a), while the *to*-dative seems to trigger no such inference, making (11b) acceptable. This view is, however, not uncontroversial (note the ‘?’ in Figure 2.8) given that the inference in the *to*-dative seems to depend on the verb type: as Rappaport Hovav and Levin (2008) argue, verbs like *give* imply successful transfer of possession even in the *to*-dative, illustrated by the unacceptability of (11c).

- (11) a. #*My aunt gave my brother some money for new skis, but he never got it.*
b. *Lewis sent a bicycle to Sam, but it never arrived.*
c. #*My aunt gave some money to my brother for new skis, but he never got it.*
(all from Rappaport Hovav and Levin 2008)

While the potential differences in constructional semantics thus remain disputed (see also Perek [2015: 155–156] for further arguments against a difference in meaning), it is generally accepted that the two dative constructions diverge in some of their information-structural properties. Specifically, the thematic roles of their postverbal arguments appear in opposite order (with recipient-theme order in the double-object and theme-recipient order in the *to*-dative), going hand in hand with differences in the discourse accessibility, pronominality, definiteness, animacy and relative length of these arguments. The double-object construction is used more often when the recipient argument is discourse-given, pronominal, definite, animate and shorter than the theme; while conversely, the *to*-dative is favoured when the recipient argument is discourse-new, lexical, indefinite, inanimate and longer than the theme (Bresnan 2008; Bresnan et al. 2007; Theijssen et al. 2013).

Finally, while many verbs can appear both in the double-object construction and the *to*-dative, this overlap is by no means complete. Not only are there verbs that only occur in one construction but not in the other: while *forgive*, for instance, only appears in the double-object construction, *submit* only occurs in the *to*-dative (Levin 1993). Of the verbs that do alternate, many are also biased towards appearing more frequently in one construction than in the other: corpus results suggest that *give* occurs more often in the double-object construction, whereas *bring* prefers the *to*-dative (Gries and Stefanowitsch 2004; see also Bresnan and Ford 2010). As Rappaport Hovav and Levin (2008) argue, these co-occurrence

biases may arise, for instance, from the information-structural properties of particular verbs, or from their use in idiomatic combinations (e.g., *give someone the boot / the creeps / a headache*, which prefer the double-object construction). In line with the network model outlined in Section 2.3.3, it is still possible to assume that speakers represent similarity links at a lower level of schematicity between the alternating uses of individual verbs, and that these verb-specific links vary in strength (see also Perek 2015: 158). Nevertheless, the larger the variation among these lower-level links, the less likely speakers may be to generalise over the subtypes and form a higher-level link between the abstract constructions that corresponds to the theoretical notion of an ‘alternation’.

In sum, the discussion in this section has outlined both arguments in favour of positing a functional similarity relation between speakers’ representations of alternating constructions, and reasons why the strength of this relation could be called into question. Experimental evidence about the degree of similarity clearly has a crucial role to play in adjudicating between these two positions. In line with this objective, Section 4.2 in the later empirical part will examine to what extent structural priming studies of the double-object construction and the *to*-dative can inform the ongoing debate about the status of constructional alternations.

2.4.3 Similar forms, (partially) different functions: constructional polysemy and homonymy

In contrast to the alternating constructions discussed in the previous section, which overlap in meaning and differ in form, other pairs of constructions are identical (or at least highly similar) in form but diverge in their functional characteristics, particularly in their constructional meaning.²² Construction Grammar approaches provide two useful concepts for the description of formally identical constructions, depending on whether they still display some functional similarity or not. On the one hand, cases in which formally identical constructions have distinct but nevertheless related meanings are usually characterised as instances of ‘constructional polysemy’ (Goldberg 1995; Michaelis 1994), in analogy to lexical

²² When referring to ‘form’, the focus in this section is on easily ‘visible’ characteristics of the ‘surface form’ of the respective constructions (see Section 2.4.1), such as the type of their clausal constituents (e.g., noun phrase versus prepositional phrase) and the presence of lexically fixed elements (e.g., specific prepositions). This is not to say that the ‘form’ pole may not include additional features such as syntactic functions, but the latter are subject to more theoretical controversy (see, e.g., footnote 27) and arguably less clearly dissociable from the ‘meaning’ pole.

polysemy. The respective constructions have been referred to as ‘polysemous constructions’ (Traugott and Trousdale 2013) or ‘polysemic constructions’ (Percillier 2020). For example, the transfer double-object construction and the benefactive double-object construction, illustrated in (12), have been analysed as polysemous because they express related but distinguishable meanings, with the former denoting ‘actual’ transfer of possession and the latter denoting ‘intended’ transfer (Goldberg 1995; see below for further analysis).

- (12) a. *The librarian gave the customer the book.* (transfer double-object construction)²³
b. *The students baked their teacher a cake.* (benefactive double-object construction)

On the other hand, there are situations in which formally identical constructions have distinct and fully unrelated meanings. These phenomena can be regarded as cases of ‘constructional homonymy’ (Goldberg 2006), in analogy to lexical homonymy; the respective constructions have been called ‘homonymous constructions’ (Ellis 2008) or simply ‘homostructions’ (Percillier 2020). An example is the relationship between the transfer double-object construction and what could be called the ‘predicative complement’ construction (Himmelmann and Schultze-Berndt 2005), illustrated in (13). Not only do these two constructions express very different meanings, but they are also etymologically distinct given the fact that their postverbal arguments were marked by different cases in Old English (Percillier 2020: 220–221), suggesting that their overlapping present-day forms are merely the result of historical accident.

- (13) a. *She gave him a book.* (transfer double-object construction)
b. *She considered him a friend.* (predicative complement construction)

Figure 2.9 provides a schematic representation of the two types of similarity relations. Besides capturing the fact that both polysemous and homonymous constructions overlap in form (marked as ‘form A’), the diagram specifies that homonymous constructions have distinct meanings (‘function A’ and ‘function B’), while polysemous constructions

²³ The specific label ‘transfer double-object construction’ is used here to distinguish it clearly from the benefactive pattern.

(represented in square brackets) have partially similar functions ('function A' and 'function A-prime').

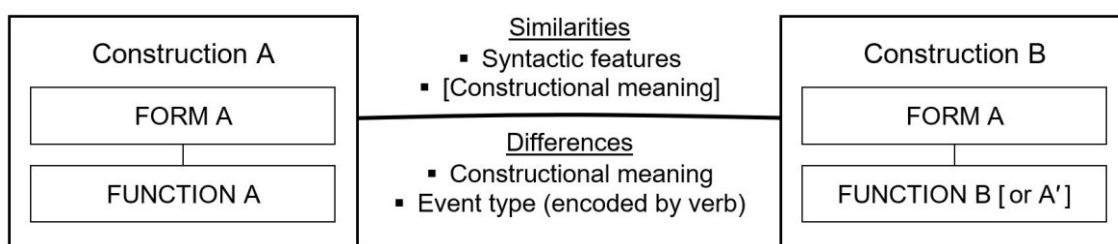


Figure 2.9. Schematic representation of similarities and differences between homonymous constructions and between polysemous constructions (additional features of the latter in square brackets)

As Figure 2.9 indicates, whether two constructions are best analysed as polysemous or homonymous crucially depends on the degree of their functional similarity. This gives rise to a number of open research questions for an empirical approach to the constructional network, as is illustrated with two examples in the following. First, it is shown that the literature contains different predictions about the relative similarity between the transfer and the benefactive double-object construction, and that researchers additionally vary in their conceptualisation of 'constructional polysemy'. Second, it is argued that for some constructions it is unclear to what degree speakers perceive their meanings as related, and whether the patterns consequently qualify as polysemous or homonymous. The phenomenon discussed here is the relation between the resultative construction and the object-oriented depictive construction (for examples, see the discussion below), which share some meaning components but contrast in others. For both examples, it is suggested that the relevant questions can be informed by the structural priming evidence that will be reviewed in the later empirical chapters.

Starting with the first example, Figure 2.10 summarises the key similarities and differences between the transfer and the benefactive double-object construction. In terms of similarities, they overlap both in the type of their syntactic constituents (two postverbal noun phrases) and in the order of their thematic roles (theme-final). In connection with the latter, Theijssen et al.'s (2009) results suggest that the benefactive double-object construction also displays similar information-structural properties to its transfer double-object relative (see Section 2.4.2), being preferred over the related *for*-dative construction when the theme

argument is discourse-new and longer than the recipient (or ‘beneficiary’; see below for the distinction).

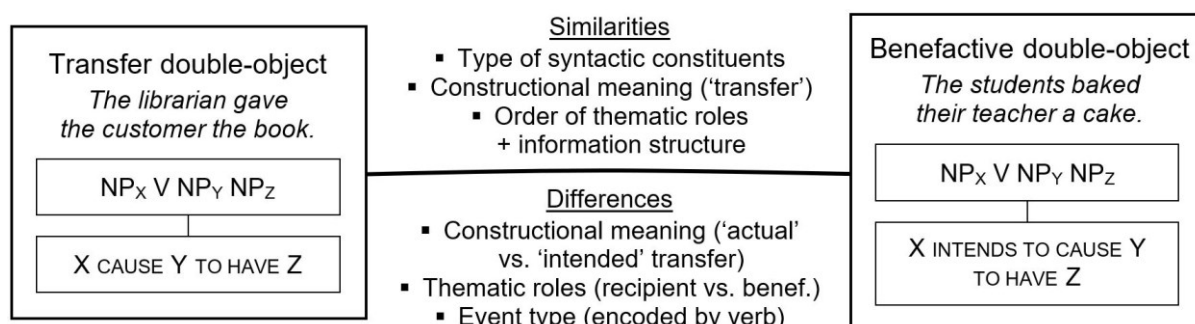


Figure 2.10. Similarities and differences between the transfer and the benefactive double-object construction

Meanwhile, Figure 2.10 indicates that with respect to their constructional meaning, the two constructions display both similarities and differences. While they both make reference to ‘transfer of possession’, it has been argued that only the transfer double-object construction encodes that this transfer actually takes place, whereas the benefactive construction merely denotes that the transfer is intended (Croft 2003; Goldberg 1995; Kay 2005).²⁴ Corresponding to this difference, a distinction is sometimes made between the thematic role of the first postverbal argument in each construction, contrasting the ‘recipient’ in the transfer double-object construction with the ‘beneficiary’ in the benefactive construction (Kittilä 2005). Other researchers, however, have emphasised the strong similarities between recipients and beneficiaries, regarding them as instances of a single role (e.g., a ‘proto-recipient’, Primus 1999; or a ‘schematic’ beneficiary, Gisborne 2010: 58). Finally, the constructions differ in the fact that they tend to combine with different verb classes, suggesting that they denote somewhat different event types (e.g., ‘physical transfer’ for the transfer construction versus ‘creation’ for the benefactive construction). Of the dative and benefactive verbs listed by Levin (1993), less than 10% can occur in both constructions.

²⁴ The discussion here focuses on the ‘intended transfer’ meaning of the double-object benefactive, which may only instantiate a subtype of a wider construction that also encompasses ‘substitutive’ readings such as *Could you iron me these shirts* (Zehentner and Traugott 2020: 176), in which an action is simply carried out on someone’s behalf. Substitutive uses of the benefactive double-object construction may, however, be largely restricted to specific varieties of English (Colleman 2010) and are otherwise often perceived as unacceptable (see Zehentner and Traugott [2020] for discussion; and compare Goldberg [2002: 332], who argues that the construction only has the ‘intended transfer’ meaning).

Given these similarities and differences, some of which are still open to debate, researchers have arrived at different conclusions regarding the degree of similarity between the two constructions. While Goldberg (1995: 75–55) and Croft (2001: 53–59) both propose that the patterns are related via constructional polysemy, the authors differ in their conceptualisation of this relationship. Goldberg does not actually refer to a distinct transfer and benefactive ‘construction’, but treats the two patterns merely as different *senses* of a single double-object (or ‘ditransitive’) construction that encompasses multiple meanings. Specifically, she regards the ‘transfer’ meaning as the central sense of the construction and the benefactive meaning as an extension of this central sense, related to it via a ‘polysemy link’. Croft, on the other hand, suggests that speakers represent multiple verb-class-specific double-object constructions (see also Section 2.3.3), each of which is associated with a different meaning (e.g., ‘actual’, ‘intended’ or ‘conditional’ transfer). His argument is that if there were a single truly polysemous double-object construction, one would expect that the *same* verb can occur with *different* senses in the construction; since this is not the case, distinct verb-class-specific (or even verb-specific) constructions should be posited.

While both Goldberg and Croft thus emphasise the functional similarity between the transfer and the benefactive pattern, their views vary in two regards: first, Goldberg’s choice to treat the two uses as part of a single construction seems to indicate that she regards them as even more strongly related than Croft, who emphasises the difference among the verb classes with which they combine. Second, Goldberg’s distinction between the central transfer sense and its benefactive extension implies an asymmetric relationship between the two patterns, while Croft’s account makes no such prediction, treating them as distinct constructions of equal standing.²⁵

The uncertainty about the degree of similarity between the transfer and the benefactive double-object construction is further illustrated by two additional views in the literature. In the context of argument structure alternations (e.g., Levin 1993; see Section

²⁵ The potential asymmetry between the two patterns in Goldberg’s (1995) account is highlighted by the fact that she treats the polysemy link between them as a type of vertical inheritance link (see Section 2.3.4). However, equating the relation between a ‘central’ sense (or prototype) and its extensions with the relation between a more abstract schema and its instantiations (as implied by the concept of ‘inheritance’) is not unproblematic (see, e.g., Langacker [1987: 380–381] on the difference between prototypes and schemas). Alternatively, the polysemy link could be treated as a horizontal similarity link between constructions at the same level of schematicity. Irrespective of this theoretical decision, the relation could still be regarded as asymmetric as a result of the prototype effects.

2.4.2), the two constructions are often regarded as members of different alternations, with the transfer double-object construction forming part of the dative alternation together with the *to*-dative, and the benefactive double-object construction belonging to the benefactive alternation together with the *for*-dative. This suggests that speakers may perceive a clear difference between the two constructions (see also Jackendoff 1990; Kay 2005). On the other hand, based on the Surface Generalisation Hypothesis (see Sections 2.4.1 and 2.4.2), Goldberg (2002) questions the psychological reality of alternations and instead highlights the similarity between the two double-object constructions. Even more explicitly than in her 1995 account, she proposes that the two patterns can be subsumed under a single construction given their strong syntactic and semantic similarities. For example, in contrast to Kay's (2005: 76) view that the recipient (or beneficiary) of the benefactive construction is categorically disallowed as a passive subject (e.g., **He was baked a cake on his birthday*), Goldberg (2002: 331) argues that this may merely be "a statistical tendency" and that some benefactives successfully undergo passivisation (e.g., *Mel was cooked a fine dinner by the new chef*).

To sum up the discussion of the first example, previous theoretical views make conflicting predictions regarding the degree of similarity between the transfer and the benefactive double-object construction. Experimental evidence about speakers' processing of these patterns may add valuable insights to the continuing debate about their status in the grammatical network. Relevant findings from structural priming between the two constructions will be reviewed in the later Section 4.3.

Moving on to the second example, the (adjectival) resultative construction and the object-oriented depictive construction illustrated in (14) constitute another pair of constructions that overlap significantly in their form.²⁶ At the same time, the two patterns have more clearly distinct meanings than the two double-object constructions discussed above. While the resultative construction describes an action that brings about a change in the state of the entity denoted by the object argument, the depictive denotes an action that the object entity undergoes while it is in a specific temporary state (Himmelmann and

²⁶ Resultatives can also have a final prepositional phrase (*John broke the bowl into pieces*) or (rarely) a noun phrase (*Claire painted the door a radiant yellow*), but the discussion here focuses on adjectival resultatives as the most frequently discussed type (e.g., Goldberg 1995). For depictives, a distinction can be made between object-oriented depictives and subject-oriented depictives (*Jess left the meeting angry*), but the discussion here focuses exclusively on the object-oriented type, which is clearly more similar to the resultative.

Schultze-Berndt 2005). In other words, resultatives characterise the result of a process whereas depictives make reference to the ‘concomitant’ (Halliday 1967: 63) of a process.

- (14) a. *Susan hammered the metal flat.* (resultative construction)
b. *Richard ate the steak raw.* (object-oriented depictive construction)

Figure 2.11 summarises the key similarities and differences between the two constructions. It captures their formal overlap in the type and order of their syntactic constituents (NP–V–NP–AP), as well as their functional difference in constructional meaning.²⁷ Interestingly, the spoken forms of the constructions also display differences in their intonational structure: while speakers tend to place the primary pitch accent on the object argument of resultatives, they more often stress the final adjective, or both the object argument and the final adjective, of depictives (Noh 2000; Winkler 1997). During the written processing of the constructions, these intonational differences, which are not marked by different punctuations, may of course play a lesser role (see the experiments in Section 5.2). Moreover, the diagram shows that the constructions both overlap but also diverge in the set of verbs with which they combine, thus hinting at both similarities and differences among the event types that they denote. On the one hand, a considerable number of verbs tend to appear in only one of the two constructions: for example, *hammer (the metal flat)*, *sweep (the path clear)* and *wipe (the table clean)* form typical examples of resultatives but are difficult to construe as depictives; while *eat (the meat raw)*, *drink (the coffee black)* and *buy (the herbs fresh)* occur more often in depictives than in resultatives.²⁸ On the other hand,

²⁷ It could be argued that the identical constituent structures only constitute a superficial kind of formal overlap, but that the constructions vary in other underlying syntactic respects, particularly the status of their final adjectives as either complements or adjuncts. The latter question, however, is a point of notorious disagreement, with some researchers treating resultative and depictive adjectives both as adjuncts (Jespersen 1965), others regarding them both as complements (Bresnan 1982), and yet others analysing the former as complements (or complex predicates) and the latter as adjuncts (Winkler 1997; see Simpson [2005] for further discussion). Given the difficulty that linguists have to differentiate the constructions syntactically, it seems justified to assume that speakers may not necessarily represent such putative differences either.

²⁸ Some of these restrictions can be explained by aspectual properties of the events typically associated with the verbs. Winkler (1997), for example, suggests that resultatives are only compatible with temporally delimited events; while Rapoport (1999) argues that object-oriented depictives do not combine with activity verbs (but note Winkler 1997: 6, who claims that depictives are compatible both with activities and accomplishments/achievements). Note also that the examples of typical depictive verbs provided above may allow for additional resultative readings, but only in connection with specific ‘unselected’ objects (Goldberg and Jackendoff 2004), as in *drink (the pub dry)* or *eat (the plate empty)*.

there are a number of verbs that readily combine with both constructions, for instance *boil* (*the carrots soft / raw*) and *cut* (*the grass short / wet*). More examples can be found in the experiments reported in Section 5.2, which make deliberate use of the fact that some verbs induce a temporary ambiguity between a resultative and a depictive interpretation.

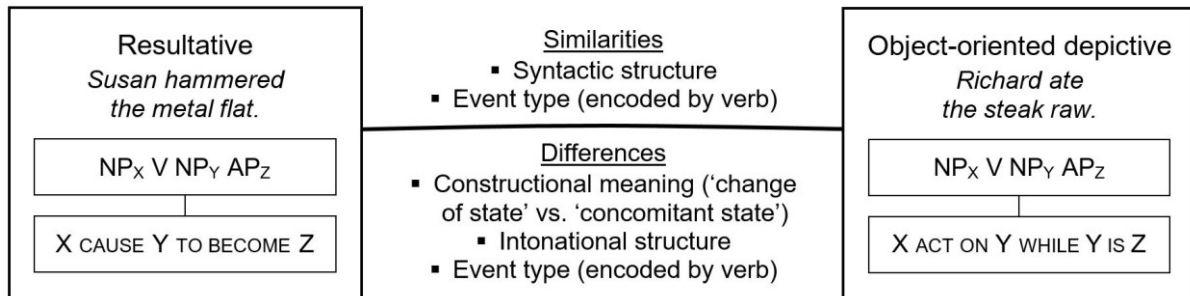


Figure 2.11. Similarities and differences between the resultative and the object-oriented depictive construction

The fact that resultatives and depictives display both partial overlap and partial difference in the verbs with which they combine suggests that speakers may perceive some (weak) functional similarity among the constructions. This raises the question of whether the constructions should best be regarded as polysemous or homonymous, or if they potentially take an intermediate position along a spectrum between these two poles. Previous theoretical analyses of the constructions do not provide a clear answer to this question. On the one hand, it was outlined above that there is a notable difference in meaning between the result state expressed by resultatives and the concomitant state encoded by depictives. This functional difference has been used as the main characteristic to distinguish between the two patterns. It is unclear, however, whether this difference is large enough for speakers to perceive the constructions as fully unrelated structures, whose formal overlap may merely be the result of historical accident. On the other hand, both constructions share the basic feature that they predicate a state of the object argument in the sentence; this is why the two patterns are typically grouped together under the label ‘secondary predicates’ (Himmelmann and Schultze-Berndt 2005). Nevertheless, this coarse similarity may not be sufficient for the two constructions to qualify as polysemous subtypes of a more abstract functional schema.

Priming between resultatives and depictives may contribute valuable psycholinguistic evidence to this discussion. If priming occurs at considerable magnitude between the two

constructions, this would suggest that speakers encode the two patterns as functionally similar, in addition to their formal overlap. On the other hand, the absence of priming between the patterns would suggest that speakers perceive them as markedly different and potentially homonymous. Section 5.2 will report two structural priming experiments that probe the relationship between resultatives and depictives.

2.4.4 Partial similarities in form *and* function

The third broad type of similarity relations holds between constructions that display both overlap but also differences in their formal *and* functional characteristics. The phenomena in this category thus lie in between the two ‘extreme’ cases of alternating constructions (which are similar in function but differ in form; see Section 2.4.2) and polysemous/homonymous constructions (which are similar in form but differ in function; see Section 2.4.3). This is schematically represented in Figure 2.12, which merges the characteristics of the other two types of similarity relations as depicted in the earlier Figure 2.7 and Figure 2.9. As the diagram shows, partially similar constructions have non-identical but related forms (marked as ‘form A’ and ‘form A-prime’) as well as non-identical but related functions (marked as ‘function A’ and ‘function A-prime’). Correspondingly, their formal and functional features appear both under ‘similarities’ and ‘differences’ in the illustration. In line with the partial functional overlap, the constructions may often combine both with a set of shared verbs that can appear in either construction, *and* with distinct verbs that are restricted to one of the patterns. The event types encoded by the verbs are thus again included both as a similarity and a difference in Figure 2.12, even though the examples discussed below display some variation in the extent to which verbs are shared between the related constructions.

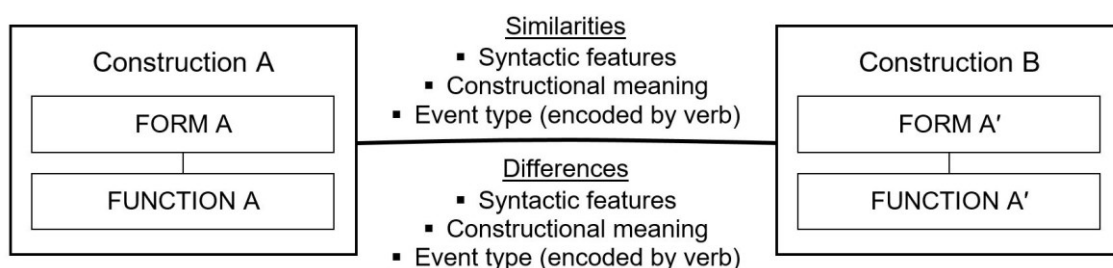


Figure 2.12. Schematic representation of similarities and differences between constructions that are partially similar in form *and* function

Despite the impression created by Figure 2.12 that partially related constructions form a unified class, the individual phenomena in this category may still vary considerably in the overall strength of their similarity. This is illustrated with the help of two examples in the following. In each case, it is shown that previous accounts have made conflicting predictions about the degree of similarity between the respective constructions. The first example concerns the relationship between the *to*-dative and the *for*-dative construction, which encode similar meanings to the ‘transfer’ and the benefactive double-object construction discussed earlier, but display an additional striking difference in their prepositions. The second example focuses on the relationship between the *to*-dative and caused-motion construction, which seem to differ in both their formal and functional characteristics, but which have sometimes been analysed as closely related or even identical.

Starting with the first example, the *to*-dative and the *for*-dative construction, illustrated in (15), display many of the similarities and differences that were observed between the ‘transfer’ and the benefactive double-object construction in Section 2.4.3. This is not surprising given that the two prepositional constructions are often regarded as the alternating variants of the two double-object constructions in what is known as the ‘dative alternation’ and the ‘benefactive alternation’, respectively (Levin 1993).

- (15) a. *The librarian gave the book to the customer. (to-dative)*
b. *The students baked a cake for their teacher. (for-dative)*

Figure 2.13 summarises the key similarities and differences between *to*-datives and *for*-datives. By analogy with the two double-object patterns (see the earlier Figure 2.10), the prepositional constructions overlap in the type of their syntactic constituents, the order of their thematic roles and the associated information-structural effects (see Section 2.4.3). On the other hand, their constructional meanings are partially different given that *to*-datives (usually) denote successful ‘transfer of possession’ while *for*-datives only encode ‘intended transfer’. In line with this, a difference is sometimes drawn between the thematic roles of their second postverbal argument, classified as a ‘recipient’ in *to*-datives and as a ‘beneficiary’ in *for*-datives. Moreover, the constructions combine with different sets of verbs, which can be regarded as a difference in the event types that they express (see Section 2.4.3 for details on these characteristics).

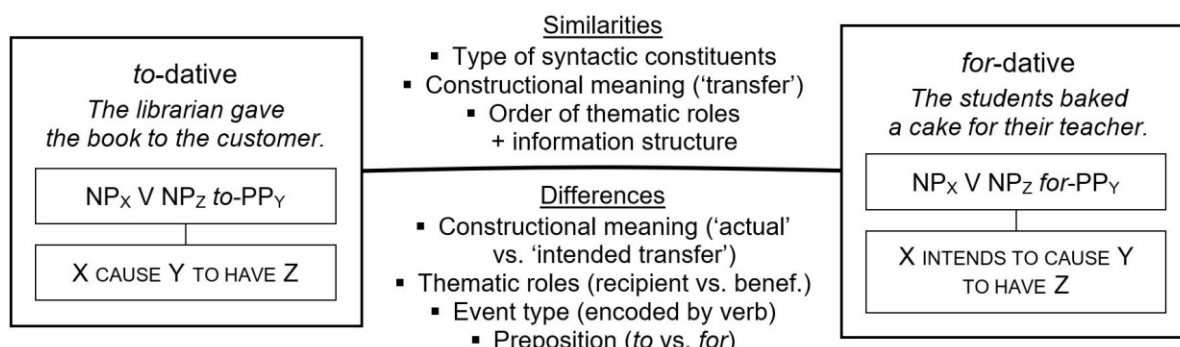


Figure 2.13. Similarities and differences between the *to*-dative and the *for*-dative construction

While the above characteristics would qualify the *to*-dative and the *for*-dative as polysemous constructions, i.e., formally identical constructions with different but related meanings (see Section 2.4.3), the two patterns differ in an additional crucial feature that sets them apart from the two double-object constructions discussed earlier. This divergence consists in the use of the prepositions *to* and *for*, which not only mark a difference among the fixed lexical elements of the constructions, but also emphasise the distinction between the 'recipient' and 'beneficiary' roles of their second postverbal argument.

It seems to be this surface-structural difference that motivates another of Goldberg's (2002) claims in the context of her Surface Generalisation Hypothesis (see Section 2.4.1), namely that the *to*-dative and the *for*-dative are more distinct from each other than the 'transfer' and the benefactive double-object construction. In fact, Goldberg proposes that the two prepositional patterns form part of two broader and clearly distinct generalisations. According to this account, the *to*-dative can be subsumed under the caused-motion construction, patterning with other instances of the construction, as suggested by the examples in (16) (see below for a detailed discussion of the relation between *to*-datives and the caused-motion construction). The *for*-dative, on the other hand, is regarded as a combination of the transitive construction with a 'benefactive adjunct construction', along with other instances as illustrated in (17).²⁹

²⁹ Goldberg's (2002: 334) original examples of the transitive + benefactive construction use the verb *send* (i.e., *Mina sent a book for Mel / for the library / for her mother's sake*), but the meaning of these sentences seems more difficult to construe and is distinct from the 'intended transfer' sense discussed above (since *Mel*, *the library* and *her mother* cannot be the intended recipients of *the book*). Note also that the above examples with *buy* have a second 'substitutive' reading in which Mina bought the book *on behalf of* Mel, the library and her mother. These substitutive readings are more readily available with the *for*-dative than with the benefactive double-object construction (Zehentner and Traugott 2020), which can be regarded as an additional argument

- (16) a. *Mina sent a book to Mel.*
b. *Mina sent a book to Chicago.*
c. *Mina sent a book through the metal detector.*

(all from Goldberg 2002)

- (17) a. *Mina bought a book for Mel.*
b. *Mina bought a book for the library.*
c. *Mina bought a book for her mother's sake.*

(all adapted from Goldberg 2002)

The above prediction that *to*-datives and *for*-datives are less similar to each other than the 'transfer' and the benefactive double-object construction stands in contrast to the traditional alternation-based account of these constructions, according to which the relation between the two prepositional patterns and between the two double-object patterns should be equivalent and thus be characterised by a comparable degree of similarity. The difference between these theoretical views will be addressed with the help of structural priming evidence in Section 4.3.

Moving on to the second example in this section, the discussion will focus more closely on the relation between the *to*-dative and the caused-motion construction. As mentioned above, Goldberg (2002) proposes in the context of her Surface Generalisation Hypothesis that the *to*-dative in (18a) can be regarded as a subtype of the caused-motion construction, which also includes patterns such as (18b). This claim rests on the assumption that the two patterns in (18) share enough similarities to be subsumed under a single construction. Alternatively, however, if the patterns can be shown to encode significant differences, it would be more feasible to maintain the distinction between the *to*-dative and the caused-motion construction. The latter construction should in this case be restricted to examples like (18b), where the locative motion element is arguably more clearly evident than in the *to*-dative. To distinguish this narrow view of the caused-motion construction from Goldberg's wider

that *for*-datives and *to*-datives are semantically more distinct than 'transfer' and benefactive double-object sentences.

construal, the label ‘locative caused-motion construction’ (Perek 2015) will be used in the following to refer specifically to the pattern in (18b).

- (18) a. *The librarian gave the book to the customer.*
 b. *James rolled the ball down the hill.*

As the discussion below will show, it is unclear what exact degree of similarity speakers encode between the *to*-dative and the locative caused-motion construction. As a result, theoretical accounts remain divided between the two alternatives outlined above, highlighting the need for empirical evidence (see the end of this section).

In terms of a theoretical overview, Figure 2.14 depicts the key similarities and differences between the *to*-dative and the locative caused-motion construction. Starting with the more straightforward characteristics, the diagram shows that the two patterns share the type of their syntactic constituents as well as the order of their thematic roles (i.e., theme–recipient/goal; see below for a discussion of the role types). In terms of their differences, the constructions differ in the fact that the second postverbal argument in the *to*-dative contains a fixed preposition (*to*), while the locative caused-motion construction allows variable prepositions (e.g., *(in)to, up, down, through, out of*). This does not, however, necessarily suggest that the patterns are distinct, but could also be interpreted in support of the above claim that the *to*-dative is a subtype of the caused-motion construction (in its wider sense) because the preposition *to* is included in the set of prepositions allowed by the locative caused-motion construction.

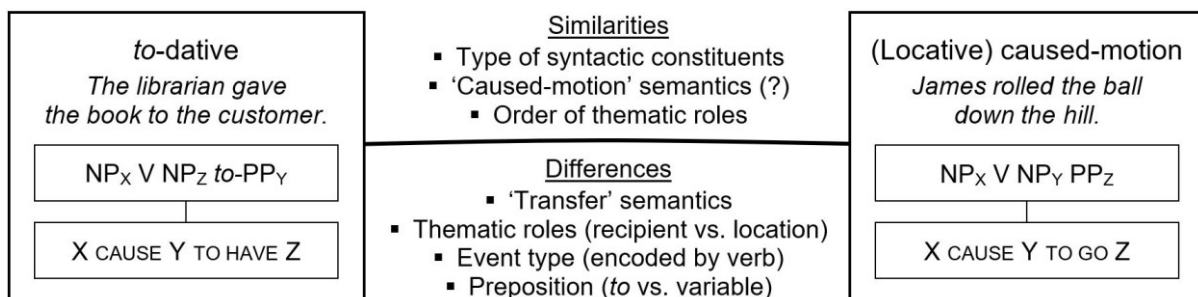


Figure 2.14. Similarities and differences between the *to*-dative and the (locative) caused-motion construction

The diagram also shows that the two patterns display both similarities and differences among the verbs with which they combine. Some verbs such as *send*, *bring* and *throw* can occur both in the *to*-dative and with variable prepositions in the locative caused-motion construction; see the examples in (16) above. On the other hand, some of the typical *to*-dative verbs such as *give* cannot be combined with prepositions other than *to* in the locative caused-motion construction, as illustrated in (19a). Even when they seem to occur with locative *to*-phrases such as *to London* in (19b), these phrases must in fact be understood as metonyms for an animate entity (e.g., 'the employees in the London office'; Rappaport Hovav and Levin 2008), thus rendering the examples more similar to *to*-datives than locative caused-motion sentences. In turn, there are caused-motion verbs such as *spray* that are difficult to construe with the *to*-dative, as illustrated in (19c), especially with the implication that possession of the theme (*the paint*) is transferred.

- (19) a. **The librarian gave the book into the room / over the fence / out of the bag.*
b. *I gave the package to London.* (Rappaport Hovav and Levin 2008)
c. ??*Ken sprayed the paint to his dad.*

The most crucial difference between the constructions, however, is their potential difference in constructional meaning. While the meaning of the *to*-dative is usually described as 'caused transfer of possession', the locative caused-motion construction owes its name to the fact that it conveys 'caused motion' to a location. This semantic difference is not uncontroversial, however, given that some researchers (e.g., Harley 2003) have argued that the *to*-dative also encodes an element of 'caused motion', based on evidence that the construction does not always entail successful transfer. In contrast, others (e.g., Rappaport Hovav and Levin 2008) have reaffirmed that at least when used with certain verbs, the *to*-dative does entail successful transfer (see Section 2.4.2 for a more detailed discussion). Goldberg (1995: 89–91) seems to take an intermediate position between these views: by treating the 'transfer of possession' meaning of the *to*-dative as a metaphorical extension of the 'physical transfer' semantics of the locative caused-motion construction, she seems to imply that the meanings of the two constructions are related but distinct (compare the

difference between ‘cause-receive’ and ‘cause-move’ in her illustrations).³⁰ To incorporate these varying perspectives from the literature, Figure 2.14 includes both the potential similarity in caused-motion semantics between the constructions (but note the ‘?’ in the diagram) but also the difference arising from the additional ‘transfer’ semantics of the *to*-dative.

Paralleling the debate about the meanings of the two constructions, views also differ on whether their second postverbal arguments bear the same or different thematic roles. Similar to the question raised in Section 2.4.3 about whether recipients and beneficiaries form distinct roles or belong to a single ‘proto-recipient’ category, some researchers have distinguished between a ‘recipient’ role in *to*-datives and a ‘location’ role (or ‘spatial goal’ or ‘destination’; Ziegler and Snedeker 2018) in locative caused-motion sentences (Pinker 1989; Rappaport Hovav and Levin 2008).³¹ In contrast, others have posited a single ‘goal’ role for both constructions (Harley 2003; Jackendoff 1983). Goldberg (1995) again seems to hold an intermediate view by distinguishing between ‘recipient’ and ‘goal’ in her diagrams, but also suggesting that recipients are animate goals (p. 2), which implies that the former are a subtype of the latter.

Previous theoretical discussions of the relation between the *to*-dative and the locative caused-motion construction thus yield a number of potential differences between the two patterns. Nevertheless, most of these observations also allow for an interpretation under which the *to*-dative forms a subtype of a more broadly construed caused-motion construction. In order to determine whether speakers’ representations of *to*-datives and locative caused-motion sentences are similar enough to treat them as part of a single generalisation, the later Section 4.3 will review evidence from structural priming between the two patterns.

³⁰ In this light, the *to*-dative and the locative caused-motion construction could also be discussed under the heading of metaphorically related constructions in Section 2.4.5. Note, however, that in her later publication, Goldberg (2002) makes no explicit reference to this putative metaphor, and instead treats the patterns as part of “a single ‘caused-motion’ construction” (p. 333). Compared with the link between the caused-motion and the resultative construction discussed in Section 2.4.5, the argument for a metaphorical relation thus seems less salient in the present case.

³¹ Note that what is here referred to as the ‘location’ role in the locative caused-motion construction does not only encompass endpoints of a movement, but also ‘sources’ (*James rolled the ball out of the room*) and ‘paths’ (*James rolled the ball through the tunnel*).

2.4.5 A special case of functional similarity: metaphorical links

The final type of similarity relation forms a special case of the partially related constructions addressed in the previous section. For some argument structure constructions, it has been suggested that they display a special kind of functional similarity relying on an asymmetrical metaphorical relation. In contrast to the previous sections, a separate schematic representation for this linking type is not provided here. Instead, the discussion focuses on a concrete example, building on Goldberg's (1995) claim that the meanings of the caused-motion and the (adjectival) resultative construction in (20) are metaphorically related.³² The theoretical arguments for this view are reviewed in the following, before concluding that additional empirical evidence is needed to assess the psychological reality of the metaphorical link.

- (20) a. *James rolled the ball down the hill.* (caused-motion construction)
b. *Susan hammered the metal flat.* (resultative construction)

The key similarities and differences of the two constructions are summarised in Figure 2.15 (see also the related discussion in Section 2.3.2). Starting with the differences, a clear syntactic distinction can be drawn between the final prepositional phrase in the caused-motion construction, and the final adjective phrase in resultatives (at least of the type examined here).³³ In terms of their constructional meanings, the patterns differ between the 'change of location' semantics of the caused-motion construction and the 'change of state' meaning of resultatives, even though it will be discussed below to what extent these meanings may be related. Another semantic difference lies in the fact that resultatives prototypically encode the endpoint of a scale, i.e., they usually refer to telic events, while the caused-motion construction can be used to describe both telic and non-telic events (Beavers 2012; Wechsler 2005). Compare the caused-motion example in (21a), where both a telic and an atelic reading are available, against the resultative example in (21b), where the atelic

³² In contrast to Section 2.4.4, the more specific label 'locative caused-motion construction' is not used here because the potential distinction between a wider and a narrower understanding of the caused-motion construction is less crucial for the comparison with resultatives.

³³ As observed in footnote 26, resultatives can also have a final prepositional phrase (*John broke the bowl into pieces*) or (rarely) a noun phrase (*Claire painted the door a radiant yellow*). Caused-motion sentences, in turn, can alternatively end in an adverb (*Mary pushed the chair inside*). The present discussion, however, focuses only on the most frequently studied types of the two constructions (compare, e.g., Goldberg 1995).

interpretation is at least questionable (but see Goldberg and Jackendoff 2004 for exceptional atelic resultatives).

- (21) a. *James rolled the ball down the hill (for an hour / in an hour).*
 b. *Susan hammered the metal flat (?for an hour / in an hour).*

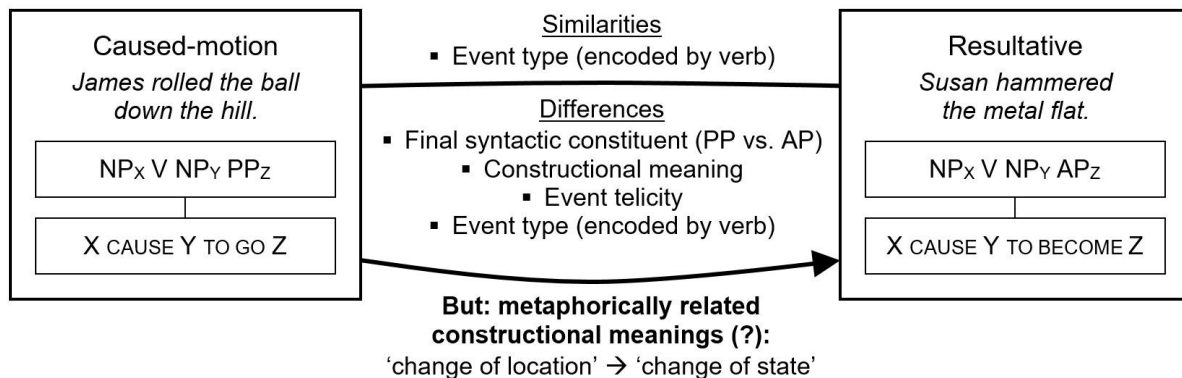


Figure 2.15. Similarities and differences between the caused-motion and the resultative construction, including their potential metaphorical asymmetry

In terms of the event types encoded by their verbs, the two constructions display both similarities and differences. Certain verbs are typically associated with only one of the constructions, for example *move* with the caused-motion construction, and *make* with resultatives (Goldberg 1995).³⁴ On the other hand, there are a number of verbs that can combine with both patterns, such as *knock (the ball over the fence / the boxer unconscious)* and *sweep (the glass into the bin / the floor clean)*. The resulting temporary ambiguity between such instances of the two constructions is exploited in the structural priming experiment discussed in Section 5.3.

This partial overlap in their event types already hints at the fact that the constructions may encode some functional similarity. This link is made explicit in Goldberg's (1995: 81–84) claim that the meanings of the two patterns are not unrelated, but that the 'change of state' meaning of the resultative forms a metaphorical extension of the 'change of location' semantics of the caused-motion construction. Under this view, the change along a 'metaphorical path' expressed by the resultative extends the concept of motion along a 'literal path' encoded in caused-motion sentences. Goldberg's core argument for this link

³⁴ But note that *move* can occur in some (idiomatic) prepositional resultatives, e.g., *She moved him to tears.*

relies on the fact that the two constructions are subject to a common ‘Unique Path Constraint’: not more than one distinct path (literal, metaphorical or a mixture of both) can be predicated of their object argument. Sentences that violate this constraint are ill-formed, as illustrated in (22).

- (22) a. **He wiped the table [dry]_{metaphorical} [clean]_{metaphorical}.*
b. **Sam kicked Bill [black and blue]_{metaphorical} [out of the room]_{literal}.*
(both from Goldberg 1995)

Moreover, Goldberg observes that the caused-motion construction is semantically less restricted than the resultative: the former encompasses additional ‘polysemous’ sub-senses besides its core meaning, such as ‘X ENABLE Y TO GO Z’ in (23a) and ‘X CAUSE Y NOT TO GO Z’ in (23b), while the latter does not allow for such polysemous extensions. This aligns well with the putative asymmetric mapping from the caused-motion construction, as the conceptually richer metaphorical source, to the resultative construction, as the conceptually more restricted metaphorical target. Finally, the 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 generally (Jackendoff 1983).

- (23) a. **She allowed him into the room.*
b. **She locked him out of the room.*
(both from Goldberg 1995)

In sum, Goldberg’s (1995) account predicts an asymmetric metaphorical relation between the caused-motion and the resultative construction.³⁵ This view is not universally

³⁵ Note that this view is logically independent from Goldberg’s (1995) claim that metaphorical relations are a type of vertical inheritance link (see Section 2.3.4). The latter claim is potentially contentious because it entails that the (locative) caused-motion construction forms a more schematic supertype that subsumes the more specific resultative construction. On an alternative view, the two patterns could be regarded as constructions at the same level of schematicity, while still accounting for their metaphorical asymmetry (for ‘horizontal’ interpretations of metaphorical links, see also Perek 2020; Smirnova and Sommerer 2020). For example, appealing to Glucksberg’s (2001) ‘categorisation’ theory of metaphor comprehension, it could be argued that the caused-motion construction provides the salient ‘attributes’ (such as the notion of ‘change’) based on which

accepted (thus the '?' in Figure 2.15), as can be seen in an interesting passage from Goldberg and Jackendoff's (2004) discussion of the two patterns. In a footnote (p. 542, note 13), the authors outline their contrasting views on the relation between the constructions: while Goldberg endorses her earlier metaphorical extension account, Jackendoff regards the patterns merely as "parallel instantiations of thematic structure". The latter view suggests that the two constructions are related, but not subject to a metaphorical asymmetry; instead, they may be linked by a symmetric relation of partial functional similarity.

As the discussion in this section has shown, the question of whether or not speakers' representations of the caused-motion and the resultative construction are related by an asymmetric metaphorical link is another research problem that calls for empirical evidence. To address this question, Section 5.3 will report relevant findings from a structural priming experiment.

To conclude the review of the different types of similarity relations in Sections 2.4.2 to 2.4.5, the empirical concerns that emerged over the course of the discussion can be summarised into two more theory-related questions. Together with the two earlier questions outlined in Section 2.3, these will guide the empirical analyses in Chapters 4 to 5. One question concerns the psychological reality of the different types of similarity relations, as well as the methodological potential of structural priming to capture such similarities across diverse phenomena:

Q_T 3: Does structural priming provide evidence that speakers encode different types of similarity relations? (for example, between constructions with similar function and constructions with similar form)

The other question is to do with the use of structural priming to test, and adjudicate between, the conflicting theoretical predictions about specific constructional pairs discussed in the previous sections:

Q_T 4: Can the structural priming evidence adjudicate between different theoretical accounts of particular similarity relations? (for example, between alternation-based views and Goldberg's [2002] Surface Generalisation Hypothesis)

speakers infer a more schematic category, which then subsumes *both* the caused-motion and the resultative construction (by leaving underspecified the exact nature of the change).

2.5 Sources of empirical evidence for constructional similarity

The previous sections have illustrated why empirical evidence about the degree of similarity between argument structure constructions is needed to flesh out existing cognitive-linguistic models of the grammatical network. The present section provides an overview of some of the key methods that can be used to test similarity relations, along with a discussion of their respective strengths and limitations. Two primary sets of techniques are distinguished: corpus-based methods and experimental methods. While an exhaustive description of all available methods cannot be provided, some widely used techniques are illustrated with examples. Their characteristics can then be compared with structural priming as the method of choice in the present investigation, which will be introduced in detail in Chapter 3.

Starting with corpus-based methodologies, one way of identifying constructional similarities builds on the fact that the meaning of argument structure constructions is usually intricately connected to the verbs that occur in them (Fried and Boas 2005; Perek 2014). Functional similarities between constructions can thus be potentially inferred by comparing the verbs with which they typically combine. A popular tool for measuring the degree of association between verbs and constructions is provided by the family of ‘collostructional analysis’ methods. These techniques compare the observed frequency of a verb in a construction with its expected frequency, calculated based on the overall frequency of the verb, the frequency of the construction and the corpus size (see Stefanowitsch [2013] for an overview). However, by identifying verbs that occur at above-chance frequencies with one construction rather than the other, the focus of collostructional analyses is often on determining the subtle differences between constructions rather than their degree of overlap. For example, using a ‘distinctive collexeme analysis’, Gries and Stefanowitsch (2004) demonstrate that many of the verbs that combine with the English double-object and *to*-dative construction are biased towards one construction over the other (see Section 2.4.2). In contrast, besides noting that there are also some verbs that are roughly equally attracted to both constructions, their investigation does not provide a straightforward way to quantify the degree of similarity between the two constructions (see also Stefanowitsch 2013: 298).

Some applications of collostructional analysis, however, have addressed this question more explicitly. For instance, Gries (2011) conducts two ‘simple collexeme analyses’ (see Stefanowitsch and Gries 2003) to assess similarity links among instances of the double-object

construction (rather than between the double-object construction and another abstract argument structure construction, as above). One simple collexeme analysis yields a ranking of verb lemmas according to how strongly they are attracted to the construction, while the other analysis instead ranks specific inflected forms of these verbs (e.g., infinitives, or *-ing* participles) in terms of their collostructional strength. Gries then shows that the lemma-based and the verb-form-based rankings are strongly correlated with each other, suggesting that speakers use different inflected forms of the same verb in very similar ways with the double-object construction. Speakers are therefore likely to store lemma-based representations that generalise over the verb-form-specific patterns (but note that Gries' study does not test for similarity relations at higher levels of schematicity).

Despite the flexible uses of collostructional methods, they are restricted to measuring lexical overlap between constructions, for example via the frequency of their verbs. As a result, the methods do not shed light on the more fine-grained semantic factors that may differentiate the meanings of those verbs (and by extension, of the constructions). To investigate semantic similarities specifically, researchers have used a different set of corpus-based techniques, relying on distributional semantic methods such as 'semantic vector space' analysis (Hilpert and Perek 2015; Levshina and Heylen 2014). These methods identify semantic similarities between lexical items via their collocates, following the rationale that words with similar meaning tend to occur in distributionally similar environments. Semantic vector spaces are often used to examine degrees of similarity among the individual verbs that appear in the same construction, for example in the *way*-construction (Perek and Hilpert 2017). However, by computing summed vectors over all the verbs that appear in one construction, the methods can also be used to compare the semantic profiles of different argument structure constructions.

For example, Percillier (2020) uses such summed vectors (or 'period vectors') to track how the degree of similarity among the verbs used in different types of resultative and depictive constructions changed during the Middle English period (see Section 2.4.3 for examples of the present-day constructions). Interestingly, the author finds that in the earlier corpus period, patterns with the same preposition (e.g., *as*, *for*, *(in)to*) combined with semantically similar verbs, irrespective of whether these patterns encoded a resultative or depictive meaning. In the later periods, on the other hand, resultative patterns contained verbs with similar meaning regardless of their preposition, and the set of resultative verbs

was semantically more distinct from the set of depictive verbs. This seems to suggest that speakers' representations of resultatives and depictives grew more distinct over time, while semantic differences between the prepositional variants within each of these construction types were levelled out.

The preceding discussion of some widely used corpus methods³⁶ reveals two important advantages that corpus-based approaches bring to the study of constructional similarities. First, corpus studies incorporate large amounts of naturalistic data; and second, they allow for both synchronic and diachronic investigations of similarity relations, as illustrated by the above examples. The most significant limitation of these methods, however, concerns the fact that they do not provide direct access to speakers' (or communities') mental representations. While corpus data, as reflections of the 'output' of speakers' grammatical knowledge, can be used to draw implicit inferences about the nature of that knowledge system, they do not shed light on the cognitive mechanisms that are involved in the real-time use, as well as emergence, of speakers' grammatical networks (see Arppe et al. 2010 for a cautionary perspective on the relationship between corpora and cognition). In particular, it cannot be assumed that the patterns of formal and/or functional overlap that emerge as statistically significant in corpus analyses are necessarily encoded in speakers' mental networks, let alone that they form salient regularities of which speakers may be consciously aware.

The latter argument provides a primary motivation for the use of experimental methods, which test directly how certain types of stimuli affect speakers' linguistic behaviour. One experimental paradigm that has been used to investigate constructional similarities relies on sorting tasks (Bencini and Goldberg 2000; Gries and Wulff 2005; Perek 2012). For example, Perek (2012) presented participants with sentences instantiating four constructions – double-object, *to*-dative, locative caused-motion (see Section 2.4.4 for examples) and '*with*-applicative' (e.g., *Dana plastered Marge with something*) – and asked them to sort the

³⁶ As mentioned above, a range of other corpus-based methods could be added here. For example, Bresnan et al. (2007) compare instances of the double-object and the *to*-dative construction by manually annotating characteristics of their recipient and theme arguments (e.g., discourse accessibility, definiteness, animacy) and entering them into a regression analysis. Theijssen et al. (2013) conduct a similar study of the dative alternation using automatic feature extraction and more advanced analysis techniques, including Bayesian networks and 'memory-based' machine learning models (see Section 2.4.2 for the results of both studies). As observed above, however, the focus of these approaches is again on determining distinctive features of each construction, which only indirectly reflect the degree of similarity between their constructional meanings.

sentences into *three groups* of semantically similar patterns. In order to arrive at only three sorts, participants thus had to merge instances from at least two constructions into a single category. Perek found that participants were more likely to group alternating constructions together in one group – either double-object and *to*-dative sentences (the dative alternation), or caused-motion and *with*-applicative sentences (the locative alternation) – than grouping the *to*-dative and the caused-motion construction together. This suggests that speakers perceived a stronger functional similarity between the former than between the latter pairs of constructions, potentially conflicting with Goldberg’s (2002) claims that alternating constructions are relatively distinct from each other, and that the *to*-dative is closely related to the caused-motion construction (see Sections 2.4.2 and 2.4.4).

While sorting tasks are easily implementable, they are also subject to limitations, three of which will be addressed here. First, sorting tasks are ‘offline’ in the sense that they only record the outcomes of the processing mechanisms that operate within speakers’ grammatical networks, rather than providing an ‘online’ measure of those mechanisms as they unfold during language production or comprehension. Second, as Perek (2012: 629) himself points out, the metalinguistic nature of the tasks may induce participants to form ad-hoc categories based on their conscious reasoning about the stimuli, rather than tapping into their stored implicit knowledge of grammar. Third, participants’ behaviour in the experiments is quite tightly constrained by the specific nature of the instructions, for instance the number of categories that they are asked to form, or the type of similarity that they are told to consider (e.g., semantic similarity in Perek [2012]). This may bias participants towards certain sorting strategies that they would not have pursued in a more naturalistic setting in which they could freely choose the number of categories and the sorting criteria.

An alternative experimental paradigm that is specifically suitable for modelling the emergence of similarity relations makes use of artificial language learning methods (Boyd and Goldberg 2011; Perek and Goldberg 2015; Perek and Goldberg 2017; Thothathiri and Rattinger 2016; Wonnacott et al. 2008). For example, Perek and Goldberg (2015) address the question of whether speakers form verb-specific or verb-general representations of two artificial alternating constructions that display distinct word orders – SOV versus OSV – and are used with novel verbs (e.g., *glim*, *moop*). In their Experiment 1, the researchers show that if participants witnessed some of the novel verbs in both constructions during the learning phase (the ‘alternating condition’), they were more likely to use all verbs, including previously

unseen ones, productively with both constructions during the testing phase. From the perspective of similarity relations, this seems to indicate that speakers generalised over the uses of different verbs in the same construction (based on their formal and functional similarities) and inferred that all verbs could be used with both abstract constructional schemas, even if they had previously only seen them in one construction or not at all. On the other hand, if participants had witnessed all verbs during the learning phase with only one of the two constructions (the ‘lexicalist condition’), they were less willing to use these and previously unseen verbs productively with both constructions during the testing phase. This suggests that when the verbs combined in more unpredictable (i.e., less similar) ways with the two constructions, speakers were less likely to generalise beyond the level of verb-specific representations.

Interestingly, Perek and Goldberg’s Experiment 2 showed that this tendency towards lexical conservatism is even stronger when the two constructions have the same information-structural properties – in their case, if both constructions were used with lexical noun phrase objects (rather than one construction being used with pronominal objects and one with lexical objects, as in Experiment 1). Under these conditions, participants might have had a stronger expectation that verbs should alternate freely between the two functionally equivalent constructions. Since participants, however, witnessed each verb in only one construction during the learning phase, this may have highlighted the dissimilarity between the verb-specific patterns, thus discouraging speakers from forming abstract constructional schemas (see also Wonnacott et al. [2008] for similar results). Perek and Goldberg use the term ‘statistical preemption’ for this tendency to avoid using a verb in a specific construction if it has been consistently witnessed in another functionally equivalent construction (see also Goldberg [2019] for a detailed discussion). In terms of similarity relations, statistical preemption effects can thus be interpreted as a conflict between speakers’ attempts to generalise over contextually similar verb-specific patterns, and the idiosyncratic formal differences that these patterns display in the usage data.

The artificial learning experiments discussed above thus provide an implicit way of studying the emergence of constructional schemas in speakers’ grammatical networks. Nevertheless, they still make use of ‘offline’ methods to track the outcomes of these learning mechanisms, rather than tapping into the real-time activation processes that lead to the restructuring of speakers’ mental networks during learning. In addition, they are restricted to

studying artificial constructions and can therefore not shed light on the similarity relations between already existing constructions in natural languages.³⁷

In order to overcome these limitations, a third experimental paradigm can be used: structural priming. Since the occurrence of priming, i.e., the observation that processing one linguistic pattern affects subsequent processing of another pattern (Branigan and Pickering 2017), is commonly interpreted as evidence that speakers' representations of the two patterns are related, the paradigm lends itself naturally to the investigation of similarity relations between constructions. By providing implicit behavioural measures of the way in which speakers process argument structure constructions in natural languages, structural priming overcomes several of the challenges faced by the other experimental methods reviewed above. These and other characteristics of structural priming methods will be discussed in detail in Chapter 3.

2.6 Summary: four theory-related questions for a structural priming approach to the grammatical network

This chapter has laid the theoretical foundations for the following empirical analyses. Section 2.1 provided a brief intellectual history of the use of network models across the modern empirical sciences, as well as their application to linguistics, and cognitive linguistics in particular. In Section 2.2, six shared characteristics of cognitive-linguistic network models were outlined that provide the broad theoretical frame in which the present study is situated. Section 2.3. explored the important role of similarity relations in structuring the grammatical network, including a discussion of the multi-dimensional nature of similarities, an 'emergent' view of generalisations as arising from similarities at lower levels of schematicity, and the difference between 'vertical' and 'horizontal' representations of similarity links. Section 2.4 introduced four different types of similarity relations between argument structure constructions (including the special case of metaphorical links), each illustrated with the help

³⁷ Some evidence about the role of similarity relations in natural languages may be provided by first language acquisition studies. For example, Diessel and Tomasello (2005) investigated English- and German-speaking children's productions of different types of relative clauses (RCs) in a sentence repetition task and found that their error rates may have been influenced by the relative similarities among the structures. For example, English-speaking children displayed similar error rates for direct object, (stranded) indirect object and (stranded) adverbial RCs, which closely resemble each other in form. German-speaking children, in contrast, produced more errors with adverbial RCs than with both direct and indirect object RCs, in line with the fact that adverbial RCs in German are structurally more distinct from the other two types.

of examples. By comparing the different predictions that previous theoretical accounts have made about the degree of similarity between particular constructions (e.g., in the context of Goldberg's [2002] Surface Generalisation Hypothesis), it was suggested that additional empirical evidence is needed to adjudicate between the competing claims. Finally, Section 2.5 provided an overview of corpus-based and experimental methods that can be used to investigate similarity relations between argument structure constructions, and foreshadowed some of the reasons for why structural priming is used as the primary method in the present investigation.

Moreover, to prepare for the following empirical discussions, the preceding sections have outlined four theory-related research questions that can be addressed with a structural priming approach to similarity relations in the grammatical network. By way of summary, these questions are repeated here; they will guide the interpretation of the structural priming findings in Chapters 4 and 5.

- Q_T 1: Can structural priming provide evidence about the degree of similarity between argument structure constructions?
- Q_T 2: Can structural priming help determine at what level of schematicity speakers form constructional generalisations?
- Q_T 3: Does structural priming provide evidence that speakers encode different types of similarity relations? (for example, between constructions with similar function and constructions with similar form)
- Q_T 4: Can the structural priming evidence adjudicate between different theoretical accounts of particular similarity relations? (for example, between alternation-based views and Goldberg's [2002] Surface Generalisation Hypothesis)

Finally, Table 2.2 provides a summary of the specific constructions that were introduced in this chapter and that will be the subject of the following empirical investigations. The phenomena are grouped according to the type of similarity relation they illustrate; in each case, a reference is provided to their earlier theoretical discussion (as part

of Section 2.4), as well as to the later empirical section in which they will be re-examined in the light of structural priming evidence (in Chapters 4 and 5).

Table 2.2. Overview of the constructions examined in the present study

Type of similarity relation	Constructions (and examples)	Theoretical discussion	Structural priming evidence
Similar functions, different forms: constructional alternations (or allostructions)	<ul style="list-style-type: none"> ▪ Double-object (<i>The librarian gave the customer the book</i>) – to-dative (<i>The librarian gave the book to the customer</i>) 	Section 2.4.2	Section 4.2
Similar forms, (partially) different functions: constructional polysemy and homonymy	<ul style="list-style-type: none"> ▪ Transfer double-object (<i>The librarian gave the customer the book</i>) – benefactive double-object (<i>The students baked their teacher a cake</i>) ▪ Resultative (<i>Susan hammered the metal flat</i>) – object-oriented depictive (<i>Richard ate the steak raw</i>) 	Section 2.4.3	Sections 4.3 and 5.2
Partial similarities in form and function	<ul style="list-style-type: none"> ▪ to-dative (<i>The librarian gave the book to the customer</i>) – for-dative (<i>The students baked a cake for their teacher</i>) ▪ to-dative (<i>The librarian gave the book to the customer</i>) – (locative) caused-motion (<i>James rolled the ball down the hill</i>) 	Section 2.4.4	Section 4.3
A special case of functional similarity: metaphorical links	<ul style="list-style-type: none"> ▪ Caused-motion (<i>James rolled the ball down the hill</i>) – resultative (<i>Susan hammered the metal flat</i>) 	Section 2.4.5	Section 5.3

3 Structural priming: background, methods and applications

Having outlined the theoretical background of the present study, this chapter introduces the methodological tools required for the following empirical analyses. As noted in Chapter 1, structural priming has been previously discussed as a potentially rich source of evidence for cognitive-linguistic models of the grammatical network (e.g., Diessel 2019; Goldberg 2006; Perek 2015). These discussions have, however, been brief, and they have not included a detailed account of how priming effects can be measured and interpreted. To prepare for the in-depth analyses of the following chapters, the present chapter therefore provides a more comprehensive summary of structural priming, including its role as a similarity measure, the different methods that can be used to test priming, and some of the factors that modulate priming effects.

Section 3.1 introduces ‘structural’ priming besides other types of priming and discusses its use for the investigation of similarity relations between argument structure constructions. Section 3.2 presents evidence that structural priming is sensitive to both the functional and formal features of clause-level patterns, thus lending itself to the study of the form-meaning pairings or ‘constructions’ posited by cognitive-linguistic approaches. Section 3.3 gives an overview of different production and comprehension priming methods and illustrates that the choice of method depends on the type of similarity relation under investigation. Sections 3.4 to 3.6 outline three key distinctions for the interpretation of structural priming effects: the difference between within-construction and cross-constructional priming, between symmetric and asymmetric priming, and between facilitatory and inhibitory priming. Finally, Section 3.7 summarises the four methods-related research questions raised by these discussions, which will then guide the empirical analyses in Chapters 4 and 5.

3.1 Priming as a similarity measure

The term ‘priming’, usually attributed to Lashley (1951), refers to the psychological phenomenon whereby “processing a stimulus with particular characteristics affects subsequent processing of another stimulus with the same or related characteristics” (Branigan and Pickering 2017: 6). Priming effects have not only been observed in language: they also occur in non-linguistic domains such as perception – for instance, faster visual

recognition of objects that have been previously seen (see Kristjánsson and Campana [2010] for a review) – as well as social judgments and behaviours – for instance, the effects of advertisements on consumer choices (see Janiszewski and Wyer [2014] for a review). Within the sphere of language, several types of priming can be distinguished depending on what kind of linguistic unit is primed. One of the most widely studied effects concerns ‘semantic priming’ between the meanings of words (see Jones and Estes [2012] for a review). In their classic study, Meyer and Schvaneveldt (1971) found that after reading a word like *nurse*, participants were faster to respond to a semantically related lexeme such as *doctor*. Apart from their semantics, however, words can also be primed by stimuli that are phonologically similar (e.g., *dread* – *dress*; Slowiaczek et al. 1987), phonetically similar (e.g., *veer* – *bull*; Goldinger et al. 1989) or orthographically similar (e.g., *couch* – *touch*; Meyer et al. 1974). Finally, priming has been demonstrated for a range of pragmatic phenomena, such as scalar implicatures (Bott and Chemla 2016; Rees and Bott 2018).

When priming occurs among structures above the word level, i.e., between phrasal and clause-level units, it is known as ‘structural priming’ (or ‘syntactic priming’; but see Section 3.2 for reasons why the former term is preferred here). Since its emergence in the 1980s, structural priming has developed into an extensive paradigm, comprising hundreds of studies that use a range of experimental methods (see Section 3.3) to investigate a variety of linguistic structures across different languages (see Branigan and Pickering [2017]; Pickering and Ferreira [2008] for reviews of the structural priming literature). The following discussion introduces some key features of the paradigm while focusing in particular on the aspects that determine its synergy with the cognitive-linguistic models of the grammatical network outlined in Chapter 2.¹

Structural priming was first reported by Bock (1986), who found that participants were more likely to produce a double-object as opposed to a *to*-dative sentence, as well as an active as opposed to a passive sentence, after witnessing another instance of the same construction. Bock’s classic study made use of a picture description task which was disguised as a recognition memory task. In the initial study phase of the experiment, participants were asked to remember a series of sentences read out by the experimenter as well as a number of

¹ Structural priming effects have also been studied in corpus data (Gries 2005; Jaeger and Snider 2008; Szmrecsanyi 2006), including historical corpora (Smet and Van De Velde 2017). The focus in the present investigation, however, is on priming as an experimental paradigm.

pictures. In the test phase, participants first listened to the prime sentences read out by the experimenter and repeated them, for example the dative primes in (1) or the active/passive primes in (2). They were then shown target pictures depicting ‘transfer’ or simple transitive events, and were asked to describe the event in each picture. While their cover task was to decide whether they had already heard the sentences and seen the pictures in the study phase, the actual focus of the experiment was on the type of construction that they used to describe the target pictures. For the transfer events, Bock found that participants produced more double-object descriptions after hearing double-object primes than after *to*-dative primes (and vice versa for *to*-dative targets). The priming effects for active and passive sentences were smaller but also statistically significant.

- (1) a. *A rock star sold an undercover agent some cocaine.*
b. *A rock star sold some cocaine to an undercover agent.*

- (2) a. *One of the fans punched the referee.*
b. *The referee was punched by one of the fans.*

(all from Bock 1986)

Bock interpreted her findings as evidence that previous activation of a syntactic structure facilitates speakers’ subsequent use of the same structure. This repetition effect occurred even though there was little lexical-conceptual overlap between the prime and target sentences, which contained different subjects, verbs and objects (as well as a mix of animate and inanimate agents in the active and passive stimuli). In Bock’s view, this suggests that speakers’ utterances can be primed at a level of abstract syntactic structure that is (at least partially) independent from the lexical content of the individual sentence elements. This interpretation should be seen in the context of subsequent research, which has shown that structural priming taps not only into the syntactic but also into the semantic aspects of speakers’ representations (see Section 3.2 below), and that the effects are usually enhanced when primes and targets share additional lexical overlap (the ‘lexical boost’ effect; see Section 4.1.2). Nevertheless, Bock’s results provide strong evidence that structural priming can be used to probe the generalisations that speakers form over structurally similar sentences.

Following in Bock's footsteps, numerous subsequent studies have used structural priming to address a diverse set of questions about grammatical processing, acquisition and representation. One of these research strands has employed structural priming to inform theoretical and computational models of sentence processing, based on psychological mechanisms such as residual activation (Pickering and Branigan 1998) and error-based implicit learning (Chang et al. 2006; see below for further discussion). Other researchers have used the paradigm to assess whether different processing modalities involve similar or distinct mechanisms, for instance by comparing language production and comprehension (Bock et al. 2007; Segaert et al. 2013), or spoken and written production (Cleland and Pickering 2006). A third line of work relies on priming evidence to study the timeline and mechanisms underlying grammatical acquisition in children (Messenger et al. 2012; Rowland et al. 2012), adult second language speakers (Hartsuiker and Bernolet 2017) and bilinguals (Cai et al. 2011). A fourth research area focuses on the extent to which priming indexes individual differences in grammatical processing, for example due to age (Hardy et al. 2020) or the influence of language disorders such as agrammatic aphasia (Cho-Reyes et al. 2016). Finally, a fifth research interest concerns the social functions of priming, in particular with respect to promoting communicative alignment between interlocutors (Branigan et al. 2000; Branigan et al. 2007).

Besides these applications, structural priming has been used for another important purpose, namely to study the nature of speakers' grammatical representations. In their review article, Branigan and Pickering (2017: 17) argue that "[w]e have now reached the stage at which structural priming is a mature method that provides extensive evidence about representation". Crucially, as the researchers point out, priming can fulfil this purpose because it indexes similarity between linguistic units. In line with the above definition that priming occurs between stimuli with the same or related characteristics, it can be assumed that the stronger the observed priming effects between two structures, the more similar their representations within speakers' linguistic systems. By combining numerous pieces of evidence about such similarities between grammatical units, it may be possible to "inform a general theory of representation" (Branigan and Pickering 2017: 6).

To explain how structural priming can contribute to network models of grammatical representation, it first needs to be clarified why priming effects can be interpreted as indicators of representational similarity. According to the 'spreading activation' model of

grammatical processing (Collins and Loftus 1975; see Section 2.2.2), on encountering a prime stimulus, speakers not only activate the representation for the particular prime structure, but activation also spreads to neighbouring nodes in the grammatical network. The more similar, and thus the more strongly connected, another node is to the original representation, the more activation it receives. In line with the ‘residual activation’ account of structural priming (Pickering and Branigan 1998; Malhotra et al. 2008), these activation levels decay gradually over time, but if speakers encounter a target during this time window that instantiates the same or a similar representation as the prime, then the remaining activation by the prime may influence processing of the target.

In addition, ‘implicit learning’ accounts of priming (Bock and Griffin 2000; Chang et al. 2006) predict that repeated activation of a pattern not only brings about short-term changes in its activation level and that of similar units, but that priming also leads to long-term adjustments in the weights of the respective network links. This is supported by evidence that priming effects can persist when several experimental trials intervene between primes and targets (Bock and Griffin 2000; Hartsuiker et al. 2008). Priming can last even longer when participants witness multiple instances of the same construction and the effects are allowed to accumulate (Kaschak 2007), with priming being potentially detectable after as much as a week (Kaschak, Kutta and Schatschneider 2011). While the two types of accounts – residual activation and implicit learning – are sometimes regarded as competing explanations for priming effects (Jaeger and Snider 2013; Tooley 2020), they can potentially also be interpreted as complementary mechanisms (Branigan and McLean 2016; Reitter et al. 2011). This is in line with the cognitive-linguistic view that repeated short-term activation of grammatical patterns leads to their routinisation and automatising, resulting in increased levels of entrenchment within speakers’ long-term memory (Langacker 2016; Schmid 2020).

Having outlined why structural priming can provide evidence of constructional similarities, it is instructive to compare the paradigm with other experimental methods that also tap into these similarities, such as the sorting tasks and artificial language learning experiments discussed in Section 2.5. In particular, three advantages of priming over these alternative methodologies deserve to be highlighted here (based on Branigan and Pickering 2017: 6). First, priming provides implicit behavioural measures (e.g., production rates or reaction times) of processes that are assumed to be automatic, resource-free and unconscious. The methods are therefore not subject to the limitations of metalinguistic

sorting tasks, in which participants are asked to group similar sentences together according to some explicitly stated criterion. Compared with the latter, priming techniques reduce the risk of biasing participants via the specific wording of the instructions, or provoking their use of conscious response strategies.

Second, structural priming can be used to examine a wide scope of phenomena in varied speaker populations. In contrast to artificial language learning experiments, the paradigm can in principle be applied to any type of phrase- or clause-level pattern, from both naturally existing and artificial languages. Moreover, and contrary to most metalinguistic methods, priming experiments can be conducted with all speaker populations, including adults, young children and participants with language impairments.

Third, structural priming provides a more direct window into the real-time mechanisms underlying the spread of activation in speakers' grammatical networks during processes of language production and comprehension. Some priming methods provide genuine 'online' measures of these processes, for example by tracking participants' reaction times or eye movements during reading. Other methods, especially in production settings, rely on measures such as production rates, which are not fully 'online', but can still be interpreted as the immediate result of short-term activation patterns in speakers' mental networks. In contrast to the 'offline' methods reviewed in Section 2.5, priming thus enables researchers to study how similarity relations between speakers' grammatical representations affect their processing of single instances of the constructions. A pertinent question in this context, for example, concerns the conditions under which similarities between constructions may lead either to facilitation of speakers' processing (by boosting related representations) or to inhibition (by suppressing related representations; see Section 3.6 for a detailed discussion).

3.2 Sensitivity of priming to formal and functional similarities

Having discussed the potential of priming to serve as a measure of similarity between linguistic units, it can next be shown that structural priming is sensitive to both formal and functional similarities between clause-level constructions. In this way, structural priming findings are naturally compatible with the cognitive-linguistic models of the grammatical network outlined in Chapter 2, which posit a variety of formal and functional similarity links

between constructions. As argued below, psycholinguistic evidence from priming and theoretical network accounts can inform each other in fruitful ways.

As noted in Section 3.1, early structural priming researchers often attributed the effects to purely formal-syntactic overlap between primes and targets, irrespective of any semantic or other functional similarity between them. The paradigm was accordingly often referred to as ‘syntactic priming’ at the time. The syntax-centred view is illustrated by Bock’s (1986) interpretation of dative and active/passive priming in terms of ‘syntactic persistence’ (but see below for an alternative interpretation), and it also seemed to be supported by some further experimental results. A frequently cited piece of evidence comes from Bock and Loebell (1990), who found that participants’ passive productions were primed equally by passive sentences with a *by*-agent like (3a) and active intransitives with a locative *by*-phrase like (3b). This effect occurred despite the fact that the latter sentences are semantically clearly distinct from passives and only resemble them in their syntactic constituents. More recent evidence from Ziegler et al. (2019), however, casts doubt on an interpretation of this result in terms of abstract syntactic priming. They observed that passives are not primed by examples like (3c), which display the same syntactic structure but contain a different preposition. This suggests that the effect found by Bock and Loebell may have been caused by lexical repetition of the preposition *by* rather than by clause-level syntactic overlap (see also Konradt and Szendrői 2020 for a potential animacy-related confound in Bock and Loebell’s study).²

- (3) a. *The 747 was alerted by the airport’s control tower.*
b. *The 747 was landing by the airport’s control tower.*
(both from Bock and Loebell 1990)
c. *The 747 has landed near the airport control tower.*
(Ziegler et al. 2019)

While Bock and Loebell’s (1990) results may be subject to controversy, some further findings suggest that structural priming can sometimes be driven by formal-syntactic

² In addition, Bock and Loebell (1990) found that *to*-datives were primed by locative caused-motion sentences (e.g., *The wealthy widow drove an old Mercedes to the church*), even though the latter potentially differ from *to*-datives in their event structure. This result, along with conflicting evidence from other studies, will be discussed in Section 4.3.2.

similarities in the absence of functional-semantic factors. Konopka and Bock (2009), for example, found priming of verb-particle constructions (*pull off a sweatshirt* versus *pull a sweatshirt off*), and Hartsuiker and Westenberg (2000) observed priming of verb-auxiliary placement in Dutch subordinate clauses (*was geblokkeerd* versus *geblokkeerd was*). In each case, previous exposure to a construction facilitated subsequent use of the same construction over its alternative, even though the two alternatives are (presumably) semantically identical and only differ in their syntactic structure.

Contrary to these syntactic explanations, however, the last decades of priming research have brought to light considerable evidence that priming can also be caused by a variety of functional similarities between structures. These factors include thematic role structure (Chang et al. 2003; Hare and Goldberg 1999; Ziegler and Snedeker 2018), event structure (Bunger et al. 2013; Raffray et al. 2014; Ziegler et al. 2018), information structure (Bernolet et al. 2009; Vernice et al. 2012; Ziegler and Snedeker 2019) and animacy (Bock et al. 1992; Vasilyeva and Gámez 2015; Ziegler and Snedeker 2018). In light of this more recent evidence, the paradigm is now usually referred to as ‘structural priming’ (instead of ‘syntactic priming’), a label that is also consistently used here.

One of the earliest findings to suggest an influence of functional factors on priming comes from Hare and Goldberg’s (1999) study. They tested how often participants produced double-object sentences, as in (4a), or *to*-datives, as in (4b), after having been primed with the double-object construction, the *to*-dative, and what the authors refer to as the ‘*provide-with* construction’, illustrated in (4c) (also called the ‘theme-second fulfilling construction’; Ziegler and Snedeker 2018). The latter construction contains the same syntactic constituents as the *to*-dative (NP–V–NP–PP), but resembles the double-object construction in the order of its postverbal thematic roles (recipient–theme). The researchers found that after *provide-with* primes, speakers’ double-object productions increased at the same rate as after double-object primes, indicating that the effect was due to functional rather than formal similarity.

- (4) 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.*
(all from Hare and Goldberg 1999)

Besides indicating that both formal and functional similarities can lead to priming, recent evidence also suggests that a single priming effect can arise from a combination of several formal and functional factors (Bernolet et al. 2009; Vernice et al. 2012; see also Ziegler and Snedeker [2018] for discussion). As Ziegler et al. (2019) note, many classic findings, such as Bock's (1986) results for dative and active/passive priming (see Section 3.1), are in fact ambiguous with respect to what features of the respective constructions give rise to priming. Actives and passives differ not only in their syntactic structure, but also in their information-structural properties; similarly, double-object sentences and *to*-datives diverge not only in their syntax, but also in their information structure and the order of their thematic roles (see Section 2.4.2 for a detailed analysis). The respective studies can therefore not distinguish which of these factors, or which combination of them, is responsible for the fact that instances of each construction prime each other.

A more explicit piece of evidence that multiple formal and functional factors together can lead to 'additive' priming is provided by Ziegler et al. (2018).³ They found that regular double-object sentences (which the authors call 'compositional' datives), as in (5a), were not only primed by other compositional datives, but also by light verb double-object primes (5b) and idiomatic double-object primes (5c). The size of the priming effect, however, was larger for compositional double-object primes than for light verb and idiomatic primes. The authors attribute this to the fact that compositional double-object sentences resemble each other in their syntactic, thematic and event structure, and thus prime each other strongly along these three dimensions. Light verb and idiomatic double-object sentences, on the other hand, yield weaker priming because they only share their syntactic structure with compositional double-object sentences, and differ from them in terms of their thematic roles (with a single patient argument after the verb, rather than a recipient–theme sequence) and event structure (or constructional meaning: X ACT ON Y rather than X CAUSE Y TO HAVE Z).

- (5) a. *The grandmother gives the baby a toy.*
b. *The boy gives the girl a hug.*

³ Ziegler et al. (2018) also adopt the term 'cumulative priming' to describe priming effects that depend on multiple factors. This label is avoided here, though, because 'cumulative' is also used in a different sense in the literature to describe increased priming effects after exposure to multiple primes of the same type (e.g., Kaschak, Kutta and Jones 2011; see Section 3.1).

c. *The boss gives his employee the boot.*

(all from Ziegler et al. 2018)

Given that structural priming can be caused by both formal and functional characteristics of the respective structures, and that it may often be determined by a combination of several of these features, the paradigm appears highly compatible with the cognitive-linguistic models of the grammatical network outlined in Chapter 2. Crucially, structural priming effects support the cognitive-linguistic core tenet that grammar consists of a network of interrelated constructions which comprise not only formal, but also a variety of functional characteristics. In line with this, Branigan and Pickering (2017) list Construction Grammar and the Parallel Architecture, two of the approaches discussed in Chapter 2, among the frameworks that they regard as compatible with the priming evidence.⁴ In their view, the same evidence is more difficult to reconcile with frameworks that restrict grammar to a set of syntactic procedures, some of them potentially situated at ‘hidden’ structural levels, and divorced from semantics: “Overall, the findings from structural priming do not support mainstream generative grammar. Our account is more compatible with a broad range of alternative frameworks that eschew syntactocentrism [...] and in which syntactic structure is shallow” (p. 14).

As a result, structural priming can serve as an important empirical tool to test formal and/or functional similarity links between constructions in the grammatical network. This will be illustrated in detail by the analyses in Chapters 4 and 5, which make use of priming evidence to address the theoretical claims about related argument structure constructions introduced in Chapter 2.

3.3 Methods and target phenomena in structural priming

Having discussed the potential of priming to inform cognitive-linguistic models of the grammatical network, this section provides an overview of the most commonly used methods in structural priming experiments. In addition, it illustrates that the choice of the experimental

⁴ Branigan and Pickering (2017: 17–18, note 10) express some reservations towards Construction Grammar accounts based on “the evidence that priming seems unaffected by whether prime and target involve the same construction (form-meaning pairing) or not”. This view rests on the findings of Bock and Loebell (1990) and others discussed at the beginning of this section. As was outlined above, however, the evidence for syntax-only priming seems weaker than previously assumed, while there is at the same time considerable support for the view that constructions can be primed along a variety of functional dimensions.

method crucially determines the type of constructions that can be investigated. This helps explain why previous studies, especially the ones testing priming in production, have focused on a limited set of argument structure constructions. Finally, the question is raised of how the paradigm can be extended to other types of argument structure constructions, in particular by using the potential of comprehension priming methods.

An overview of production and comprehension priming methods is provided in Table 3.1, along with a summary of the target phenomena to which these techniques are typically applied. The respective characteristics of each method will be discussed in the following.

Table 3.1. Overview of priming methods and the construction types to which they are typically applied

Method	Typical target phenomena
Production methods	
Picture description	Alternating constructions
Sentence completion (spoken or written)	Alternating constructions
Sentence recall	Alternating constructions
Scrambled sentence task (= sentence generation)	Alternating constructions
Comprehension methods	
Visual world eye-tracking	Alternating constructions
Sentence-picture matching	Fully ambiguous instances of functionally distinct constructions
Self-paced reading (incl. the 'maze task' – see Chapter 5)	Temporarily ambiguous instances of functionally distinct constructions
Eye-tracking during reading	Temporarily ambiguous instances of functionally distinct constructions
Acceptability judgments	Marginally acceptable constructions (of any type)

Starting with the production methods, Mahowald et al.'s (2016) meta-analysis of production priming studies indicates that the most commonly used techniques are picture description (used in 72% of the reviewed experimental conditions) and sentence completion (27%). The picture description task was already introduced in Section 3.1 when discussing Bock's (1986) original structural priming study. It has since been employed in numerous other experiments (e.g., Bock et al. 2007; Hartsuiker and Kolk 1998), occasionally with animated videos instead of pictures (Ziegler and Snedeker 2018). In the task, participants are exposed

to a prime sentence before describing a target picture (or video animation) depicting an event that can be expressed with two alternative constructions, such as the double-object and the *to*-dative example in (6).

- (6) a. *The man passed the lady the cup.*
b. *The man passed the cup to the lady.*
(both from Ziegler and Snedeker 2018)

The primary outcome measure in picture description experiments is a categorical variable encoding which of the two target constructions participants produce. By comparing the proportions of target productions after different types of primes, researchers can assess the size of the priming effect. Only a few studies (e.g., Segaert et al. 2011) have obtained response latencies as an additional outcome measure, i.e., the time that passes until participants start producing their target utterances. Sometimes, picture description experiments are disguised as recognition memory tasks (Bock 1986), in which the alleged purpose of the description is only to help participants decide whether they have already seen the picture in a previous training phase. Alternatively, the task can be embedded in a communicative context, for example by using Branigan et al.'s (2000) 'confederate-scripting' technique: participants play a game with the experimenter's confederate in which the players take turns describing the target pictures and selecting the cards that match their interlocutor's descriptions.⁵

The sentence completion task (e.g., Cleland and Pickering 2006; Pickering and Branigan 1998), which can be conducted either in the spoken or written modality, is another commonly used production method. In this task, participants read or hear sentence fragments and complete them into full sentences. While the prime fragments are strongly biased towards a particular construction (e.g., *The driver showed the mechanic...*, which induces a double-object completion), the target fragments are constructed such that they can be completed with either of the two alternative structures (e.g., *The patient showed ...*, which can be completed either as a double-object or a *to*-dative sentence). As with the picture

⁵ In addition to the behavioural outcome measures discussed here, a few picture description studies have also recorded changes in brain activity levels as an indicator of priming, for example using functional magnetic resonance imaging (fMRI; e.g., Segaert et al. 2013).

description task, the outcome measure consists of participants' choice between the two target constructions (see Corley and Scheepers [2002] for the additional measure of production latencies).

Another production method that features in some of the experiments that will be discussed in Chapter 4 is sentence recall (e.g., Chang et al. 2003; Potter and Lombardi 1998). In one version of this task, participants first read a prime and a target sentence presented word by word in rapid succession, then complete a numerical distractor task and finally repeat the target sentence from memory. The outcome measure is how often participants recall the target sentence in its original structure (e.g., double-object), compared to how often they 'misrecall' it with the alternative structure (e.g., *to*-dative). A final, though less frequently used, production method is the scrambled sentence task (also called 'sentence generation'; Lev-Ari 2016; Pappert and Pechmann 2013). In this task, participants are first exposed to the primes and then presented with a series of target words in scrambled order. As participants assemble the words into complete target sentences, they have to choose between two alternative constructions (e.g., double-object and *to*-dative).

Surveying the four production methods discussed here, it is evident that they all follow a similar logic: participants describe an event (or recall an event description) that can be expressed with two alternative structures, to (roughly) equally felicitous effect. The primary outcome measure is which of the two target constructions speakers produce. Naturally, all of these methods therefore lend themselves to the investigation of alternating constructions, i.e., constructions that are (presumably) functionally similar but differ in form (see Section 2.4.2). Compare Branigan and Pickering (2017: 7), who note that production priming methods usually "rely on the existence of structural alternatives" and cannot be applied to constructions that differ in function and thus encode distinct events.

Given that the majority of structural priming studies to date have employed one of the above production methods (while comprehension experiments have been a more recent addition; see below) and that all of these production methods rely on alternating target constructions, it is no surprise that the existing experimental evidence predominantly concerns constructional alternations. Previously studied phenomena encompass not only argument structure alternations, but also alternating constructions in other grammatical domains. A non-exhaustive list of such phenomena includes: clause-level information structure constructions, for example actives versus passives (Bock 1986; see Section 3.1);

noun-phrase internal structures, for instance *s*-genitives versus *of*-genitives (Bernolet et al. 2012); complex sentences, for example object-raising verbs with infinitive complements versus *that*-complements (e.g., *The police suspected Joan to be the criminal / suspected that Joan was the criminal*; Griffin and Weinstein-Tull 2003); and other construction types, such as verb + gerund + noun phrase versus coerced verb + noun phrase structures (e.g., *The celebrity began drinking the champagne / began the champagne*; Raffray et al. 2014), and verb-particle constructions (e.g., *The jogger pulled off his sweatshirt / pulled his sweatshirt off*; Konopka and Bock 2009).

With respect to argument structure constructions, the above characteristics of production priming methods explain why previous investigations have largely focused on the relatively small set of alternating constructions among them. In particular, the literature has been dominated by studies of the dative alternation, which has been investigated in English (e.g., Bock 1986; Pickering and Branigan 1998; Thothathiri and Snedeker 2008) and other languages such as Dutch (Hartsuiker and Kolk 1998), German (Pappert and Pechmann 2013) and Mandarin (Cai et al. 2012). In Mahowald et al.'s (2016) meta-analysis of production priming studies, the dative constructions feature in a total of 217 (63%) out of the 343 reviewed experimental conditions, which notably include all construction types, not just argument structure constructions (a further 22% of conditions instantiate the active/passive alternation, the second most commonly investigated phenomenon).

Other alternating argument structure constructions have been tested much less frequently, with only a few studies existing for each of the following alternations: the benefactive alternation (Bock 1989; Chang et al. 2003; Ziegler and Snedeker 2018), illustrated by the experimental stimuli in (7); the locative alternation (Chang et al. 2003; Yi and Koenig 2016; Ziegler and Snedeker 2018), illustrated in (8); the 'fulfilling' alternation (Cho-Reyes et al. 2016; Hare and Goldberg 1999; Ziegler and Snedeker 2018), exemplified in (9); and the 'unspecified object' alternation (Miller and Deevy 2006; van Gompel et al. 2006; van Gompel et al. 2012), as in (10). Experimental results from several of these studies will be reviewed in Chapter 4, focusing on the two alternations that were highlighted in the theoretical discussions of Chapter 2: the dative alternation and the benefactive alternation (in addition, the locative alternation will be addressed in Section 4.1.1).

- (7) a. *The secretary was baking her boss a cake.*
b. *The secretary was baking a cake for her boss.*
(both from Bock 1989)

- (8) a. *The farmer heaped straw onto the wagon.*
b. *The farmer heaped the wagon with straw.*
(both from Chang et al. 2003)

- (9) a. *The boy presented the trophy to the athlete.*
b. *The boy presented the athlete with the trophy.*
(both from Ziegler and Snedeker 2018)

- (10) a. *The panda's eating a leaf.*
b. *The panda's eating.*
(both from Miller and Deevy 2006)

The production methods discussed so far can be contrasted with comprehension priming methods. As will be shown in the following, these comprehension methods are not limited to the investigation of alternating constructions. They may thus offer more flexible ways of investigating a wider range of constructions, including the non-alternating constructions that will be the focus of Chapter 5. While structural priming in comprehension has been studied less frequently than in production, the last two decades have seen a growing body of research that employs a range of comprehension methods, as illustrated in the bottom part of Table 3.1 (see also Tooley and Traxler [2010] for a review of comprehension priming). Moreover, cross-modality comparisons suggest that priming effects in production and comprehension may be of comparable magnitude (Segaert et al. 2013; Tooley and Bock 2014). Commenting on this trend, Branigan and Pickering (2017: 17) predict that “priming in comprehension is likely to become a technique of similar importance to priming in production”, even though they also observe that the comprehension priming literature faces a number of open questions. As argued below, one of these questions is whether comprehension priming methods, which have so far been largely applied to phenomena other than argument structure constructions, can also be used to test network relations between the latter.

The first comprehension method to be reviewed here, an eye-tracking paradigm known as the ‘visual world’ paradigm (e.g., Arai et al. 2007; Ziegler and Snedeker 2019), follows a similar logic to the production techniques described above, and is therefore also usually applied to alternating constructions. In visual world experiments, participants listen to the prime and target sentences while seeing a visual display that contains the animate or inanimate entities mentioned in those sentences. Participants’ anticipatory eye movements towards a specific entity, for instance towards the recipient or the theme entity in a depiction of a transfer event, can be taken as indicators of whether they were expecting a double-object or a *to*-dative structure in the target sentence. The proportion of participants’ gazes to either visual item therefore provides a similar outcome measure to the proportion of structure choices measured in production experiments.

Other comprehension priming methods, however, do not rely on alternating target structures and can therefore be used to investigate non-alternating constructions. For example, the sentence-picture matching task (e.g., Branigan et al. 2005; Nitschke et al. 2014) is typically applied to structurally ambiguous sentences such as the example in (11), in which the prepositional phrase can either be interpreted as part of the verb phrase (‘high attachment’) or as a modifier of the noun (‘low attachment’), or the German example in (12), which is ambiguous between a subject and an object relative clause interpretation. Rather than constituting alternating constructions with similar function and distinct forms, each of these phenomena illustrates two constructions that are semantically distinct but can sometimes be realised with a single, perfectly ambiguous sentence (due to syntactic overlap or case syncretism). In sentence-picture matching experiments, participants select between two pictures that instantiate the alternative interpretations of the ambiguous target sentences. The question of interest is whether participants’ choices are affected by previous exposure to prime sentences that unambiguously instantiate either of the two constructions.

(11) *The policeman is prodding the doctor with the gun.*

(Branigan et al. 2005; without *is* in the original experiment)

(12) *Hier ist die Ballerina, die_[Subj/Obj] das Mädchen erschreckt.*

‘Here is the ballerina that scares the girl / that the girl scares.’ (Nitschke et al. 2014)

Two further methods are self-paced reading (e.g., Myslín and Levy 2016; Wells et al. 2009) and eye-tracking during reading (e.g., Tooley et al. 2019; Traxler and Tooley 2008), which have been employed in similar ways to investigate yet another type of phenomenon, namely functionally distinct constructions that are only temporarily ambiguous. Previously studied phenomena include, for instance, the contrast between active main clauses and reduced passive relative clauses illustrated in (13), which are ambiguous until the post-verbal phrase is reached, and the contrast between transitive sentences with direct objects and transitive main clauses with clausal complements, as in (14), which remain ambiguous until after the first post-verbal noun. These examples illustrate so-called ‘garden-path’ phenomena in which a temporary ambiguity between two structures can lead to the misinterpretation of the less frequent structure (e.g., reduced relative clauses). In self-paced reading experiments, participants read the target sentences word by word at their own speed, while the researchers measure their reading times. In eye-tracking studies, participants are presented with the whole sentences and researchers record their eye movements (using measures such as gaze duration or the proportion of participants’ regressive eye movements). The focus of the methods is on whether speakers’ reading times or gaze durations at the critical disambiguating regions are speeded up or slowed down by previous exposure to the same or the alternative construction.⁶

- (13) a. *The defendant examined the glove but was unreliable.*
b. *The defendant examined by the lawyer was unreliable.*
(both from Traxler and Tooley 2008)

- (14) a. *She had forgotten the procedure during her month of vacation.*
b. *She had forgotten the procedure had called for adding water.*
(both from Myslín and Levy 2016)

⁶ As noted for the production methods above, a few comprehension priming studies have additionally obtained brain-related measures besides the behavioural responses. For example, priming effects can be detected via changes in brain activity levels during reading tasks, as indicated by event-related potentials (ERP; e.g., Ledoux et al. 2007) or functional magnetic resonance imaging (fMRI; e.g., Weber and Indefrey 2009).

A final, though less common, comprehension priming method uses acceptability (or grammaticality) judgments (e.g., Luka and Barsalou 2005; Zervakis and Mazuka 2013). The logic of the method makes it less suitable for studying fully conventional constructions; instead, it is usually applied to marginally acceptable constructions (of any type), such as the ones illustrated in (15) and (16). In the experiments, participants are typically exposed to a series of marginally acceptable primes, and are then asked to rate structurally similar target sentences. Priming is expected to manifest itself via higher acceptability ratings for the previously witnessed constructions. It should be noted, however, that due to their metalinguistic nature, judgment tasks differ from the indirect observational methods discussed above, and that their interpretation in terms of implicit unconscious priming is more controversial (see Zervakis and Mazuka 2013 for discussion).

(15) *We hate to bake pies anymore.*

(16) *From the CIA, I assure you that I would never accept a penny.*

(both from Luka and Barsalou 2005)

As the above examples show, comprehension methods can be used to investigate priming between non-alternating constructions, but they have so far been hardly applied to non-alternating argument structure constructions. A central question for the present investigation is therefore whether comprehension methods can be extended to such constructions, which are otherwise difficult to test in production for the reasons discussed above. Several non-alternating argument structure constructions were introduced in Chapter 2: the resultative construction in (17a), the object-oriented depictive construction in (17b), and the caused-motion construction in (17c). These three constructions have so far not been investigated systematically with the help of structural priming (see Chapter 5 for a discussion of the limited evidence from previous studies).

(17) a. *Susan hammered the metal flat.*

b. *Richard ate the steak raw.*

c. *James rolled the ball down the hill.*

The question of how structural priming can be extended to previously understudied constructions like the ones above therefore forms a first methodological concern that will be addressed by the experimental investigations in the following chapters. More succinctly, this methods-related question (Q_M) can be stated as:

Q_M 1: Which methods can be used to study structural priming between non-alternating argument structure constructions?

This question will be addressed in Chapter 5, which reports three priming experiments that test similarity relations between the resultative, depictive and caused-motion construction. In particular, the experiments explore to what extent these constructions can be studied with the help of self-paced reading, which as noted above has previously been mainly applied to garden-path phenomena in complex sentences. It will be argued that the applicability of the method can be extended by using a more engaging version of self-paced reading known as the ‘maze task’ (Forster et al. 2009). In this task, participants do not merely read sentences word by word, but at each step they have to choose between a word that correctly continues the sentence and an incorrect distractor word (see Section 5.1 for a detailed description of the method).

3.4 Within-construction and cross-constructional priming

Having introduced the main methods used in structural priming experiments, the remainder of this chapter will outline three further methodological distinctions that are crucial for interpreting priming effects. The first of these is the difference between *within-construction* and *cross-constructional* priming. The term ‘within-construction priming’ (see also Wittenberg 2016: 55) is used here to describe priming effects between instances of the same construction. Examples of within-construction priming come from the classic effects observed by Bock (1986) that double-object primes increased speakers’ productions of double-object targets (compared to *to*-dative primes), and that passive primes increased speakers’ productions of passive targets (compared to active primes; see Section 3.1). Besides Bock’s experiments, numerous other studies have investigated within-construction priming effects: for example, all 69 studies reviewed in Mahowald et al.’s (2016) meta-analysis of

production priming studies reported priming between primes and targets that instantiated the same construction.

Figure 3.1 provides a simple schematic representation of the within-construction priming effects that have emerged in these studies. Typically, experiments of this kind use the *same* pair of constructions as both primes and targets (e.g., the two dative constructions). This contrasts with some cross-constructural priming studies in which primes and targets instantiate different sets of constructions (see below). As Figure 3.1 shows, within-construction priming effects are expected to emerge between primes and targets of the same type (i.e., $A \rightarrow A$ and $B \rightarrow B$), even though the two effects are not necessarily equally strong (see the discussion of asymmetric priming in Section 3.5).

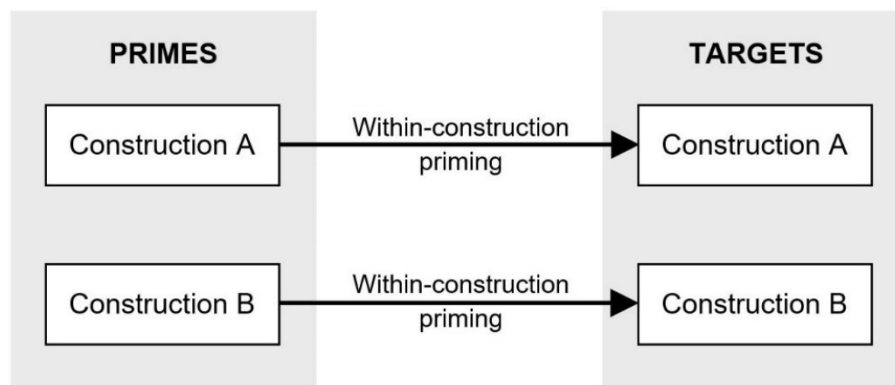


Figure 3.1. Potential within-construction priming effects in experiments that use the same constructions as primes and targets

Within-construction priming effects can be naturally accommodated within a cognitive-linguistic view of grammar as a network of similarity relations, as outlined in Chapter 2. From the perspective of this model, within-construction effects reflect intra-categorical similarity relations that speakers encode among instances of a single construction. Section 4.1 will discuss in more detail what the previous evidence from within-construction priming among argument structure constructions reveals about the structure of the grammatical network.

In contrast to within-construction priming, some other experiments have tested priming between instances of different constructions. A few examples of this type were discussed in Section 3.2: they include Bock and Loebell's (1990) result (albeit controversial) that active intransitives with a locative adverbial primed passives, Hare and Goldberg's (1999)

finding that *provide-with* sentences primed double-object targets, and Ziegler et al.'s (2018) result that light verb double-object sentences primed regular double-object targets. These effects can be referred to as 'cross-constructural priming' (Perek 2015; Wittenberg 2016), alternatively called 'cross-structural priming' (Loncke et al. 2011; Ziegler and Snedeker 2018).⁷

Compared with the extensive evidence for within-construction priming, it appears that cross-constructural priming has been tested less frequently, that the evidence from the respective studies has been less systematically reviewed, and that cross-constructural effects across different phenomena have not yet been integrated into an overall interpretative framework. This is illustrated, for example, by the fact that Mahowald et al.'s (2016) meta-analysis of production priming studies excludes experiments that tested cross-constructural priming. No data is therefore available about the average size of cross-constructural effects, their consistency across different constructions, and the factors that may modulate the effects. Moreover, none of the well-known structural priming reviews (e.g., Branigan and Pickering 2017; Pickering and Ferreira 2008) use the term 'cross-constructural' or 'cross-structural' priming, and the distinction between within-construction and cross-constructural priming plays no major role in them. In addition, these reviews do not address the methodological challenge of distinguishing between within-construction and cross-constructural effects when they both potentially occur in the same experiment (see below).

From a theoretical perspective, however, cross-constructural priming effects constitute a central source of evidence for the cognitive-linguistic model of the grammatical network outlined in Chapter 2. This model predicts not only that instances of the same construction are (highly) similar to each other, but also that different constructions are related by a multitude of similarity links of varying strength. In this context, cross-constructural priming effects can be taken to reflect *inter-categorical* similarity relations between distinct constructions (as opposed to the *intra-categorical* similarities indexed by within-construction priming). Studying cross-constructural priming effects between a variety of constructions offers an opportunity to test previous theoretical claims about the nature

⁷ The distinction between within-construction and cross-constructural priming resembles Szmrecsanyi's (2006) distinction between 'α-persistence' and 'β-persistence' in the context of his corpus study. α-persistence refers to speakers' increased likelihood to use a pattern after previous exposure to the *same* pattern (e.g., increased use of analytic comparatives like *more friendly* over synthetic comparatives like *friendlier* after exposure to analytic comparatives). In contrast, β-persistence denotes increased use of a pattern following an instance of a *distinct but similar* pattern (e.g., increased use of analytic comparatives after any other instance of *more* that does not express comparison, such as *it was developed more*).

and the degree of the similarities that hold the grammatical network together (see the four theory-related questions outlined in Chapter 2). For this reason, most of the analyses in Chapters 4 and 5 will focus on how cross-constructional priming effects can be identified and integrated (together with within-construction priming effects) into a cognitively oriented network account of grammar.

As a first step towards a more systematic examination of cross-constructional priming effects, it is important to note that these effects can arise in two different types of experimental design. In the first and more straightforward type, cross-constructional effects emerge between primes and targets that instantiate *different* sets of constructions. This is schematically represented in Figure 3.2, which illustrates the potential priming effects that may arise between two prime constructions A and B and two distinct target constructions C and D (i.e., $A \rightarrow C$ and $B \rightarrow D$). In most experiments of this kind, the constructions are chosen such that primes of type A are expected to be more similar to targets of type C, and primes of type B are expected to be more similar to targets of type D.⁸

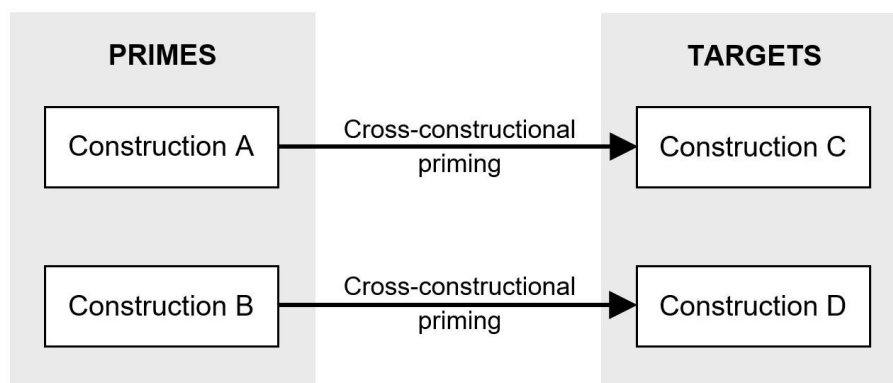


Figure 3.2. Potential cross-constructional priming effects in experiments that use different constructions as primes and targets

This type of study design is illustrated, for example, by Bock's (1989) study, which will be discussed in detail in Section 4.3.1. In her experiments, the author tested whether the two

⁸ It is possible that experiments of the type illustrated in Figure 3.2 give rise to additional cross-constructional priming effects (e.g., $A \rightarrow D$ or $B \rightarrow C$). In this case, it could be difficult to isolate the different effects because they might cancel each other out: for instance, if construction A primed constructions C and D equally strongly, then the relative proportions of the two target types may remain constant (since structure choice proportions are complementary). For most of the experiments examined in Chapter 4, this is unlikely because each prime construction is expected to be more similar to one target type than to the other. But see Section 4.2.3 for an example in which a single prime construction (the shifted *to*-dative) gives rise to multiple cross-constructional effects (which are distinguished with the help of a specific analysis technique).

members of the benefactive alternation – the benefactive double-object construction and the *for*-dative – prime the two members of the dative alternation – the transfer double-object construction and the *to*-dative (see Sections 2.4.3 and 2.4.4 for a theoretical analysis of the constructions). The same logic, though it may be less apparent, is also applied in experiments like the one by Hare and Goldberg (1999) discussed in Section 3.2. In their study, the researchers tested the influence of three prime constructions – double-object sentences, *to*-datives and *provide-with* sentences – on speakers’ dative productions. Crucially, the target pictures were chosen such that they could not be described with the *provide-with* construction. As far as this construction was concerned, it therefore only occurred as a prime, but not as a target in the experiment. As a result, any effect it had on the targets was necessarily cross-constructional. Generally, it is thus relatively straightforward to identify cross-constructional priming effects when primes and targets instantiate different sets of constructions.

The second type of study design in which cross-constructional priming can occur is the same as the one discussed above for within-construction priming effects. Note that when the primes and targets instantiate the *same* set of constructions, cross-constructional effects can potentially emerge in addition to the within-construction effects. This is represented in Figure 3.3, which constitutes an extension of the earlier Figure 3.1. Assuming that the two constructions A and B share some aspect of their representation, within-construction priming ($A \rightarrow A$ and $B \rightarrow B$) and cross-constructional priming ($A \rightarrow B$ and $B \rightarrow A$) may occur in parallel.

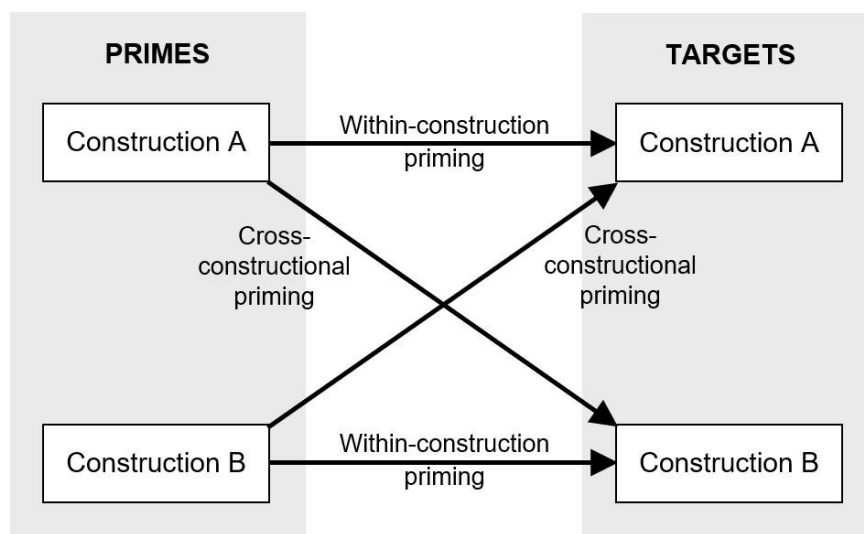


Figure 3.3. Potential effects of within-construction *and* cross-constructional priming in experiments that use the same constructions as primes and targets

This second type of design in which cross-constructural priming may occur is illustrated by the numerous studies that have tested the effect of two alternating prime constructions (e.g., the double-object and the *to*-dative construction) on speakers' productions of the same two patterns. As argued for Bock's (1986) classic study above, the results of these experiments are usually interpreted in terms of within-construction priming between the instances of the same construction. However, under the view that alternating constructions are functionally similar, it is possible that in addition to the within-construction effects, secondary cross-constructural priming effects arise between the two alternating constructions (i.e., from double-object primes to *to*-dative targets, and from *to*-dative primes to double-object targets). These effects are, however, likely to be weaker than the within-construction priming effects because the similarity among instances of the same construction should be higher than among instances of related constructions (see Section 2.3.3).

Given that within-construction and cross-constructural priming effects would overlap in this kind of design, it can be challenging to distinguish between the two, and especially to identify the potentially weaker cross-constructural effects. This is particularly the case with experiments that yield structure choice proportions as their outcome measure (which, as outlined in Section 3.3, applies to most production priming methods). The reasons for this will be discussed in detail in Section 4.2, but the general idea is that due to the complementary nature of proportions (i.e., they always add up to 100%), an increase in the proportion of one target construction always leads to a decrease in the proportion of the other target construction. As a result, no matter whether prime construction A in Figure 3.3 gives rise to within-construction priming only, or to both stronger within-construction priming and weaker cross-constructural priming, the observable outcome would be the same: the proportion of target construction A would increase, and the proportion of target construction B would decrease. Under these circumstances, it seems impossible to identify whether or not cross-constructural priming occurred.

A second methods-related question for the following empirical analyses is therefore how cross-constructural priming effects can be isolated in cases in which they overlap with effects of within-construction priming:

Q_M 2: How can within-construction and cross-constructural priming be distinguished when they co-occur in the same experiment?

In response to this question, Section 4.2 will outline a potential strategy for identifying cross-constructural effects even when the primes and targets instantiate the same set of constructions and the outcome measure consists of complementary structure choice proportions. Moreover, it will be shown in Chapter 5 how the above challenge can be altogether avoided by employing comprehension priming methods that yield mutually independent outcomes, such as response times.

3.5 Symmetric and asymmetric priming

Another relevant distinction for the empirical analyses in the following chapters is the difference between *symmetric* and *asymmetric* priming. This distinction has been applied to both within-construction and cross-constructural priming effects, though in different ways. In the context of within-construction priming, the term ‘symmetric’ priming can be used to refer to a scenario in which two constructions give rise to (roughly) equal degrees of within-construction priming in the same experiment. ‘Asymmetric’ priming, on the other hand, denotes a situation in which priming among instances of one construction is larger than priming among instances of the other construction (see, e.g., Ferreira [2003] for this use of the terms). Alternatively, the same difference can be expressed with Pickering et al.’s (2002) terms ‘balanced’ versus ‘biased’ priming. Asymmetric, or biased, priming in this sense has been observed, for instance, for actives and passives: passives tend to prime other passives more strongly than actives prime other actives (Bernolet et al. 2009; Bock 1986; Segaert et al. 2016).

One common explanation for this type of asymmetry is based on the frequencies of the respective patterns. In particular, the *inverse frequency effect* (Ferreira 2003; Scheepers 2003; also called ‘inverse preference effect’; Ferreira and Bock 2006) describes the observation that the less frequent structure usually gives rise to stronger priming than the more frequent structure. This effect is consistent with the above example of actives and passives (given that passives are much less frequent than actives) as well as with other findings, such as Hartsuiker and Westenberg’s (2000) result that priming among Dutch subordinate clauses with the less frequent participle-auxiliary order is stronger than among sentences with the more frequent auxiliary-participle order. A natural explanation for the inverse frequency effect is provided by implicit learning accounts of priming (Chang et al. 2006; Jaeger and Snider 2013; see also Section 3.1). These models assume that priming effects

arise as a result of expectation adaptation: on encountering a prime, speakers update the weights of the connections in their mental networks. Since a less frequent prime construction is less expected to occur, it should give rise to a larger prediction error and thus result in larger changes among the connection weights between the network units. As a consequence, the less frequent a prime, the stronger should be its effect on speakers' subsequent productions.⁹

Asymmetric, or biased, effects of within-construction priming have also been observed among argument structure constructions, especially for the two dative constructions. Section 4.1.3 will examine the evidence that previous studies have provided about differences in the magnitude of priming among double-object sentences and among *to*-datives. It will address the extent to which these findings can be accounted for by the inverse frequency effect, and what insights they provide about the structure of the grammatical network.

Moving on to cross-constructional priming, the distinction between symmetric and asymmetric priming has a somewhat different meaning in this context. Here it refers to the directionality of priming: 'symmetric' priming can be said to occur when priming from one construction to another is equally strong as in the opposite direction; while 'asymmetric' priming occurs when one construction primes another more strongly than vice versa (see, e.g., Hilpert and Correia Saavedra [2018] for this usage). Given that cross-constructional priming has been tested less frequently than within-construction priming (see Section 3.4), little evidence is available about the symmetry of cross-constructional effects, as well as potential explanations for it. In principle, the inverse frequency effect may apply to cross-constructional relations too: a less frequent construction may prime a more frequent one more strongly than the other way round. To date, however, it appears that such a frequency-based asymmetry in cross-constructional priming has not yet been demonstrated.

Besides frequency, other factors could influence the directionality of priming between constructions. For example, Section 2.4.5 outlined the claim that the caused-motion and the resultative construction may be metaphorically related. On this view, the conceptual

⁹ See Huettig et al. (2021) for an activation-based account of the inverse frequency effect, based on the assumption that the resting activation level of linguistic units increases asymptotically with rising frequency. Since high-frequency items already have a high resting activation, they are less boosted by exposure to additional primes, while low-frequency items have a lower resting activation and thus receive a more substantial boost. Also note the suggestion made above in Section 3.1 that activation-based and implicit learning accounts may be more compatible than is sometimes assumed.

asymmetry between the ‘change of location’ semantics of the metaphorical source and the ‘change of state’ semantics of the metaphorical target may lead to stronger priming from the former construction to the latter than vice versa. Together, these considerations about the potential role of frequency and other explanatory factors give rise to a third methods-related question to be addressed in the following chapters:

Q_M 3: What factors determine the symmetry of cross-constructural priming effects?

The role of frequency and other explanatory factors will be discussed in Section 5.2, which reports experiments that provide evidence of asymmetric priming between resultatives and depictives. Meanwhile, the influence of a potential metaphorical asymmetry will be addressed in Section 5.3 with respect to priming between the resultative and the caused-motion construction. It will also be briefly discussed in Section 4.3.1 with respect to priming between the transfer and the benefactive double-object construction.

3.6 Facilitatory and inhibitory priming

A final aspect that plays a role in the analysis of priming effects is the distinction between *facilitatory* and *inhibitory* priming. The concepts of ‘facilitation’ and ‘inhibition’ have been used with varying meanings in the psychological literature to characterise, among other things, patterns of neural activation, physical responses, cognitive mechanisms or social behaviours (see MacLeod [2007] for a discussion of the different uses of ‘inhibition’). In the priming literature, the terms are typically used to describe changes in participants’ behavioural responses to the target stimuli. In this sense, facilitation can be said to occur when previous exposure to a prime stimulus enhances participants’ subsequent target response, while inhibition occurs when the prime impedes participants’ target response.

In studies of lexical priming (i.e., priming effects at the word level), both facilitatory and inhibitory priming effects have been frequently reported. For example, facilitation has been observed when prime and target words are semantically related (e.g., *nurse* – *doctor*; Meyer and Schvaneveldt 1971) or phonologically similar (e.g., *dread* – *dress*; Slowiaczek et al. 1987). Depending on the task type, facilitatory effects manifest themselves, for instance, as a speed-up of participants’ responses when recognising words, or an increase in accuracy when naming pictures. Inhibition, on the other hand, has been found when primes and targets are

phonetically similar (e.g., *veer* – *bull*; Goldinger et al. 1989) or orthographically but not phonologically similar (e.g., *couch* – *touch*; Meyer et al. 1974). Conversely to facilitation, inhibitory effects may be reflected by a slowdown in response time or a decrease in accuracy. Interestingly, inhibition has also sometimes been observed when primes and targets are semantically related (e.g., *bag* – *sack*; Schriefers et al. 1990); see below for further discussion.

In structural priming, on the other hand, the distinction between facilitation and inhibition has played a much lesser role than in lexical priming research. Commentators have noted that “structural priming studies have focused so far on facilitatory effects” (Branigan and Pickering 2017: 17, note 2) and that “[i]nhibitory effects have seldom been reported” (Pietsch et al. 2012: 29). In production experiments, facilitation is usually diagnosed via an increase in target productions of a certain type (e.g., double-object targets) after prime instances of the same construction (e.g., double-object primes). In comprehension experiments, facilitation can manifest itself in a variety of ways depending on the outcome measure: in self-paced reading experiments, for instance, it is typically reflected by a speed-up in reading time. For inhibitory effects, on the other hand, previous studies have left unclear how these effects would manifest themselves in structural priming, and whether they should occur at all. In the following, a possible explanation will therefore be proposed for why inhibitory priming has not been observed in previous structural priming experiments, and under what conditions inhibition may nevertheless be expected to emerge.

The central suggestion is that whether priming manifests itself as facilitation or inhibition depends on the nature of the experimental task and the specific processes implicated by that task. Consider again the seemingly conflicting findings from lexical priming above: while semantically related words facilitated each other in Meyer and Schvaneveldt’s (1971) experiment, they inhibited each other in Schriefers et al.’s (1990) study. The two experiments, however, used distinct methods which entailed different task demands. In Meyer and Schvaneveldt’s lexical decision task, participants saw two words on the same screen and judged whether they were real words or not. Participants were thus expecting two distinct words and their task was merely to recognise them both. Under these conditions, it seems plausible that a word like *nurse* would facilitate a semantically related word like *doctor* because the two are not competing with each other. In contrast, in Schriefers et al.’s (1990) picture naming study, participants heard a word like *bag* and were then asked to name a picture of a related but different object, such as ‘sack’. In this type of task, participants may

temporarily consider the pre-activated prime word (*bag*) as a possible label for the target picture, due to their conceptual similarity. Once participants realise that a more accurate label (*sack*) is available for the target, they reject the prime word in favour of the new candidate. As argued by Schiefers et al., this temporary competition (or ‘semantic interference’) between the two related lexemes would explain why priming emerged as inhibition (see also Berg and Schade 1992; Luce et al. 2000).

In structural priming, too, the specifics of the experimental design may determine whether priming manifests itself as facilitation or inhibition. As noted in Section 3.3, the majority of experiments so far have used production priming techniques like picture description or sentence completion to test priming among alternating constructions (e.g., the double-object and the *to*-dative construction). In this type of setting, participants are likely to make increased use of the target construction that is identical with the prime construction (in the case of within-construction priming) or at least similar to the prime construction (in the case of cross-constructural priming). The effects are thus naturally expected to be facilitatory, which explains why previous studies have predominantly reported facilitatory priming. More examples of such facilitatory effects will be provided in Chapter 5, which focuses exclusively on production priming studies.¹⁰

The question remains whether structural priming can manifest itself as inhibition in other types of experimental tasks. In fact, there are a few hints in the literature suggesting that inhibitory priming may emerge in certain comprehension settings. One such piece of evidence comes from Traxler’s (2008) eye-tracking study, in which participants’ eye movements were recorded while they read garden-path sentences like (18), in which the first prepositional phrase is a modifier of the preceding noun while the second prepositional phrase encodes a locative goal. Participants were primed either with ‘modifier-goal’ sentences of the same type, as in (19a), or with simpler ‘goal-only’ clauses that contain only one locative prepositional phrase, as in (19b). The primes thus instantiated two temporarily

¹⁰ It could potentially be argued that a decrease in the proportion of the *alternative* target construction in production priming studies (e.g., a decrease in *to*-dative productions after double-object primes) reflects inhibitory priming. This is, however, questionable given the complementary nature of structure choice proportions, i.e., the fact that an increase in the proportion of one target type automatically leads to a decrease in the proportion of the other target type (see Section 3.4). As a result, processing of the alternative construction may appear to be ‘inhibited’ relative to the prime construction; but it may be unaffected compared with a neutral baseline situation in which participants are not primed. This explains why previous researchers have interpreted effects in production priming as facilitatory only.

ambiguous constructions; some other priming studies with a similar design were mentioned in Section 3.3.

(18) *The vendor tossed the peanuts in the box into the crowd during the game.*

(19) a. *The girl tossed the blanket on the bed into the laundry this morning.*

b. *The girl tossed the blanket into the laundry this morning.*

(all from Traxler 2008)

Among other things, Traxler compared participants' target responses at the critical disambiguating region (*into the crowd*) after modifier-goal primes, goal-only primes, and unrelated primes (as a baseline). He found that participants processed the targets faster after modifier-goal primes like (19a) than in the baseline; at the same time, he found that participants' responses were *slower* after goal-only primes like (19b) than in the baseline. This means that the experiment yielded both facilitatory and inhibitory priming, even though Traxler did not explicitly discuss the latter and instead focused on the facilitatory effect.

The fact that participants' processing of modifier-goal sentences was inhibited after goal-only primes receives a natural explanation by considering what processes are implicated by the reading task. On reading a prime sentence like (19b), participants' representation of the goal-only construction is activated, thus increasing their likelihood to interpret the first prepositional phrase of subsequent sentences as a locative goal. When participants then encounter a modifier-goal target like (18), the first half of the sentence matches participants' expectation and thus reinforces it (due to the temporary ambiguity between modifier-goal and goal-only sentences). Once participants reach the disambiguating region, however, they have to suddenly revise their initial interpretation of the sentence. The cost of this reanalysis is higher the more strongly the incorrect goal-only interpretation has been previously activated. This explains why participants' responses are slowed down after goal-only primes compared with the other conditions.

While this offers a potential account of how inhibition could occur in structural priming, the conclusions rely on sparse previous evidence and should be corroborated with additional findings. This is particularly relevant given that few other comprehension studies have used the same design as in Traxler's (2008) study above, thus providing the conditions

in which inhibitory priming could emerge. Further questions remain about how facilitatory and inhibitory effects can be interpreted in the context of similarity relations between constructions; and how they relate to the distinction between within-construction and cross-constructional priming outlined in Section 3.4. Together, these questions form a final methods-related concern for the following empirical chapters:

Q_M 4: Under what conditions does priming manifest itself as facilitation and inhibition, and how can the effects be interpreted?

This question will be primarily discussed in Chapter 5, which reports a series of comprehension priming experiments in which both facilitatory and inhibitory effects could potentially emerge. In particular, Section 5.3 will discuss the implications of an experiment that reflects inhibitory priming between the caused-motion and the resultative construction.

3.7 Summary: four methods-related questions for a structural priming approach to the grammatical network

This chapter has outlined the methodological preliminaries for the use of structural priming to investigate similarity relations in the grammatical network. Section 3.1 introduced ‘structural’ priming alongside other types of priming, explained why priming effects can be interpreted as indices of representational similarity, and discussed the advantages of structural priming over alternative experimental methods. Section 3.2 presented evidence that structural priming, contrary to early syntax-centred interpretations of the effects, is also sensitive to a variety of functional similarities between clause-level constructions. Recent findings suggest that the effects may often be driven by a combination of several formal and functional factors, thus lending themselves to an analysis in terms of the multidimensional similarity links posited by cognitive-linguistic network models. Section 3.3. gave an overview of commonly used production and comprehension priming methods, explaining how the characteristics of the method constrain the type of constructions (and constructional similarities) that can be investigated with them.

Sections 3.4 to 3.6 then outlined three important distinctions for the interpretation of structural priming effects. Section 3.4 introduced the difference between within-construction priming (between instances of the same construction) and cross-constructional priming

(between instances of different but related constructions). It was argued that cross-constructional priming effects have so far been analysed less systematically and that within-construction and cross-constructional effects can be difficult to distinguish when the two effects co-occur together. Section 3.5 outlined the distinction between symmetric and asymmetric priming, applying the terms both to within-construction priming (where two constructions can prime themselves to the same or different degrees) and to cross-constructional priming (where priming in the two directions can be equally strong or differ in strength). The inverse-frequency effect (i.e., stronger priming by the less frequent construction) was discussed as one possible explanation for asymmetric priming, even though the role of other factors still needs to be explored. Finally, Section 3.6 contrasted facilitatory with inhibitory priming, noting that the latter effects have seldom been reported in the structural priming literature. Despite this fact, it was suggested that inhibitory cross-constructional effects may occur under certain experimental condition (e.g., in comprehension priming experiments that test temporarily ambiguous targets), and that the effects can be fruitfully related to inhibitory effects in lexical priming.

Over the course of the chapter, the discussions have also highlighted several open research questions regarding the design, analysis and interpretation of structural priming experiments. By way of summary, these four methods-related questions are repeated below. Together with the four theory-related questions outlined in Chapter 2, they will guide the empirical analyses in the following Chapters 4 and 5.

Q_M 1: Which methods can be used to study structural priming between non-alternating argument structure constructions?

Q_M 2: How can within-construction and cross-constructional priming be distinguished when they co-occur in the same experiment?

Q_M 3: What factors determine the symmetry of cross-constructional priming effects?

Q_M 4: Under what conditions does priming manifest itself as facilitation and inhibition, and how can the effects be interpreted?

4 Priming evidence of similarity relations among alternating constructions: a reinterpretation

This chapter comprises the first half of the empirical analyses in the present investigation. It provides novel interpretations of previous structural priming studies in the context of a cognitive-linguistic network model of grammar. The focus is on priming among the instances of alternating constructions, which have so far been the dominant type of argument structure constructions examined in priming experiments (primarily for methodological reasons, as discussed in Section 3.3). By interpreting the priming effects as reflexes of similarity relations between speakers' grammatical representations, the experimental evidence is used to address the four open theory-related questions about the organisation of the grammatical network raised in Chapter 2. Moreover, the discussions touch on some of the methodological questions outlined in Chapter 3, especially with respect to how within-construction and cross-constructural priming can be distinguished when they co-occur in the same experiment (Q_M 2). Both the theory- and methods-related questions will be further discussed in Chapter 5, which extends structural priming to a previously understudied group of non-alternating constructions.

The present chapter provides an innovative perspective on the existing priming evidence, both from a conceptual and methodological angle. On the conceptual side, the analysis extends the focus beyond within-construction priming, which has received much attention in the literature, and provides a synthesis of findings from cross-constructural priming, which has been less systematically studied (see the discussion in Section 3.4). It is shown how a cognitive-linguistic view of grammar as a network of similarity relations can provide an integrative framework for interpreting priming effects between a variety of argument structure constructions. At the same time, it is examined to what extent the priming evidence can adjudicate between previous theoretical claims about the structure of the grammatical network. On the methodological side, several innovative analysis techniques are employed to derive new interpretations of the existing data. This includes the consistent use of baseline comparisons in order to identify the sources of priming (see Section 4.1.3 and the rest of the chapter); and a new way of analysing the proportions of 'other' targets in order to identify subtle effects of cross-constructural priming (see Section 4.2.2).

The chapter is organised as follows: Section 4.1 presents evidence from within-construction priming that speakers represent argument structure constructions simultaneously at different levels of abstraction in the grammatical network, including both abstract constructional schemas and verb-specific representations. Given the evidence that constructional schemas are psychologically plausible, Section 4.2 and Section 4.3 shift the focus to similarity relations between different abstract constructions, as reflected by cross-constructional priming. Section 4.2 addresses priming between the members of a single argument structure alternation, relating it to previous theoretical claims about the functional similarity between these constructions. Section 4.3 discusses priming between the members of different alternations, whose degree of formal and functional overlap is a matter of debate. Section 4.4 summarises the results of the analysis and highlights some remaining theoretical and methodological questions.

4.1 Within-construction priming at multiple levels of abstraction

As outlined in Chapter 2, grammarians have traditionally assumed that speakers' knowledge of argument structure constructions consists to a large extent of abstract constructional schemas such as the double-object construction or the *to*-dative. More recently, however, a number of cognitive linguists have expressed doubt that these schematic representations are psychologically real and have instead proposed that speakers may form salient generalisations at lower levels of schematicity, for example in the form of verb(-class)-specific constructions (see Section 2.3.3 for discussion). Of course, abstract schemas and lexically specific representations do not mutually exclude each other but could instead co-exist (Goldberg 2006). As illustrated in the network model proposed in Section 2.3.3, abstract constructions may emerge from lower-level similarities, for instance among their verb-specific subtypes, in the same way in which these verb-specific representations emerge from the similarities among their instances. In addition, the model predicts that the similarities at these different levels of abstraction vary in strength: more specifically, the similarities among instances of a verb-specific pattern are likely to be stronger than among instances of an abstract construction.

This section discusses to what extent previous results from within-construction priming, i.e., among instances of the same construction, support the above claims about the organisation of the grammatical network. Section 4.1.1 focuses on priming effects that

support the existence of abstract argument structure constructions, while Section 4.1.2 addresses the evidence for additional verb-specific representations. Section 4.1.3 examines the role of frequency in determining the strength of within-construction priming effects. It is shown that all these effects can be naturally accounted for within a network model of grammar in which speakers form generalisations at different levels of abstraction as a result of their previous linguistic experience. The focus of the following discussions is therefore on the first two theory-related research questions outlined in Chapter 2: whether structural priming provides evidence about the degree of similarity between constructions (Q_T 1), and whether it can help determine at what level of schematicity speakers form generalisations (Q_T 2).

4.1.1 Priming of abstract constructional schemas

The question of whether speakers form abstract constructional schemas that generalise over sentences with distinct lexical content has been of central concern in the structural priming literature. As argued in Section 3.1, it was already in Bock's (1986) original study that the author interpreted her findings as evidence that speakers store abstract syntactic structures, independent of the lexical elements that comprise them. Since then, numerous scholars have argued that priming provides key evidence for the existence of abstract structural representations (Bock and Loebell 1990; Branigan and Pickering 2017; Chang et al. 2006; Pickering and Ferreira 2008; Rowland et al. 2012).

To understand how structural priming reflects the existence of abstract constructional schemas, consider again the double-object and *to*-dative examples in (1) and (2) from Bock's (1986) Experiment 1. The sentences in (1) are examples of the primes that participants heard; the sentences in (2) are typical targets that participants produced in their picture descriptions. Critically, the prime and target sentences differed in all their contentful lexical elements, including the subject noun, object nouns and, most critically, the verb as the major determinant of the event conveyed by the sentence. Eliminating this 'lexical overlap' between primes and targets, as it is usually termed in the priming literature, is a necessary precondition for isolating the effect of functional and formal similarities at the level of the abstract clause-level construction. In addition, Bock tried to minimise other sources of prime-target similarity, such as rhythmic or intonational overlap, or the possibility of establishing co-reference between the arguments in the prime and target sentences.

- (1) a. *A rock star sold an undercover agent some cocaine.*
 b. *A rock star sold some cocaine to an undercover agent.*
- (2) a. *The man is reading the boy a story.*
 b. *The man is reading a story to the boy.*
 (all from Bock 1986)

The results of Bock’s experiment are summarised in Table 4.1.¹ Despite the absence of lexical overlap, Bock found that after hearing double-object primes as opposed to *to*-dative primes, participants produced double-object targets for an additional 35% of stimuli (72% vs. 37%).

Table 4.1. Results from Bock (1986: Experiment 1)

Prime type	Proportion of target productions	
	Double-object	<i>to</i> -dative
Double-object	72%	28%
<i>to</i> -dative	37%	63%

Alternatively, the size of this priming effect can be expressed via the odds ratio, which is calculated by dividing the odds of producing one target type (e.g., double-object) instead of the other target type (e.g., *to*-dative) after prime instances of the same construction (double-object) by the odds of producing the same target types after prime instances of the alternative construction (*to*-dative). An odds ratio of 1 means that the odds for the target productions were exactly the same in both prime conditions. In Bock’s experiment, the odds ratio can be computed as $(72\% / 28\%) / (37\% / 63\%)$; note that the complementary calculation $(63\% / 37\%) / (72\% / 28\%)$ yields the same result. The priming effect in the experiment thus

¹ The results in Table 4.1 are based only on the members of the dative alternation, excluding Bock’s (1986) additional data for the members of the benefactive alternation. Moreover, the results are presented in a slightly different way than in the original article in order to make them more comparable with other priming studies. While Bock reported the proportions of double-object and *to*-dative targets out of *all* target productions (i.e., including ‘other’ responses), Table 4.1 only provides binary proportions of each target construction among all *dative* productions. Recalculating Bock’s results in this way is justified since the proportion of ‘other’ responses remained constant across the prime conditions (see Section 4.2 for cases in which ‘other’ proportions vary between conditions).

corresponded to an odds ratio of 4.3, meaning that the odds of participants producing a target construction were 4.3 times greater when they had been primed with the same construction rather than with the alternative construction.² One advantage of the odds ratio is that it makes it easier to compare the strength of priming effects across different studies. In this section, the odds ratio is therefore used as the preferred measure of effect size whenever studies provide structure choice proportions as their outcomes.

Bock's results suggest that on encountering a double-object or a *to*-dative prime, not only do speakers activate a representation for the specific prime sentence, but activation also spreads to similar units in their mental networks. The fact that subsequent productions of other double-object and *to*-dative sentences that share no lexical overlap with the primes are facilitated suggests that speakers encode similarity relations between instances of the same abstract construction. As argued in Chapter 2, these similarity relations are what underlies the theoretical notion of an abstract constructional schema. Within-construction priming effects of the type observed by Bock thus lend support to the existence of abstract argument structure constructions in speakers' grammatical networks.

Bock's findings have been replicated in numerous other studies with the double-object and *to*-dative construction (which, as mentioned in Section 3.3, have dominated the priming literature). As far as production priming is concerned, an overview of the relevant results is provided by Mahowald et al.'s (2016) meta-analysis, which includes 32 production studies that tested priming among the dative constructions in the absence of lexical overlap. Despite the fact that these studies used a range of different designs and methods, the large majority of them report statistically significant effects of within-construction priming. According to Mahowald et al.'s analysis, the average size of the priming effects in their sample corresponds to a weighted mean odds ratio of 1.67 (the mean ratio is 'weighted' because studies with a smaller standard error counted more strongly towards the estimate). Even though this also includes experiments with other constructions, studies of the dative alternation make up 63% of the sample, so the result can be taken as a rough approximation for the size of abstract within-construction priming among the dative constructions. While the average priming effect in Mahowald et al.'s sample is thus smaller than in Bock's (1986)

² The odds ratio is calculated based on the exact values reported by Bock (1986), not based on the rounded values displayed in Table 4.1. This explains slight discrepancies in the size of the odds ratios. The same applies to the other odds ratios presented in the remainder of this chapter.

original study (compare the odds ratio of 4.3 from above), the meta-analysis nevertheless suggests that within-construction priming occurs consistently among the two dative constructions across a large number of studies. The lower average effect size in Mahowald et al.'s meta-analysis may be partly due to methodological differences: for example, the authors report a marginally significant trend suggesting that priming effects in written sentence completion experiments are generally smaller than in picture description studies.

Comprehension priming studies, too, have provided evidence of abstract within-construction priming among the dative constructions, even though the findings are less clear-cut. Some early studies failed to detect abstract priming in comprehension, obtaining statistically significant effects only in conditions in which primes and targets contained the same verb (Arai et al. 2007; Branigan et al. 2005; Traxler et al. 2014). Other studies, however, have since provided considerable evidence that abstract priming without verb overlap can also be observed in comprehension (Giavazzi et al. 2018; Kim et al. 2014; Thothathiri and Snedeker 2008). See Ziegler and Snedeker (2019) for a possible explanation of these differences in terms of the task demands imposed by the study designs.

Besides the two dative constructions, abstract within-construction effects have also been reported for some other argument structure constructions, even though considerably fewer studies exist for these phenomena. One case that has yielded a number of interesting findings concerns the two locative constructions in (3) and (4), which are usually regarded as members of the 'locative alternation' (see Section 2.4.2).³

- (3) a. *The maid rubbed polish onto the table.* (theme-first locative)
b. *The maid rubbed the table with polish.* (theme-second locative)
- (4) a. *The farmer heaped straw onto the wagon.*
b. *The farmer heaped the wagon with straw.*
- (all from Chang et al. 2003)

³ Besides this example, abstract within-construction priming has also been demonstrated for the members of the 'unspecified object' alternation (e.g., *The panda's eating a leaf* versus *The panda's eating*; Miller and Deevy 2006). Both children and adults tend to increase their use of the transitive or the intransitive pattern after primes of the same type in the absence of lexical overlap (see also van Gompel et al. 2006: Experiment 3; van Gompel et al. 2012: Experiment 1).

Using a sentence recall task (see Section 3.3 for an explanation of the method), Chang et al. (2003: Experiment 1) found that when participants had just recalled a theme-first locative prime as in (3a), they were subsequently more likely to *misrecall* a theme-second locative sentence like (4b), remembering it instead in its theme-first locative form (4a). The same effect occurred in the other direction: participants were more likely to misrecall a theme-first target as a theme-second sentence after having been primed with the theme-second locative construction. The change in the proportion of misrecall was relatively small (4.2%) but statistically significant.⁴ This effect can be interpreted as evidence of abstract within-construction priming: not only did the prime and target sentences differ in their lexical material, but the researchers additionally tried to use semantically dissimilar verbs (e.g. *rub – heap*, or *spray – engrave*) in the same prime-target pair.

Other studies have broadly confirmed Chang et al.’s results, even though with some interesting caveats. Yi and Koenig (2016: Experiment 3 and 4) used the same method – sentence recall – but they additionally distinguished trials in which the prime and target verbs were semantically highly similar (but non-identical, e.g., *smear – spread*) and trials that contained less similar prime and target verbs (e.g., *smear – load*). In their study, they found statistically significant within-construction priming effects only in the high-similarity condition (11.4% priming by theme-first locatives and 5.2% by theme-second locatives) but not in the low-similarity condition. This could suggest that speakers do not perceive *any* two instances of the same locative construction as similar, and therefore do not store fully abstract schemas for each construction. Rather, the fact that priming only emerges when instances of the same construction display some additional semantic similarity between their verbs could indicate that speakers store multiple subschemas at slightly lower levels of abstraction. This interpretation remains, however, tentative given that Yi and Koenig’s results conflict with Chang et al.’s (2003) findings discussed above, who found statistically significant priming even when primes and targets contained dissimilar verbs (note, however, that Chang et al. judged the similarity between their verbs intuitively, while Yi and Koenig determined their similarity

⁴ Note that the odds ratio is not a suitable measure of effect size for sentence recall data because it is possible that participants *never* misrecall the targets when they are preceded by prime instances of the same construction. Dividing by a proportion of 0% would make the odds ratio incalculable. As a result, only raw percentages are reported for sentence recall results here as well as in the remainder of the chapter. Also note that Mahowald et al. (2016) excluded sentence recall studies from their meta-analysis and thus avoided this issue when calculating their odds ratios.

scores via Latent Semantic Analysis and the results of a judgment study). Considering that priming effects in sentence recall tasks are often quite small, it is possible that Yi and Koenig's study was simply unable to detect the more subtle effects of within-construction priming that may have occurred in the low-similarity condition. Nevertheless, their findings provide evidence that abstract priming effects can be strengthened by some additional similarity between the prime and target sentences, a phenomenon that resembles the way in which priming effects can be enhanced by lexical overlap (see Section 4.1.2 for discussion, and Section 4.1.3 for a synthesis of the findings).

Finally, Ziegler and Snedeker (2018: Experiment 2) observed effects of abstract within-construction priming among the two locative constructions in an event description task (which used video animations rather than pictures). Using similar prime sentences as Chang et al. (2003), the researchers found that participants' productions of a locative construction increased by 20% (odds ratio 2.9) when they had been primed with an instance of the same rather than the alternative construction. In their Experiment 3, however, the authors paired target pictures in which both the theme and the location consisted of inanimate noun phrases (evoking descriptions similar to the examples in (3) and (4)), with primes that contained inanimate themes but animate locations (or 'destinations'), such as *the man* in (5).

- (5) a. *The boy sprayed the man with the cologne.*
b. *The boy sprayed the cologne on the man.*
(both from Ziegler and Snedeker 2018)

When primes and targets differed in the animacy of their location arguments, Ziegler and Snedeker found that priming was reduced to only 8% (odds ratio 1.6), even though the effect was still statistically significant. This means that abstract priming in the absence of animacy overlap was weaker than priming with animacy overlap. Similar to Yi and Koenig's (2016) results above, this suggests that speakers are sensitive to additional similarities between primes and targets, such as the animacy of their arguments, which may not be encoded as part of the abstract constructional schemas. These additional similarities at lower levels of abstraction can give rise to enhanced priming effects such as the one observed by Ziegler and Snedeker (see also Bock et al. [1992] for further animacy-related effects in structural priming).

4.1.2 Priming of verb-specific representations

The previous section summarised the evidence that instances of the same pattern that do not display any lexical overlap can prime each other at the level of the abstract construction. Beyond that, however, many studies have reported that priming effects are larger when prime and target sentences share lexical material – in particular, when they contain the same verbs. This enhancement of priming in the presence of lexical overlap is commonly known as the ‘lexical boost’ effect; even though recently, some researchers have started to use other terms such as ‘lexically mediated priming’ (Tooley et al. 2019) or ‘lexicalised priming’ (Ziegler and Snedeker 2019). As will be outlined in the following, these effects provide potential evidence that in addition to the similarities that underlie their representations of abstract constructional categories, speakers encode additional, even stronger similarity relations among instances of the same verb-specific patterns (or ‘subconstructions’).

The lexical boost was first reported by Pickering and Branigan (1998) in a series of sentence completion experiments. In their Experiment 1, participants were primed with sentence fragments like the ones in (6), which were biased towards either a double-object completion, as in (6a) and (6c), or a *to*-dative completion, as in (6b) and (6d). Participants then completed target fragments like (7), which are compatible with both constructions. Critically, half the primes, such as (6a) and (6b), contained the same verb as the target, whereas the other half, such as (6c) and (6d), used different verbs.

- (6) a. *The racing driver showed the helpful mechanic ...*
b. *The racing driver showed the torn overall ...*
c. *The racing driver gave the helpful mechanic ...*
d. *The racing driver gave the torn overall ...*

(7) *The patient showed ...*

(all from Pickering and Branigan 1998)

Pickering and Branigan found that in trials with verb overlap, participants produced the same construction as in the prime for an additional 25% of stimuli (odds ratio 2.8).⁵ In trials without verb overlap, on the other hand, speakers reproduced the prime construction only for an additional 7% of targets (odds ratio 1.3), an effect that did not reach statistical significance in the authors' by-participants analysis. Statistically reliable effects of within-construction priming without lexical overlap only emerged when each target was preceded by two primes of the same type, as Pickering and Branigan demonstrated in their Experiment 2.

Together, the results from Pickering and Branigan's Experiments 1 and 2 suggest that both verb-specific and abstract within-construction priming can occur in a similar experimental setting, but that the former effects are stronger and potentially more robust than the latter. Pickering and Branigan account for this phenomenon with a simple network model in which on encountering a sentence, speakers activate both a verb-specific 'lemma node' and a 'combinatorial node' that is linked to the lemma node and represents the abstract construction. The authors attribute the lexical boost effect to the fact that in trials with verb overlap, speakers activate a lemma node and a combinatorial node on processing the prime; the residual activation of both these nodes then jointly facilitates speakers' productions of the same construction for the targets. In trials without verb overlap, on the other hand, only the residual activation of the abstract combinatorial node facilitates speakers' productions of the same target construction, since prime and target activate different lemma nodes.

This explanation appears at least partially compatible with the network model outlined in Section 2.3.3, which treats both verb-specific and abstract constructional representations as emergent structures that arise from the similarity relations among their instances. This model, too, predicts stronger priming among instances of the same verb-specific pattern, which are assumed to be connected by stronger similarity relations, than among instances of the same abstract construction without lexical overlap, which are expected to share fewer similarities. One advantage of this model over Pickering and Branigan's (1998) account may be that the former regards the nodes in the network merely as notational devices that constitute 'summary' representations of similarities at a lower level

⁵ As above for Bock (1986), the non-binary proportions out of *all* target productions reported by Pickering and Branigan (1998) were recalculated as binary proportions out of all *dative* targets. This is justified because the proportions of 'other' targets were nearly constant across prime conditions.

of schematicity. The abstract constructional nodes therefore have no psychological reality independently from the verb-specific nodes; instead, they are 'immanent' in the similarity relations among all their verb-specific subtypes (see Section 2.3.3). Pickering and Branigan's model, on the other hand, stipulates different types of nodes, including lemma nodes, 'combinatorial' nodes and additional nodes for lexical categories and morphological features. The model leaves open the nature of the cognitive process that creates these nodes, and the question of whether they are stored as discrete and fully independent mental units or as partially overlapping structures.

Apart from Pickering and Branigan's (1998) findings, lexical boost effects have been demonstrated in numerous other studies; for argument structure constructions, the majority of the evidence comes from studies of the dative alternation (e.g., Hartsuiker et al. 2008; Kaschak 2007; Pickering et al. 2002).⁶ According to Mahowald et al.'s (2016) meta-analysis of production priming studies, the average within-construction priming effect with lexical overlap corresponds to a weighted mean odds ratio of 3.26. As pointed out in Section 4.1.1, this estimate includes phenomena other than argument structure constructions, but given that dative studies make up the majority of the sample (63%), the result can be used as a rough approximation in the present context. This effect of verb-specific priming is considerably larger than the average effect of abstract priming discussed in Section 4.1.1, where the odds ratio was only 1.67. With the help of a regression model, Mahowald et al. confirm the impression that the enhancing effect of the lexical boost is actually stronger than the effect of abstract priming itself.

As outlined above, at least one possible interpretation of lexical boost effects is that speakers encode stronger similarity relations among instances of the same verb-specific pattern than among instances of the same abstract construction. Nevertheless, it is important to note that the mechanisms that give rise to the lexical boost continue to be debated (Branigan and McLean 2016; Tooley 2020; Tooley et al. 2019). For example, some researchers have raised the possibility that, rather than reflecting the structure of speakers' grammatical knowledge within their long-term memory, lexical boost effects may simply arise from

⁶ Besides the dative alternation, van Gompel et al. (2012: Experiment 1) report a lexical boost effect among the members of the 'unspecified object' (or transitive/intransitive) alternation (*The ambulance driver and the policewoman were following* versus *The ambulance driver was following the policewoman*). Within-construction priming was stronger in trials with verb overlap than in trials without verb overlap.

speakers' explicit short-term memory of the prime sentence, which is triggered again when they encounter the same verb in the target sentence (Bernolet et al. 2016; Chang et al. 2006). This account is supported by evidence that lexical boost effects tend to be short-lived, decaying quickly when prime and target are separated by intervening trials, while abstract priming effects can persist over several trials and even across experimental sessions (Branigan and McLean 2016; Hartsuiker et al. 2008; Kaschak, Kutta and Schatschneider 2011; but see Coyle and Kaschak [2008]; Pickering et al. [2013] for longer-lasting lexical boosts). If the explicit memory account is correct, lexical boost effects may not be informative about the more 'stable' structural aspects of speakers' grammatical networks. However, some doubt about the explicit memory view is raised by Yan et al.'s (2018) finding that aphasic speakers whose explicit short-term memory is impaired still display the lexical boost effect (see also Kutta et al. [2017] for further counter-evidence).

In contrast to the explicit memory account, other views relate both the short-lived lexical boost and longer-lasting effects of abstract priming to speakers' stored grammatical representations. Tooley (2020), for instance, proposes a dual-mechanism account according to which the lexical boost results from the short-term activation of nodes and links in speakers' grammatical networks (as in Pickering and Branigan's [1998] model discussed above), while persistent abstract priming relies on an implicit learning mechanism (see Section 3.1). Under this view, lexical boost effects are indeed informative about speakers' grammatical representations, and in particular about the way in which activation spreads between interlinked units in the network. This account thus seems more compatible with the above interpretations of priming effects (both abstract and verb-specific) in terms of similarity relations between speakers' constructional representations.

4.1.3 Frequency-based differences in the degree of priming

The previous two sections have summarised the evidence that speakers' use of alternating argument structure constructions increases after prime instances of the same construction compared with instances of the alternative construction, both in the presence and absence of lexical overlap. One limitation of the discussion so far, however, has been that these analyses do not reveal whether the within-construction priming effects are driven equally by *both* alternating patterns, or whether one pattern primes more strongly than the other. As outlined in Section 3.5, there is evidence of asymmetric priming (or 'biased' priming;

Pickering et al. 2002) among other constructions, such as actives and passives, where one pattern gives rise to stronger priming than the other. These asymmetries, it was noted, often display the inverse frequency effect (Ferreira and Bock 2006), according to which the less frequent construction primes more strongly.

In order to distinguish the individual contributions of two prime constructions in an experiment, it is crucial to compare them with a neutral baseline condition. In most studies, this baseline consists of a prime construction that is presumably unrelated to either target construction. For example, Bock’s (1986) Experiment 1 included a baseline of intransitive primes, which are presumably unrelated to the two dative constructions. The results in this baseline condition are shown in Table 4.2, which provides an extended version of the earlier Table 4.1.

Table 4.2. Results from Bock (1986: Experiment 1), including the baseline condition

Prime type	Proportion of target productions	
	Double-object	<i>to</i> -dative
Double-object	72%	28%
<i>to</i> -dative	37%	63%
Intransitive (baseline)	47%	53%

Table 4.2 indicates that compared with the baseline condition, both double-object primes and *to*-dative primes gave rise to within-construction priming. However, the data also suggest that the 25% priming among double-object sentences (odds ratio 2.8) was larger than the 10% priming among *to*-datives (odds ratio 1.5).⁷ These differences should be treated with some caution given that Bock did not test them for statistical significance, but they provide a tentative indication that asymmetric priming occurred in her study.

As this example shows, the inclusion of a neutral baseline condition is crucial for identifying which prime construction(s) drive(s) a given priming effect. As a result, baseline comparisons will be used again and again in the remainder of this investigation. Even though

⁷ In contrast to the previous sections, the odds ratios are here calculated relative to the baseline rather than relative to the alternative construction. I.e., they are computed by dividing the odds of producing one target type instead of the other target type after prime instances of the same construction by the odds of producing the same target types after baseline primes. For example, the size of priming by double-object primes is calculated as: (72% / 28%) / (47% / 53%). Again, the above ratios are based on the exact values reported by Bock (1986), not on the rounded values presented in Table 4.2.

the role of baselines has been noted before (e.g., Melinger and Dobel 2005: B16; Pickering et al. 2002: 587), their importance for a fine-grained analysis of priming effects may not always be fully acknowledged. This is illustrated by the fact that the majority of structural priming studies to date do not seem to feature a baseline. To support this claim, all dative priming experiments included in Mahowald et al.'s (2016) meta-analysis were manually examined for whether or not they incorporate a neutral baseline condition. The result is that only 40 (19%) out of the 215 reviewed experimental conditions feature a baseline.

Among the studies of argument structure constructions that *do* include a baseline, most experiments have targeted the members of the dative alternation, which is therefore the focus of the following discussion. The question is whether these studies have found similar asymmetric priming as in Bock (1986), and to what extent these effects can be explained by frequency-based factors. Interestingly, previous results have varied considerably in terms of the priming asymmetries they display. Some studies, for instance, have reported the opposite asymmetry to the one in Bock's experiment, with stronger priming among *to*-datives than among double-object sentences. In Kaschak et al. (2011), the comparison with the baseline condition indicates that double-object primes led only to a 9% increase in double-object productions (odds ratio 1.5), while *to*-datives led to a 14% increase in *to*-dative productions (odds ratio 2.9); see also Kaschak (2007: Experiment 1) for similar results.⁸ Likewise, in Potter and Lombardi's (1998: Experiment 1) sentence recall experiment, the probability of participants misrecalling a *to*-dative as a double-object target after double-object primes was only approximately 16%, while the probability of them misrecalling a double-object sentence as a *to*-dative after *to*-dative primes was approximately 45%.⁹ Other studies, in contrast, have found roughly symmetric (or 'balanced') priming among both dative constructions: for example, in Pickering et al. (2002: Experiment 1), double-object primes led to a 11% increase in double-object productions (odds ratio 1.6), while *to*-datives led to a 14% increase in *to*-dative productions (odds ratio 1.9).

⁸ Note that Kaschak et al. (2011) and Kaschak (2007) tested 'cumulative' priming across many experimental trials rather than trial-by-trial priming. Moreover, they collected their baseline data differently by conducting an experimental pre-phase in which participants completed dative targets without having been primed. Finally, note that the values provided above are based on the estimates of Kaschak et al.'s (2011) logistic regression model, not based on the raw means.

⁹ The values for Potter and Lombardi (1998) are estimated based on visual inspection of their results plot; the authors do not report the exact values in the text.

Most of these findings are in line with the inverse frequency effect. As Table 4.2 shows, Bock's (1986) participants produced more *to*-datives than double-object targets in the baseline condition (though only slightly so). In line with the inverse frequency effect, the less frequent double-object construction was primed more strongly in her study than the *to*-dative. Conversely, Kaschak et al.'s (2011) and Kaschak's (2007) participants produced more double-object sentences than *to*-datives in the baseline, which matches the fact that *to*-datives gave rise to stronger priming in their study (for Potter and Lombardi [1998], this analysis is not possible because the study provides no data about participants' baseline preferences). Meanwhile, Pickering et al.'s (2002) finding concerning symmetric priming is not fully in line with the inverse frequency effect because their participants produced more *to*-datives in the baseline, which should give rise to stronger priming among double-object sentences.

To the extent that the results of previous studies support the inverse frequency effect, they provide interesting insights about the role of frequency in determining activation patterns in the grammatical network. As outlined in Section 3.5, one explanation for the inverse frequency effect is that less frequent, and therefore more unexpected, structures give rise to a stronger prediction error and lead to more significant changes among the connection weights in speakers' mental networks (Chang et al. 2006; Jaeger and Snider 2013). This account fits in naturally with the model of grammar as a network of similarity relations outlined in Chapter 2. Crucially, the inverse frequency effect demonstrates that the similarity relations between argument structure constructions (both abstract and verb-specific) are influenced by the more specific instances over which these constructional schemas generalise. To further unpack this point, consider the well-supported claim that the number of instances of a construction that speakers have previously witnessed affects (together with other factors) the degree of entrenchment of that construction and thus its base-level activation in speakers' grammatical networks (Divjak and Caldwell-Harris 2015; Schmid 2016; see also Section 2.2.5). The inverse frequency effect then suggests that when speakers are exposed to a new prime instance of the construction, the influence that this prime instance has on the short-term activation of the construction, as well as longer-term changes in the connectivity pattern of the network, depends on the amount of experience that speakers have previously had with the construction.

Importantly, inverse frequency effects in structural priming also suggest that it may be the frequency of lexically specific subtypes of constructions, rather than the overall frequency of the abstract schema, that determines the strength of priming effects. One piece of evidence for this comes from the fact that the studies reviewed above vary so widely in the baseline proportions they report for double-object and *to*-dative targets. It seems unlikely that the participants of these studies should have such different overall preferences for one dative construction over the other. Nor can the differences be attributed to the influence of language variety (as described, e.g., by Bresnan and Ford [2010]) given that Bock (1986) and Kaschak et al. (2011), for instance, both tested speakers of American English and still found opposite effects. Rather, the differences in baseline frequencies are likely to be the result of the specific stimuli used in the experiments. It is well known that individual verbs differ in their biases towards either of the dative constructions (Gries and Stefanowitsch 2004; see also Section 2.4.2). Experiments with a higher baseline frequency for one dative construction are thus likely to contain more verbs that are biased towards that construction.

Based on this reasoning, the inverse frequency effect illustrates that it is indeed the frequencies of these verb-specific subtypes of the dative constructions that determine the amount of priming brought about by specific prime instances. This is further supported by more fine-grained analyses of inverse frequency effects on a verb-by-verb basis, which have shown that the strength and symmetry of priming depends on the verbs that are used in the prime sentences (Bernolet and Hartsuiker 2010; Jaeger and Snider 2013; Segaert et al. 2014). Another interesting finding in this context is Kutta et al.'s (2017) result that inverse frequency effects also differ between individual participants in the same experiment. This supports the view that speakers' grammatical networks display some structural variation as a result of their previous linguistic experience (see Section 2.2.6).

4.1.4 Interim summary

This section has illustrated that within-construction priming effects among argument structure constructions support several key elements of the cognitive-linguistic model of the grammatical network outlined in Chapter 2. Section 4.1.1 reviewed the evidence that speakers encode similarity relations between instances of the same abstract construction which do not share lexical material. At the same time, some of the findings (Yi and Koenig 2016; Ziegler and Snedeker 2018) already hint at the fact that stronger similarity relations

may exist between more specific subtypes of these constructions which contain semantically similar verbs or overlap in their animacy features. More evidence of such stronger similarities at lower levels of abstraction was provided by the discussion of lexical boost effects in Section 4.1.2. The fact that priming is enhanced when instances of a construction share the same verb supports a network model in which stronger similarities give rise to low-level schemas and weaker similarities lead to the formation of abstract high-level schemas.

Finally, Section 4.1.3 presented evidence suggesting that the strength of within-construction priming is affected by the frequency of constructions, and more specifically by the frequency of their verb-specific subtypes (as witnessed by the individual speaker). Priming thus provides a promising window into the ways in which speakers' previous linguistic experience affects the recurring activation patterns in their mental networks. On the methodological side, the discussion highlighted the importance of baseline comparisons for determining how much priming the individual constructions in an experiment give rise to, and how symmetric (or balanced) their effects are. It was noted that many previous studies have not included a baseline condition, or not performed a statistical analysis on the differences between critical and baseline primes. Contrary to this trend, the analyses in the following sections and in Chapter 5 will make consistent use of baseline comparisons, thus further illustrating their role for fine-grained interpretations of structural priming results.

Despite the insights offered by previous studies on within-construction priming, the discussion has also pointed out some of their limitations. In particular, most of the evidence for argument structure constructions concerns the members of the dative alternation, while other alternating constructions have been less frequently tested (see Section 4.1.1). Even more strikingly, there seems to be hardly any evidence of within-construction priming among non-alternating constructions. One question for the experiments reported in Chapter 5 will therefore be whether comparable within-construction effects also emerge among the resultative, the depictive and the caused-motion construction.

4.2 Cross-constructional priming between members of a single alternation

Having addressed in Section 4.1 to what extent within-construction priming supports the existence of argument structure constructions at different levels of schematicity (abstract and verb-specific), the discussion can move on to similarity relations between distinct constructions. In particular, the present section addresses the potential similarities between

the members of a single alternation, focusing on priming between the double-object and the *to*-dative construction (while Section 4.3 addresses priming between members of different alternations). As outlined in the theoretical analysis in Section 2.4.2, it has been frequently argued that alternating constructions display formal differences but are functionally similar, or even (near-)equivalent. Nevertheless, it was also pointed out that the strength of this similarity remains a matter of debate: while some cognitive linguists (Cappelle 2006; Perek 2015; Zehentner 2019) endorse the view that alternations form important generalisations within speakers' grammatical knowledge, Goldberg (2002) has, in the context of her Surface Generalisation Hypothesis, expressed doubt about the cognitive salience of alternations, arguing that the similarity between alternating constructions may be less strong than often assumed.

The following discussions address the question of whether priming reflects strong similarity relations between alternating constructions that would support the status of alternations as cognitive plausible representations. It is important to note that in order to provide such evidence, it is not sufficient to point out merely that speakers freely produce both alternating variants in priming experiments, suggesting that the patterns can be used to encode the same events. This is a trivial assumption of the experimental designs rather than an outcome of the studies. Rather, if priming is to underscore the psychological reality of alternations, it needs to be demonstrated that one alternating construction primes the other, *i.e., that processing one pattern influences the activation level of the other pattern in speakers' grammatical networks.*

As mentioned earlier in Section 3.4, it is challenging to distinguish between within-construction and cross-constructural effects in experiments in which both types of effects co-occur. Section 4.2.1 outlines this methodological challenge in more detail, while Sections 4.2.2 and 4.2.3 illustrate two strategies for how cross-constructural priming between alternating constructions can still be (tentatively) identified. With the help of innovative analysis techniques, the discussion will provide novel interpretations of previous experimental results, while pointing out some limitations among previous interpretations of the same data.

Methodologically, this section thus addresses the second methods-related question from Chapter 3, concerning ways of distinguishing between overlapping effects of within-construction and cross-constructural priming ($Q_M 2$). On the theoretical side, the discussion

focuses on the two final theory-related questions from Chapter 2: whether structural priming provides evidence of similarity links between specific types of argument structure constructions – in this case, functional similarities between the members of a single alternation (Q_T 3); and whether this evidence can be used to adjudicate between previous theoretical claims about the degree of similarity between these constructions (Q_T 4).

4.2.1 A methodological challenge: isolating cross-constructional priming effects

As mentioned above, distinguishing between within-construction and cross-constructional priming effects when both of these effects co-occur in the same experiment is not a trivial matter. The following discussion first outlines what this challenge consists in and then describes strategies for how it can potentially be overcome. A clear understanding of these issues is not only important for interpreting the priming evidence presented in Sections 4.2.2 and 4.2.3, but it also makes explicit the assumptions that these interpretations rely on. Compared with other researchers' interpretations of the same results (see especially Section 4.2.2), in which these assumptions were largely left implicit, this allows for a more nuanced evaluation of the strength of the evidence.

In order to distinguish within-construction from cross-constructional priming, two conditions must be fulfilled. The first condition is that experimenters need to be able to identify *which prime construction gives rise to the effect*. Without knowing which prime construction drives a particular effect, it cannot be decided whether a change in speakers' target productions is due to priming by instances of the same or of the alternative construction. As outlined in Section 4.1.3, the individual contributions of the prime constructions can only be identified by comparing them with a neutral baseline, thus highlighting the importance of baselines for the fine-grained interpretation of priming effects. In line with this, the analyses in the following sections will make consistent use of baseline comparisons.

The second condition for distinguishing within-construction and cross-constructional priming is that experimenters need to be able to identify *which target construction is affected by priming*. Again, without this knowledge, it remains unclear whether a particular prime construction affects speakers' productions of the same construction, the alternative construction or both. As briefly introduced in Section 3.4, this condition presents a particular challenge for production priming experiments, which usually rely on structure choice

proportions as their outcome measure. Structure choice proportions are complementary: if the proportion of one target construction increases, the proportion of the other target construction automatically decreases (because the proportions always add up to 100%). This would be not only be the case if *only* within-construction priming took place, but also if both within-construction *and* cross-constructural priming occurred, because the (putatively) stronger effects of the former would ‘suppress’ the weaker effects of the latter. Based on this analysis, cross-constructural priming can therefore not be detected.

In order to overcome this challenge, it is necessary to take a closer look at the nature of structure choice proportions. So far, it has been assumed that this outcome measure is always binary: i.e., speakers either produce one alternating construction or the other. In reality, however, participants usually also produce a number of other target constructions in an experimental setting. In many studies of alternating constructions, researchers report a third category of such ‘other’ targets which comprises all productions that do not instantiate either of the two critical constructions (e.g., all non-dative responses that speakers produce in a dative priming experiment). As further outlined below, these ‘other’ targets may arise from a number of different sources and it should be critically discussed to what extent they can be informative about the activation levels of speakers’ grammatical representations (or whether they may partially arise from non-linguistic processing effects).

Nevertheless, as will be illustrated in Section 4.2.2, some researchers have suggested that a change in the proportion of ‘other’ targets can potentially help identify cross-constructural priming effects. The reason for this is that when three types of target categories are analysed, their respective proportions are still complementary (i.e., all three together add up to 100%), but they are no longer binary. As a result, the changes in the proportions of the two alternating constructions can be compared against the change in the proportion of ‘other’ targets. The effects of within-construction and cross-constructural priming can thus be potentially distinguished. If *only* within-construction priming occurred in an experiment, the proportion of target productions that instantiate the same construction as the primes should increase, while the proportion of targets that instantiate the alternative construction and the proportion of ‘other’ targets should decrease *at the same rate*. However, if both within-construction *and* (weaker) cross-constructural priming occurred, then the proportion of same-construction targets should still increase, but the proportion of alternative-construction targets should either not decrease or at least decrease *less strongly*

than the proportion of 'other' targets. This is because target instances of the alternative construction would receive some additional activation via cross-constructional priming, while 'other' targets, which presumably instantiate unrelated constructions, would not be facilitated at all. The 'other' target productions thus provide a reference point against which the two critical target constructions can be compared, in a similar way in which baseline primes provide a reference point against which the critical prime conditions can be compared.

As mentioned above, however, this analysis of 'other' target proportions assumes that 'other' targets are directly informative about speakers' grammatical representations. In particular, the underlying assumption is that 'other' targets represent (an approximation of) all the other constructions that are activated in speakers' mental networks apart from the two alternating constructions while the speakers are describing a dative event. This assumption is most likely idealised given that 'other' target productions form a heterogeneous category comprising not only other argument structure constructions, but also a variety of potentially less informative responses. For example, the 'other' category usually includes a variety of 'unscorable' responses such as incomplete sentences, ungrammatical responses, or invalid trials in which the participants spoke between the prime and target sentences (see, e.g., Miller and Deevy 2006). To add to this mixture, when speakers produce one of the alternating constructions but with a verb that is itself not alternating (e.g., a double-object sentence that has no *to*-dative counterpart), then these targets are usually also counted as 'other' (e.g., in Bock 1986), even though they could potentially be subject to priming. As a result, it is likely that a subset of 'other' targets is not directly informative about activation levels within speakers' grammatical networks. The conclusions that can be drawn from analyses of 'other' targets therefore remain tentative, as will be emphasised again in Section 4.2.2 when discussing the relevant findings along with previous researchers' interpretations.

Apart from analyses of 'other' target proportions, there is another potential way to identify cross-constructional priming effects among alternating constructions. This second strategy, which will be applied in Section 4.2.3, relies on experiments that include a third member of the alternation. For example, it has been observed that besides the double-object and the *to*-dative construction, speakers sometimes use 'shifted' *to*-datives to describe transfer events. Shifted *to*-datives contain the same syntactic constituents as regular *to*-datives, but in a different order (see Section 4.2.3 for examples). As a result, they are formally

more similar to regular *to*-datives but functionally more similar to the double-object construction. Crucially, in the experiment discussed below, participants are *primed* with double-object sentences, regular *to*-datives and shifted *to*-datives, but they do not *produce* shifted *to*-datives themselves. As a result, any effect that the shifted *to*-dative primes had on participants' productions of double-object and regular *to*-dative targets was necessarily an instance of cross-constructional priming. In this way, the above challenge of distinguishing between within-construction and cross-constructional priming does not arise. It should, however, be noted that Section 4.2.3 shifts the focus away from the similarity relation between the double-object and the regular *to*-dative construction (the two main members of the alternation), and instead targets the relations between these two constructions and shifted *to*-datives (a marginal third member of the alternation).

4.2.2 Double-object and *to*-dative: evidence from 'other' targets

Only few studies of the dative alternation fulfil the two conditions for identifying cross-constructional priming effects outlined in the previous section. The relevant experiments must include a baseline prime condition; and in order to make an analysis of 'other' target productions feasible, the proportion of these 'other' targets must vary significantly between the baseline and the critical prime conditions. Two dative priming experiments which fit these criteria will be discussed in the following: Goldwater et al.'s (2011) study with children, and one of Pickering et al.'s (2002) experiments with adults.

In the cognitive-linguistic literature, Goldwater et al.'s (2011) findings have been discussed as key evidence for the fact that priming reflects the similarity relation between alternating constructions (Perek 2015: 166; Zehentner 2019: 72–73). The experimental results have thus been taken as support for the psychological reality of alternations, "suggesting that speakers indeed store generalizations of a common meaning over formally different constructions" (Perek 2015: 215). As the following discussion will show, however, a closer look at Goldwater et al.'s data reveals a more nuanced picture which provides only some tentative evidence of the similarity between the double-object and the *to*-dative construction.

In Goldwater et al.'s study, two groups of children – four-year-olds and five-year-olds – described pictures of transfer events after having been primed with two instances of either the double-object construction or the *to*-dative, such as in (8). In the baseline condition, they

described the pictures in the absence of primes. The dative prime conditions were further subdivided into a 'high similarity' condition, in which prime and target scenes encompassed similar types of events with similar participants (e.g., 'tell her classmates a story' and 'teach the students the alphabet'), and a 'low similarity' condition, in which primes and targets referred to less similar events (e.g., 'throw the catcher a baseball' and 'hand her mother a cookie').

- (8) a. *The girl is telling her classmates a story.*
b. *The girl is telling a story to her classmates.*
(both from Goldwater et al. 2011)

Goldwater et al. found that both groups of children produced considerably more dative targets – double-object and *to*-dative combined – after dative primes than in the baseline condition. In other words, the proportion of 'other' targets was higher in the baseline (between 75% and 85%, depending on age group and similarity condition) than after the dative primes (between 28% and 54%).¹⁰ This result in itself does not distinguish between within-construction and cross-constructural priming. In addition, however, Goldwater et al. observed that four-year-olds in the low-similarity condition produced roughly equal proportions of both double-object and *to*-dative targets, irrespective of whether they had been primed with the same construction or the alternative construction. Combined with the above finding that the overall proportion of dative productions in this group increased compared to the baseline, this means that *both* the double-object and the *to*-dative construction must have been facilitated by the same prime construction. The results thus suggest that both within-construction and cross-constructural priming occurred at comparable magnitude.

This is especially striking given that prime type was a between-subjects factor in Goldwater et al.'s study: each child was exposed to prime instances of only one dative construction during the course of the experiment. Nevertheless, the four-year-olds in the low-similarity condition alternated freely between both constructions in their own productions. Goldwater et al. interpret this as evidence that these children were subject to what they call

¹⁰ The proportions are calculated from the averaged absolute numbers of target productions provided by Goldwater et al. (2011).

“semantic structural priming” (p. 159): i.e., an increased activation of the semantic features shared by the two constructions, including their ‘transfer’ meaning and the accompanying set of thematic roles (agent, recipient, theme). As noted by Perek (2015), this account is strongly akin to a cognitive-linguistic network analysis in which the cross-constructional priming effect reflects the functional similarity between the two constructions.

Importantly, however, Goldwater et al.’s conclusions only apply to a subset of their data, namely the four-year-old children in the low-similarity condition. For the four-year-olds in the high-similarity condition, and the five-year-olds in both similarity conditions, the proportion of targets that instantiated the same dative construction as the primes (called ‘same-construction datives’ below) was higher than the proportion of targets that instantiated the alternative dative construction (called ‘alternative-construction datives’ below). This indicates that within-construction priming was stronger than the potential effects of cross-constructional priming in these cases; in fact, it raises the question of whether cross-constructional priming occurred at all. In either case, Goldwater et al.’s conclusion that “one dative alternate increased the likelihood of the use of both dative alternates equally in a subsequent scene description” (p. 166) applies only to one out of their four experimental groups, a fact that may have been overlooked in previous interpretations (Perek 2015; Zehentner 2019).

In order to assess whether cross-constructional priming occurred in the other three groups, it is necessary to compare, for each of them, the proportions of same-construction dative productions, alternative-construction dative productions and ‘other’ targets between the dative prime condition and the baseline condition. Goldwater et al. do not provide a complete tabulation of their data, but such an overview can be obtained by combining their separate analyses, as in Table 4.3.¹¹ The table only shows a single combined ‘dative primes’ condition because Goldwater et al. do not report separate results for double-object and *to*-dative primes. This means that in the analysis below, within-construction and cross-constructional priming can be distinguished, but it cannot be determined whether the effects

¹¹ As above, the proportions are calculated from the averaged absolute values provided by Goldwater et al. (2011). The proportions of same-construction and alternative-construction dative targets in the baseline conditions are calculated as: $(100\% - \text{proportion of ‘other’ targets}) / 2$. Logically, these two proportions must be equal even if double-object and *to*-dative targets are produced at different frequencies in the baseline conditions (since these frequency differences cancel each other out when the proportions for same-construction and alternative-construction datives are combined across both constructions). Also note that the values in Table 4.3 are rounded, which explains why they sometimes do not add up to 100%.

are driven by double-object primes, *to*-dative primes, or both. Moreover, it should be noted that Goldwater et al. do not apply statistical tests to the differences between prime conditions shown in Table 4.3, so the interpretations below can only refer to tentative trends in the data which await statistical corroboration.

Table 4.3. Results from Goldwater et al. (2011) (in brackets: expected proportions of alternative-construction targets if no cross-constructional priming occurred)

Prime type	Proportion of target productions		
	Same-construction datives	Alternative-construction datives	'Other'
Four-year-olds, high similarity condition			
Dative primes	44%	17% (5%)	39%
No prime (baseline)	8%	8%	85%
Four-year-olds, low similarity condition			
Dative primes	19%	26% (7%)	54%
No prime (baseline)	8%	8%	85%
Five-year-olds, high similarity condition			
Dative primes	49%	13% (7%)	38%
No prime (baseline)	13%	13%	75%
Five-year-olds, low similarity condition			
Dative primes	43%	15% (8%)	43%
No prime (baseline)	13%	13%	75%

The rightmost column of Table 4.3 illustrates again the above observation that across both age groups and both similarity conditions, the proportion of 'other' targets was higher in the baseline condition than after dative primes. The column on the left ('same-construction datives') reveals considerable effects of within-construction priming, given the increase in the proportion of same-construction datives after dative primes compared with the baseline condition. Meanwhile, the middle column ('alternative-construction datives') is most important in the present context since it illustrates the potential effects of cross-constructional priming between the dative constructions. At first sight, the data seem to suggest that cross-constructional priming occurred only among the four-year-olds: ignoring the values in brackets for the moment, the proportions suggest that these children produced an additional 9% (high similarity condition) and 18% (low similarity condition) of alternative-

construction datives after dative primes compared with the baseline. Meanwhile, there seems to be no effect for the five-year-olds, for which the proportion of alternative-construction targets changed not at all (high similarity condition) or only by 2% (low similarity condition).¹²

There is, however, one problem with this simple comparison: as noted in Section 4.2.1, the complementary nature of structure choice proportions means that an increase in the proportion of same-construction datives automatically leads to a decrease in the proportion of alternative-construction and 'other' targets. A potential cross-constructural priming effect for the alternative-construction targets might therefore be 'suppressed' by the stronger magnitude of within-construction priming. In order to adjust for this effect, the observed proportion of alternative-construction targets after dative primes can be compared with the *expected* proportion of alternative-construction targets if only within-construction priming but no cross-constructural priming occurred. These expected values are included in brackets in Table 4.3.¹³ For example, for the four-year-olds in the high-similarity condition, it would be expected that if only within-construction priming occurred, the proportion of alternative-construction datives after dative primes should be 5% (because it would be 'suppressed' by the increase in the proportion of same-construction datives). This expected proportion of alternative-construction datives can be compared with the observed proportion of 17%.

This adjusted comparison confirms the previous impression that cross-constructural priming is likely to have occurred for the four-year-olds, increasing the proportion of alternative-construction targets by 12% (high similarity condition) and 19% (low similarity condition). For the five-year-olds, this revised analysis reveals that the effects of cross-constructural priming are still small but potentially non-negligible, increasing the proportion of alternative-construction targets by 6% (high similarity condition) and 7% (low similarity condition). While these results provide some indication that cross-constructural priming may have occurred among the five-year-olds too, it is not clear whether the effects are statistically significant.

¹² Note that contrary to Section 4.1, the odds ratio is not used to quantify the size of the priming effects in this section. This is because it is less clear how the odds should be computed in the presence of 'other' target proportions.

¹³ The expected proportions of alternative-construction targets (if only within-construction but no cross-constructural priming occurred) are calculated as: proportion of alternative-construction targets in baseline * (100% - proportion of same-construction targets after dative primes) / (100% - proportion of same-construction targets in baseline).

This analysis provides a more nuanced picture of Goldwater et al.'s findings. The cross-constructional priming effects among the four-year-old children provide evidence that the two constructions can indeed facilitate each other in a production setting, suggesting that the children perceive them as functionally related. In fact, the comparable magnitude of within-construction and cross-constructional priming in the low similarity condition may suggest that the four-year-olds do not differentiate between the constructions but instead treat them as instances of a single underspecified 'dative' schema. They may only recognise construction-specific characteristics when the prime and target scenes share some additional contextual similarities, thus leading to higher rates of within-construction priming than cross-constructional priming in the high-similarity condition. For the five-year-olds, on the other hand, within-construction priming is more pronounced than cross-constructional priming in both similarity conditions, and it is in fact unclear if the cross-constructional effects are statistically reliable. The results thus raise an interesting possibility, namely that children's representations of the two dative constructions change along a developmental path. As the children grow older, their representation of double-object and *to*-dative sentences may increasingly 'emancipate' from each other, leading to larger amounts of within-construction priming and smaller amounts of cross-constructional priming. This possibility is particularly relevant in the present context because it raises the question of whether older children and adults still encode a functional similarity relation between the alternating constructions that is strong enough to give rise to cross-constructional priming.

In response to this question, Pickering et al.'s (2002) Experiment 3 may provide some tentative evidence that cross-constructional priming between the dative constructions can also occur in adults. The researchers used a written sentence completion task in which participants first completed prime fragments that were strongly biased towards a double-object, a *to*-dative or an intransitive (baseline) structure, as illustrated by the examples in (9). After each prime, participants were then presented with target fragments like (10), which can be completed with either the double-object or the *to*-dative construction.

- (9) a. *The racing driver showed the helpful mechanic ...*
b. *The racing driver showed the torn overall ...*
c. *The racing driver sneezed very ...*

- (10) *The patient showed ...*
 (all from Pickering et al. 2002)

Besides testing adult participants, Pickering et al.'s study differs in a few other regards from the above experiment by Goldwater et al. (2011). In contrast to the latter, Pickering et al.'s target sentences contained the same verb as the primes that immediately preceded them. The results of their study can thus shed light only on lexically specific priming effects among verb-specific subtypes of the two dative constructions (see Section 4.1.2), but they do not necessarily generalise to priming at the level of the abstract constructions. Moreover, prime type was a within-subjects factor in Pickering et al.'s experiment, meaning that each participant witnessed instances of all three prime constructions over the course of the experiment. In contrast to Goldwater et al.'s between-subjects design, in which some of the priming effects may have been 'cumulative' (i.e., accruing over several experimental trials), Pickering et al. thus focused on the (potentially smaller) effects of 'trial-by-trial' priming between the members of a single prime-target pair.

The results of Pickering et al.'s experiment are summarised in Table 4.4 in a similar format as above for Goldwater et al.'s (2011) study.¹⁴ While Pickering et al. also included an additional prime condition of 'shifted' *to*-dative primes in their design, this condition will be discussed separately in Section 4.2.3 and is therefore not shown in Table 4.4.

Table 4.4. Results from Pickering et al. (2002: Experiment 3) (in brackets: expected proportions of alternative-construction targets if no cross-constructural priming occurred)

Prime type	Proportion of target productions		
	Double-object	<i>to</i> -dative	'Other'
Double-object	39%	30% (29%)	31%
<i>to</i> -dative	23% (19%)	49%	28%
Intransitive (baseline)	23%	37%	40%

¹⁴ The *non-binary* proportions in Table 4.4 (i.e., including 'other' targets) are obtained by combining the *binary* proportions (i.e., excluding 'other' targets) provided by Pickering et al. (2002) with the proportion of 'other' targets that they report separately. The non-binary proportions are calculated as: binary proportion * (1 - proportion of 'other targets').

Pickering et al. observed a statistically significant difference in the proportion of ‘other’ productions such that speakers produced more ‘other’ targets after neutral baseline primes (40%) than after both double-object and *to*-dative primes (31% and 28%, respectively). The authors interpret this difference as evidence of a “second” (p. 598) priming effect which they regard as distinct from the “syntactic” effect of within-construction priming. While they point out that “[i]t is impossible to be certain of the source of the priming” (p. 598), they tentatively attribute the second priming effect to the shared features of the two dative constructions, including the fact that sentences of both types contain three arguments and describe scenes that involve three entities. As in the above interpretation of Goldwater et al.’s (2011) conclusions, this interpretation seems highly compatible with a network-based account in which the putative ‘secondary’ effect of cross-constructural priming reflects the functional similarity link that speakers encode between the dative constructions.

One limitation of Pickering et al.’s analysis, however, is that they do not explicitly demonstrate that the decrease in ‘other’ targets after double-object and *to*-dative primes is due to both within-construction *and* cross-constructural priming, instead of being brought about by within-construction priming only. The results in Table 4.4 indicate considerable effects of within-construction priming: speakers produced more double-object targets after double-object primes compared with the baseline, and more *to*-dative targets after *to*-dative primes. Meanwhile, the proportion of alternative-construction targets – i.e., *to*-datives after double-object primes, and double-object targets after *to*-dative primes – seems to differ less from the baseline proportions. As outlined above, the cross-constructural effects may potentially be ‘suppressed’ by the stronger effects of within-construction priming, so the same analysis as for Goldwater et al.’s results should be conducted. Specifically, the observed proportions of alternative-construction targets are compared with the proportions that would be expected if only within-construction priming and no cross-constructural priming occurred. These expected proportions are provided in brackets in Table 4.4.

The comparison between the observed and expected values suggests that double-object primes hardly increased the rate of participants’ subsequent *to*-dative productions, while *to*-dative primes may have led to a slight increase in speakers’ double-object productions (by 4%). In the absence of statistical testing, this can only be regarded as a potential trend in the data. Overall, the evidence for a ‘secondary’ effect of cross-constructural priming seems to be weaker than Pickering et al. suggest.

Combining the above discussions of Goldwater et al.'s (2011) and Pickering et al.'s (2002) results, it appears that previous priming studies which have found variations in the proportions of 'other targets' provide only some tentative evidence for the occurrence of cross-constructural priming between the double-object and the *to*-dative construction. Previous, more optimistic interpretations of the results in terms of cross-constructural priming may thus not be fully supported by the data. Compared with these earlier analyses, the present discussion has highlighted the challenges that arise for the interpretation of cross-constructural and within-construction priming when the two types of effects co-occur in the same experiment. A new strategy has been proposed for how cross-constructural priming can still be identified in such cases, based on a comparison between the observed proportion of alternative-construction targets and the proportion that would be expected if no cross-constructural priming occurred. Nevertheless, these revised analyses have not provided conclusive evidence for cross-constructural priming between the two dative constructions.¹⁵

One interesting possibility raised by the above results is that young children may start out with an underspecified schema comprising both dative constructions, as evidenced by the considerable magnitude of cross-constructural priming among the four-year-olds in Goldwater et al.'s (2011) experiment. While this may point to a common conceptual core of the two patterns, the small amounts of cross-constructural priming among Goldwater et al.'s five-year-olds and Pickering et al.'s (2002) adult participants suggest that speakers, as they grow older, form increasingly distinct representations for the double-object and the *to*-dative construction. Given the lack of statistical corroboration for these potential cross-constructural effects, along with the open questions about how reliable analyses of 'other' target proportions are (see Section 4.2.1), the results thus do not provide clear evidence that adult speakers still encode a functional similarity relation between the alternating dative constructions.

¹⁵ Studies from languages other than English do not provide clear evidence of cross-constructural priming between the dative constructions either. In their study of Dutch datives, for example, Hartsuiker and Kolk (1998: Experiment 1) also report a lower proportion of 'other' targets after dative primes than in the baseline condition. Visual inspection of their results (particularly at an inter-stimulus interval of 1000 ms) suggests that *both* double-object and prepositional dative targets were produced more frequently in the dative prime conditions than in the baseline. As pointed out by the authors (pp. 159-160), however, this result could also be accounted for via within-construction priming since all baseline trials occurred at the beginning of the experiment. As the experiment progressed, participants witnessed an increasing number of double-object and prepositional dative primes, which might have facilitated their productions of both dative constructions via cumulative within-construction priming (across many trials) rather than via cross-constructural priming (within a single trial).

Of course, it is possible that the experimental designs examined so far may not be able to detect the potentially subtle effects of cross-constructural priming, especially given their overlap with the stronger effects of within-construction priming. The discussion in the next section will therefore turn towards a special case in which within-construction priming does not occur and cross-constructural effects among particular members of the dative alternation may therefore be observed more clearly.

4.2.3 Evidence from ‘shifted’ *to*-datives

As mentioned in Section 4.2.1, speakers of English have a third construction at their disposal that they can use to encode dative events. This construction, which has been called the ‘shifted’ *to*-dative (Pickering et al. 2002), is illustrated by the examples in (11). It involves the same syntactic constituents as the *to*-dative but in reverse order (PP–NP).

- (11) a. *I gave to Mary the valuable book that was extremely difficult to find.*
b. *[What did John give to Mary?] – John gave to Mary a very valuable book.*
(both from Hawkins 1994)

In terms of their formal and functional features, shifted *to*-datives take an intermediate position among the two main members of the dative alternation, the double-object and the regular *to*-dative construction. Since shifted *to*-datives encode the same constructural core meaning as the other two constructions (‘transfer of possession’) and are compatible with a similar set of verbs, they qualify as a third member of the dative alternation (if the concept of ‘alternations’ is broadened beyond a binary choice between only two variants). Meanwhile, shifted *to*-datives share certain additional similarities with each of the other two patterns. On the one hand, they are formally more similar to regular *to*-datives, displaying the same type of syntactic constituents, including the specific preposition *to*. On the other hand, they are functionally more closely related to double-object sentences given their overlap in the order of thematic roles (recipient–theme) and their information-structural properties. Regarding the latter, it was noted in Section 2.4.2 that the double-object construction is usually preferred over the regular *to*-dative when the theme argument is longer than the recipient and discourse-new. These effects of ‘heaviness’ and ‘newness’ have also been observed for the shifted *to*-dative (Arnold et al. 2000; Hawkins 1994; Wasow 1997).

In fact, shifted *to*-datives are usually *only* felicitous when these specific information-structural conditions hold. Compare (11a), which is felicitous because the theme (*the valuable book that was extremely difficult to find*) is considerably longer, i.e. heavier, than the recipient (*to Mary*). The shifted *to*-dative thus illustrates the more general phenomenon of ‘heavy NP shift’, i.e., the tendency to move heavy constituents towards the end of the sentence (Ross 1967). Meanwhile, example (11b) illustrates the effect of newness: in the specific utterance context, the shifted *to*-dative is felicitous because the recipient (*to Mary*) represents given information while the theme (*a very valuable book*) is new.

As a result, shifted *to*-datives are arguably more closely related to both the double-object and the regular *to*-dative construction than the latter two constructions are related amongst themselves. Given the stronger similarity relation, it may therefore be easier to observe cross-constructural priming between shifted *to*-datives and instances of the other two patterns. Such cross-constructural effects, if they occur, do of course not substantiate the claim that the double-object and the *to*-dative are functionally related in speakers’ grammatical networks. Nevertheless, these effects would suggest that speakers encode additional similarities between the two dative constructions and a third member of the alternation, thus providing some support for the psychological reality of ‘alternations’ in a broader sense of the term.

Moreover, the rare nature of shifted *to*-datives, as well as their specific information-structural constraints, offer an opportunity to avoid the problem of distinguishing between within-construction and cross-constructural priming. As mentioned in Section 4.2.1, a few researchers have tested the effect of shifted *to*-dative primes on speakers’ productions of double-object and regular *to*-dative targets in a situation in which speakers were unlikely to produce shifted *to*-dative targets themselves. As a result, within-construction priming does not occur in these settings and any observed priming effects are necessarily cross-constructural.

This special case is illustrated by Pickering et al.’s (2002) Experiment 3, which was already partially introduced in Section 4.2.2. Apart from the results discussed there, the researchers included shifted *to*-datives as an additional prime condition in their experiment.¹⁶

¹⁶ Pickering et al.’s (2002) rationale for testing shifted *to*-datives was different from the focus of the present discussion. Their goal was to investigate whether language production involves separate stages for the encoding of hierarchical structure among unordered syntactic constituents and the subsequent linearisation of those

These primes consisted of sentence fragments like (12), which reliably induced shifted *to*-dative completions by participants. On the other hand, the nature of the target fragments, illustrated in (13), was such that participants almost never used shifted *to*-datives to complete them. The reason is probably that shifted *to*-datives are generally infrequent, and that nothing in the targets suggested that the specific information-structural conditions applied which would make shifted *to*-datives appropriate. This is different from the prime fragments, which contained explicit structural cues that strongly biased participants towards shifted *to*-dative completions (no matter how information-structurally felicitous those completions were).

(12) *The racing driver showed to the helpful mechanic ...*

(13) *The patient showed ...*

(both from Pickering et al. 2002)

In the absence of within-construction priming, Pickering et al.'s results can therefore be examined for the potential cross-constructural effects that the shifted *to*-datives may have had on the two regular dative constructions. Table 4.5 provides an extended version of the earlier Table 4.4, including an additional row for the shifted *to*-dative prime condition.

Table 4.5. Results from Pickering et al. (2002: Experiment 3), including shifted *to*-dative primes

Prime type	Proportion of target productions		
	Double-object	<i>to</i> -dative	'Other'
Double-object	39%	30%	31%
<i>to</i> -dative	23%	49%	28%
Shifted <i>to</i> -dative	27%	41%	32%
Intransitive (baseline)	23%	37%	40%

As illustrated in the bottom two rows of Table 4.5, Pickering et al. found that participants produced fewer 'other' targets after shifted *to*-dative primes than after

constituents. At the hierarchy-only (or 'dominance-only' level), shifted *to*-datives should be identical to regular *to*-datives and therefore prime the latter. The authors did not, however, take into account the functional overlap between shifted *to*-datives and double-object sentences which is central in the present context.

intransitive baseline primes; this difference was statistically significant. This means, in turn, that participants produced a higher proportion of dative targets after shifted *to*-dative primes, suggesting that their dative productions were facilitated by prime instances of the third member of the alternation. Moreover, the data indicate that this effect of cross-constructional priming may have been about equally strong for both double-object and *to*-dative targets, leading to a 4% increase in their respective proportions compared with the baseline. While these individual differences should be treated with some caution given that Pickering et al. do not assess their statistical significance, the results have subsequently been interpreted as evidence that shifted *to*-datives can prime both double-object and regular *to*-dative productions (Cai et al. 2012; Ziegler and Snedeker 2019).¹⁷

From a network-based perspective, Pickering et al.'s findings thus provide at least tentative evidence that speakers encode similarities between the shifted *to*-dative and the double-object construction as well as between shifted and regular *to*-datives. The fact that the two cross-constructional effects were of comparable magnitude suggests that speakers may be sensitive both to the functional overlap among the former pair in terms of their thematic and information-structural properties, and to the formal overlap among the latter pair in terms of their syntactic constituents and the preposition. Priming evidence from experiments that include a third member of the dative alternation can therefore provide some additional (though tentative) support for the existence of similarity relations between alternating constructions.¹⁸

¹⁷ The discussion also illustrates the importance of considering non-binary target proportions, including 'other' targets, in the analysis of priming results. Pickering et al. (2002) originally calculated only binary target proportions, excluding 'other' targets, concluding that shifted *to*-dative primes "behaved like baseline primes" (p. 601). This is because on such an analysis, the two facilitatory effects that shifted *to*-datives had on double-object and regular *to*-dative targets cancel each other out, seemingly not leading to a change in target proportions (Ziegler and Snedeker 2019: 378). Once 'other' targets are included in the analysis, however, the actual priming effect of the shifted *to*-datives is revealed.

¹⁸ Cross-constructional priming effects like the one discussed above have only been partially replicated in other studies. For example, a visual inspection of Hartsuiker and Kolk's (1998: Experiment 1) results suggests that, at an inter-stimulus interval of 1000 ms, shifted prepositional datives in Dutch (which the researchers called 'medial datives') facilitated regular *to*-dative targets (increasing their proportion by 10% compared with the baseline), but not double-object targets (less than 1% increase). Moreover, and in contrast to Pickering et al.'s (2002) results, Salamoura and Williams (2007: Experiment 2) found no facilitation by shifted *to*-dative primes in English for either double-object or *to*-dative targets (but note that they tested cross-language priming from L1 Greek to L2 English).

4.2.4 Interim summary

The preceding discussions have presented novel interpretations of previous priming results between the members of the dative alternation. Section 4.2.1 highlighted the challenge of identifying cross-constructional priming effects between these constructions when they overlap with stronger within-construction priming effects. Two strategies were suggested to overcome this challenge, but their potential limitations were also outlined. The first strategy was applied in Section 4.2.2, where the observed target proportions (including ‘other’ targets) were compared with the proportions that would be expected if no cross-constructional priming occurred. The second strategy was used in Section 4.2.3, which examined the effect of shifted *to*-datives on double-object and regular *to*-dative targets in a special setting in which no within-construction priming occurred.

The picture that emerges from these analyses is a complex one: while there is some tentative evidence that alternating constructions may give rise to cross-constructional priming, the evidence appears less robust than has been assumed in some previous interpretations (Perek 2015; Zehentner 2019). As far as the similarity relation between the double-object and the regular *to*-dative is concerned, clear evidence of cross-constructional priming was only found among young children, while the effects for older children and adults were smaller or potentially absent. The additional evidence for shifted *to*-datives suggests that these sentences can facilitate both regular dative constructions, but the effects are relatively small and should be replicated more widely.

As far as tentative conclusions can be drawn from these findings, they seem to provide some support for Goldberg’s (2002) claim, in the context of her Surface Generalisation Hypothesis, that alternations may be less salient parts of speakers’ grammatical knowledge than is often assumed. Otherwise, one might expect larger and more robust effects of cross-constructional priming to emerge across a larger set of studies. On the other hand, the fact that the experiment reviewed above provide some tentative evidence of cross-constructional priming between the members of the dative alternation still allows for the existence of (potentially weak) functional similarity links between alternating constructions, thus lending some (limited) psychological support to the theoretical concept of ‘alternations’.¹⁹

¹⁹ See also Zehentner (2019) and Zehentner and Traugott (2020) for historical evidence that may support the cognitive reality of alternations. The present discussion only relates to the strength of the psycholinguistic

Finally, the analysis in Section 4.2.2 raised the interesting possibility that children's representations of the dative constructions may follow a developmental path. The large size of cross-constructural priming among Goldwater et al.'s (2011) four-year-olds suggests that these young children might encode a single underspecified dative schema which only later evolves into functionally distinct representations for the double-object and the *to*-dative construction. This broadly aligns with previous evidence that young children's representations of argument structure constructions may differ considerably from adult speakers' grammatical knowledge and only gradually develop toward the latter (Ambridge et al. 2008; Goldberg 2006; Tomasello 1992). On the other hand, some interesting questions remain about how Goldwater et al.'s results relate to other evidence from structural priming with children.²⁰

4.3 Cross-constructural priming between members of different alternations

Having addressed priming between members of the same alternation in Section 4.2, the present section extends the discussion to cross-constructural priming between constructions that are typically regarded as members of different alternations. In particular, the section brings together previous findings about the similarity relations between five different argument structure constructions, and it is discussed how these results can be accommodated within a network model of grammar.

Section 4.3.1 focuses on the similarity relation between the two constructions that are usually regarded as members of the dative alternation – the transfer double-object construction and the *to*-dative – and the two constructions that have been grouped under the separate benefactive alternation – the benefactive double-object construction and the *for*-dative. As outlined in the earlier theoretical analyses (Sections 2.4.3 and 2.4.4),

evidence that structural priming provides for alternations, leaving open the question of whether stronger support for the concept can be gained from other sources.

²⁰ Both Rowland et al. (2012) and Peter et al. (2015) have found abstract within-construction priming among the two dative constructions in 3- to 6-year-old children, suggesting that the children already have distinct representations for the two patterns. While it cannot be assessed whether cross-constructural also occurred in these experiments (because they did not include a baseline), the results suggest that within-construction priming was at least considerably stronger than cross-constructural priming. This is potentially at odds with Goldwater et al.'s (2011) finding that within-construction and cross-constructural priming were roughly equal for 3- to 4-year-olds in the low similarity condition. One relevant difference between the studies may be that the task in Rowland et al. (2012) and Peter et al. (2015) was more constrained: rather than freely producing the targets, children were given sentence stems (e.g., *The king gave ...*) and completed them to describe the pictures. It may be possible that when task demands are lower, children are better able to reproduce the specific prime construction that they previously witnessed.

alternation-based accounts (e.g., Levin 1993) regard the members of each alternation as strongly similar amongst themselves, but as distinct from the members of the other alternation. In contrast, Goldberg (2002) proposes that the two double-object constructions may be more closely related to each other than the two prepositional constructions, thus raising doubts about the role of alternations in capturing the relevant generalisations across the four constructions. Previous results about the degree of priming between the members of the two alternations will be used to distinguish between these two accounts. On a more detailed level, it will be discussed whether the priming evidence can help assess whether the transfer and the benefactive double-object construction should be regarded as polysemous constructions with partially similar but still distinguishable meanings (Croft 2003; Goldberg 1995) or whether they can simply be subsumed under a single construction (Goldberg 2002).

Section 4.3.2 focuses on another case that strictly speaking does not involve priming across two different alternations, but instead concerns priming between a member of one alternation (the *to*-dative) and a related construction *outside* that alternation (the locative caused-motion construction). As outlined in Section 2.4.4, Goldberg (2002) predicts that these two constructions are highly similar and can in fact be subsumed under a single caused-motion construction. It will be assessed to what extent this claim is supported by cross-constructural priming between the two patterns, and what implications this has regarding Goldberg's critique of the psychological salience of alternations.

On the theoretical side, the following discussions thus contribute further to two of the theory-related questions raised in Chapter 2: whether structural priming provides evidence of similarity links between specific types of argument structure constructions – in this case, between constructions that display at least partial similarities in form *and* function (Q_T 3); and whether this evidence can help adjudicate between previous theoretical accounts of the relations between these constructions (Q_T 4). Methodologically, one difference between this section and the previous Section 4.2 is that cross-constructural priming should be easier to identify in the following analyses. This is because the primes and targets in the relevant experiments instantiate *different* sets of constructions, so there is no risk of cross-constructural priming overlapping with within-construction priming (see Section 3.4 for more explanation). At the same time, the following discussions once again highlight the importance of baseline comparisons for the successful interpretation of priming results.

4.3.1 Priming between dative and benefactive constructions

As outlined in detail in Sections 2.4.3 and 2.4.4, the theoretical literature makes competing claims about the degree of relatedness between the two dative constructions in (14) and the two benefactive constructions in (15). The examples are taken from the materials used in Bock's (1989) study (see below for a discussion of the results).

- (14) a. *A cheerleader offered her friend a seat.*
b. *A cheerleader offered a seat to her friend.*

- (15) a. *A cheerleader saved her friend a seat.*
b. *A cheerleader saved a seat for her friend.*

(all from Bock 1989)

Under an alternation-based view (e.g., Levin 1993), the members of each pair are usually attributed to two distinct alternations – the dative alternation and the benefactive alternation. As outlined in Section 2.4, however, some theorists (e.g., Goldberg 2002) have expressed doubt about the psychological reality of alternations, arguing that the similarities between members of the same alternation may not be as strong as assumed – a view that receives some tentative support from structural priming (see Section 4.2). Instead, these researchers have argued that stronger similarity relations may be found *across* alternations than within alternations; and in addition, that the cross-alternation link between the two double-object constructions in (14a) and (15a) may differ in strength from the link between the two prepositional constructions in (14b) and (15b).

Faced with these competing views, cross-constructural priming between datives and benefactives provides a promising tool to assess the strength of the respective similarities. The presence or absence of these priming effects, along with their relative size, can potentially be used to differentiate between the above views. For instance, if speakers encode the constructions as part of two distinct alternations which display significant differences in their formal and/or functional properties, one would expect the effects of cross-constructural priming between the two double-object constructions and between the two prepositional constructions to be small or entirely absent. As outlined in Section 2.4, this prediction is motivated by the observation that datives and benefactives seem to express

somewhat different constructional meanings ('actual transfer' versus 'intended transfer'), and that a potential distinction can be made between the thematic role of one of their arguments (recipient versus beneficiary). Moreover, as far as the *to*-dative and *for*-dative are concerned, these two constructions additionally differ in the preposition that heads the recipient/beneficiary phrase.

On the other hand, Section 2.4 also detailed a number of similarities between the members of both alternations: not only do they share a key aspect of their constructional meaning ('transfer'), but they also overlap in the order of the thematic roles of their post-verbal arguments and the related information-structural properties of those arguments (with regard to discourse accessibility, etc.). The latter two features differ between the members of each alternation, but they are identical among the two double-object constructions and among the two prepositional members of each alternation. If these cross-alternation similarities were to outweigh the differences, one would expect considerable amounts of cross-constructional priming between the benefactive and the dative constructions. In order to quantify the size of these effects, they can be compared to within-construction priming among instances of the same construction. In the event that cross-constructional and within-construction priming are of equal strength, this would suggest that the two alternations can be collapsed into one, with the two double-object patterns and the two prepositional patterns each forming a single construction.

Finally, it is possible that cross-constructional priming occurs between benefactives and datives but that the effects are smaller than the ones observed for within-construction priming. In this scenario, one relevant question would be whether one of the cross-alternation links can be primed more strongly than the other. In particular, it has been suggested that only the two double-object patterns are closely related: either as polysemous constructions with similar but still distinguishable meanings (Croft 2003; Goldberg 1995), or as part of a single construction (Goldberg 2002). The two prepositional constructions, on the other hand, may be rather distinct from each other and in fact be more closely related to other constructions outside the dative and benefactive alternation (Goldberg 2002; see Section 2.4.4 for details). In order to test these hypotheses with the help of priming, the influence of double-object and prepositional primes needs to be compared with a neutral baseline.

Having outlined these competing predictions, the analysis below assesses to what extent previous structural priming results can distinguish between the theoretical accounts. A number of studies have tested priming between the dative and benefactive constructions (Bock 1986; Bock 1989; Chang et al. 2003; Pappert and Pechmann 2013; Ziegler and Snedeker 2018). Most of these have focused on priming in one direction, from benefactives to datives, which is therefore the focus of the discussion (but see the end of this section for evidence about priming in both directions). Also note that in all of these studies, the primes and their targets contained different verbs, so the following interpretations concern the level of abstract argument structure constructions rather than their verb-specific subtypes.

All of the above studies report statistically significant effects of cross-constructural priming between the two alternations. For example, Chang et al. (2003: Experiment 2) found that in their sentence recall experiment, participants were between 5% and 9% (depending on the coding scheme) more likely to recall a 'transfer' double-object target incorrectly as a *to*-dative target after having been previously exposed to a *for*-dative prime rather than a benefactive double-object prime. This suggests that the benefactive primes influenced speakers' subsequent ability to remember dative targets, thus suggesting that speakers encode similarities between at least one member of each alternation. Chang et al. did not, however, compare the size of their cross-constructural effects with within-constructural priming, thus leaving open the question of *how* similar speakers' representations of the benefactive and dative constructions are.

Meanwhile, several other experiments have performed such a comparison. For instance, Bock (1989: Experiment 2) used a picture description task to compare cross-constructural priming from benefactives to datives with within-constructural priming between dative primes and targets. Examples of the prime stimuli were provided above in (14) and (15). Table 4.6 provides a summary of the results. In contrast to Section 4.2, the outcomes are presented as binary structure choice proportions, i.e., out of all dative targets but excluding 'other' targets. This is justified since the proportion of 'other' targets remained nearly stable across all four prime conditions (varying only slightly between 36% and 38%). The same applies to the other studies reported in this section.

Table 4.6. Results from Bock (1989: Experiment 2)

Prime type	Proportion of target productions	
	Transfer double-object	<i>to</i> -dative
Transfer double-object	73%	27%
<i>to</i> -dative	59%	41%
Benefactive double-object	72%	28%
<i>for</i> -dative	58%	42%

The results in Table 4.6 show that Bock's participants produced 14% more transfer double-object targets after transfer double-object primes than after *to*-dative primes (odds ratio 1.9).²¹ At the same time, participants also produced 14% more transfer double-object targets after benefactive double-object primes than after *for*-dative primes (odds ratio 1.8). The fact that within-construction priming and cross-constructural priming were nearly identical in magnitude could suggest that participants treated the dative and benefactive primes alike, and that the two double-object constructions and the two prepositional constructions are not only similar but can in fact each be collapsed into a single construction. There are, however, two caveats: first, the priming effects in Bock's study were relatively small compared with other picture description studies of the same constructions (see below). It is therefore possible that more subtle variations in the strength of within-construction and cross-constructural priming were obscured by the small overall size of the effects. Second, Bock's study did not include a baseline condition; it is therefore not possible to determine whether the cross-constructural priming effect was driven by both benefactive double-object primes and *for*-dative primes, or by only one of them. This leaves open the question of whether the similarity relations between the two double-object constructions and the two prepositional constructions may potentially vary in strength.

Two other studies incorporate a neutral baseline condition and provide slightly different results from Bock (1989). In her earlier picture description study, Bock (1986: Experiment 1) already compared the influence of dative and benefactive primes on participants' dative productions (though with fewer experimental items). The results of her study are summarised in Table 4.7, which provides an extension of the earlier Table 4.2.

²¹ See Section 4.1.1 for how the odds ratio is computed. Also note again that the odds ratios are calculated based on the exact values provided by the studies, not based on the rounded values displayed in the tables.

Table 4.7. Results from Bock (1986: Experiment 1), including benefactive primes

Prime type	Proportion of target productions	
	Transfer double-object	<i>to</i> -dative
Transfer double-object	72%	28%
<i>to</i> -dative	37%	63%
Benefactive double-object	60%	40%
<i>for</i> -dative	44%	56%
Intransitive (baseline)	47%	53%

Ignoring the baseline for the moment, Bock's (1986) findings contrast in an interesting way with the results of her 1989 study. As Table 4.7 shows, participants produced 35% more transfer double-object targets after transfer double-object primes than after *to*-dative primes (odds ratio 4.3), but only 16% more transfer double-object targets after benefactive double-object primes than after *for*-dative primes (odds ratio 2.0). Because of the small number of stimuli in her experiment, Bock was not able to assess whether this difference in the size of the priming effect was statistically reliable. At least numerically, however, the cross-constructional priming effects appears smaller than the effect of within-construction priming. In contrast to Bock's (1989) results above, this suggests that speakers may perceive the two dative and the two benefactive constructions as related but nevertheless distinct.

Moreover, the comparison with the baseline condition allows for a tentative assessment of the individual contributions that the two benefactive constructions made to the cross-constructional priming effects. Given the absence of statistical tests, the results of this analysis should be interpreted with caution, regarding them merely as potential trends in the data. Compared with baseline primes, benefactive double-object primes increased speakers' productions of transfer double-object targets by 13% (odds ratio 1.7), while *for*-dative primes increased speakers' productions of *to*-datives by only 3% (odds ratio 1.2). This seems to suggest that the cross-constructional effect was driven primarily by the benefactive double-object primes, while *for*-datives had an almost negligible influence on speakers' subsequent dative productions. As a result, the experiment provides tentative evidence that speakers encode a stronger similarity relation between the two double-object constructions than between the two prepositional constructions.

Finally, Ziegler and Snedeker’s (2018) results seem to at least partially support Bock’s (1986) findings. Using an event description task (in which participants described video animations rather than pictures), the researchers conducted a separate experiment for within-construction priming among datives (Experiment 1) and for cross-constructural priming from benefactives to datives (Experiment 6). The two experiments only differed in the prime sentences but used the same target items; their results are therefore combined in Table 4.8. Apart from that, neither of the two experiments contained a baseline condition. A potential baseline can, however, be inferred by comparing the results with Ziegler and Snedeker’s Experiment 4, which tested the effect of locative primes (i.e., *spray/load*-type sentences; see Section 4.3.2 for examples) on speakers’ dative productions, again using the same target items as in the other experiments. Since the locative primes did not give rise to any priming, it appears that speakers perceived them as unrelated to the dative targets. They can consequently be used as an approximate baseline for the other experiments and are therefore included in the final row of Table 4.8.²² Of course, the results should be interpreted with some caution given that they rely on cross-experimental comparisons rather than within-subject comparisons in a single experiment.

Table 4.8. Combined results from Ziegler and Snedeker (2018: Experiments 1, 4 and 6)

Prime type	Proportion of target productions	
	Transfer double-object	<i>to</i> -dative
Transfer double-object	57%	43%
<i>to</i> -dative	25%	75%
Benefactive double-object	61%	39%
<i>for</i> -dative	40%	60%
Locatives (approximate baseline)	35%	65%

Ignoring the baseline for a moment, the results in Table 4.8 indicate that participants produced 32% more transfer double-object targets after transfer double-object primes than

²² The values in this baseline condition are only approximations: they were calculated by averaging over the proportion of transfer double-object and *to*-dative targets produced after theme-first and theme-second locative primes in Ziegler and Snedeker’s (2018) Experiment 4 and its replication. The full range of these values was 31-36% for the transfer double-object targets and 64-69% for the *to*-dative targets; the average was weighted by the sample size of the two experiments.

after *to*-dative primes (odds ratio 4.0), and 21% more transfer double-object targets after benefactive double-object primes than after *for*-dative primes (odds ratio 2.3). Numerically, cross-constructural priming from benefactives to datives was thus weaker than within-constructural priming among datives. According to Ziegler and Snedeker's analysis, however, this difference was not statistically significant. This suggests that speakers' representations of the dative and benefactive constructions are highly similar, even though there is also a possible indication that they may not be fully identical.

As for Bock (1986) above, the contributions that the individual benefactive constructions made to the cross-constructural priming effects can be identified by comparing them with the (approximate) baseline. Since Ziegler and Snedeker did not perform statistical tests on these differences, the analysis relies on numerical trends only. The baseline comparison suggests that the cross-constructural effect of benefactive double-object primes was 26% (odds ratio 2.9) and the effect of *to*-dative primes was -5% (odds ratio 0.8). The negative proportion of the latter effect would mean that *to*-dative primes gave rise to a slightly lower proportion of *to*-dative productions than baseline primes, but given the small value, a more likely interpretation is that *to*-datives did not give rise to any priming. The data thus tentatively suggest that benefactive double-object primes may have primed at a similar rate to transfer double-object targets while *for*-datives did not prime at all, suggesting that speakers encode strong similarities between the two double-object constructions but weaker or no similarities between *to*-datives and *for*-datives.

In sum, the experiments reviewed above allow for the following conclusions. First, the evidence suggests that the transfer and the benefactive double-object construction are more similar to each other than the *to*-dative and *for*-dative construction. This aligns well with the predictions of Goldberg's (2002) Surface Generalisation Hypothesis outlined at the beginning of this section. The experimental evidence does not support a view on which datives and benefactives belong to clearly distinct alternations, and which would predict equally low rates of cross-constructural priming between the two double-object constructions and between the prepositional patterns. Instead, the findings suggest that speakers perceive the double-object constructions as functionally and formally similar, while simultaneously encoding the additional formal differences between the prepositional patterns.

Second, the data do not clearly distinguish between an account that treats the transfer and the benefactive double-object construction as polysemous constructions with related but

still separable meanings (Croft 2003; Goldberg 1995), and an account on which the two patterns are regarded as so similar that they can be subsumed under a single construction (Goldberg 2002). On the one hand, there is a potential trend in Bock's (1986) study that transfer double-object primes primed more strongly than benefactive double-object primes (25% versus 13%; see Table 4.7). This would, for instance, be compatible with Croft's (2003) view that speakers store separate verb-specific constructions that express 'actual transfer' and 'intended transfer', respectively. On the other hand, Ziegler and Snedeker's (2018) results suggest that transfer and benefactive double-object sentences gave rise to roughly equal amounts of priming (22% and 26%; see Table 4.8), thereby supporting Goldberg's (2002) arguments in favour of a single double-object schema.

Finally, under the assumption that the two double-object constructions are similar but not identical, structural priming can help assess an additional claim in the literature. Goldberg (1995) hypothesises that the two patterns are in fact asymmetrically related, with the 'intended transfer' meaning of the benefactive construction being a polysemous extension of the more central 'actual transfer' meaning of the transfer double-object construction (see Section 2.4.3 for the theoretical background). Based on this asymmetry, one might expect cross-constructural priming between the two constructions to be asymmetric, too, with potentially stronger priming from the transfer construction (the prototype) to the benefactive construction (the extension) than the other way round (see Pappert and Pechmann [2013] for this argument). The example therefore provides a first test case for the phenomenon of asymmetric priming (understood in terms of the directionality of the effect) that was introduced in Section 3.6 (other case studies will be discussed in more detail in Sections 5.2 and 5.3). Contrary to the prediction, however, two studies that have compared dative-to-benefactive with benefactive-to-dative priming have found symmetric rather than asymmetric priming. As Chang et al. (2003) report for English and Pappert and Pechmann (2013) report for the German double-object constructions, priming occurred in both directions at roughly equal magnitude. This suggests that the transfer and the benefactive double-object construction may be related via a symmetric similarity relation in speakers' grammatical networks, rather than via an asymmetric hierarchical link.

4.3.2 Priming between the *to*-dative and the locative caused-motion construction

Given that the priming evidence in the previous section suggests that *to*-datives and *for*-datives may share little similarity with each other, a relevant follow-up question is whether speakers encode a stronger similarity relation between *to*-datives and another construction *outside* the dative and benefactive alternation. In particular, another claim by Goldberg (2002) in the context of her Surface Generalisation Hypothesis is that *to*-datives are highly similar to locative caused-motion sentences, and that the two patterns can consequently be subsumed under a single ‘caused-motion’ construction. The two constructions are illustrated in (16a) and (16b), respectively (repeated from Section 2.4.4). As was outlined there, Goldberg’s view rests on the fact that the two constructions share the type of their syntactic constituents and the order of their postverbal thematic roles (theme-first). Moreover, they both potentially incorporate an element of ‘caused motion’ in their semantics (Harley 2003), even though the latter is controversial for the *to*-dative (Rappaport Hovav and Levin 2008). In the context of priming, the prediction of this view would be that the two constructions give rise to strong cross-constructional priming, potentially to the same degree as within-construction priming among instances of only one construction.

- (16) a. *The librarian gave the book to the customer.*
b. *James rolled the ball down the hill.*

In contrast to this view, which highlights both formal and functional similarities between the two constructions, other researchers have argued that the constructions are still functionally distinct (Pinker 1989; Rappaport Hovav and Levin 2008). Under this view, the ‘transfer of possession’ meaning of the *to*-dative contrasts with the ‘caused motion’ meaning of the locative caused-motion construction; by analogy, the thematic role of ‘recipient’ in the former construction differs from the ‘location’ role in the latter. In addition, the *to*-dative uses the fixed preposition *to*, whereas the locative caused-motion construction can contain a range of spatial prepositions (e.g., *(in)to, up, through, out of*). This view would predict weaker or no cross-constructional priming between the two patterns when compared with within-construction priming. It is, of course, possible that stronger priming occurs between *to*-datives and the subset of locative caused-motion sentences that contain the preposition *to* (see below for examples). In this case, the conclusion would be that speakers form an

intermediate-level generalisation below the level of abstract argument structure constructions (something like a ‘caused-motion construction with *to*’). This subschema would, however, be distinct from caused-motion patterns with other prepositions.

Finally, Goldberg (1995) seems to take an intermediate position between the above perspectives by suggesting that the meanings of the two constructions are distinguishable, but that the ‘transfer of possession’ meaning of the *to*-dative forms a metaphorical extension of the ‘physical transfer’ implied by locative caused-motion sentences. Under this view, priming would be expected to occur between the two constructions, even though perhaps at a lower rate than within-construction priming. In addition, this perspective would suggest a potential asymmetry (similar to the prototype-induced asymmetry discussed in Section 4.3.1), with potentially stronger priming from locative caused-motion sentences (the metaphorical source) to *to*-datives (the metaphorical target) than the other way round. This claim can, however, not be investigated because the priming experiments below tested priming in only one direction (but see Section 5.3 for an investigation of a potential metaphorical asymmetry).

To address the above predictions, the following discussion combines evidence from three previous priming studies (Bock and Loebell 1990; Potter and Lombardi 1998; Ziegler and Snedeker 2018). All of these studies tested priming in the direction from locative caused-motion sentences to *to*-datives, and in the absence of verb overlap between primes and their targets. Starting with Bock and Loebell’s (1990) Experiment 1, the authors used a picture description task to compare the influence of double-object primes like (17a), *to*-dative primes like (17b) and locative caused-motion primes like (17c) on speakers’ dative productions. Notably, the locative caused-motion sentences always contained the preposition *to* and should therefore be regarded as a special subtype of the broader construction.

- (17) a. *The wealthy widow sold the church an old Mercedes.*
b. *The wealthy widow gave an old Mercedes to the church.*
c. *The wealthy widow drove an old Mercedes to the church.*

(all from Bock and Loebell 1990)

Bock and Loebell’s results are summarised in Table 4.9. They show that speakers produced more *to*-datives after both *to*-datives *and* locative caused-motion primes compared

with double-object primes. This seems to suggest that cross-constructional priming by the locative caused-motion sentences was as strong as within-construction priming among the *to*-datives, in line with the view that the two constructions can be subsumed under a single caused-motion construction. While Bock and Loebell interpreted their findings as evidence that structural priming primarily reflects formal-syntactic similarity (see the discussion in Section 3.2), the results are also compatible with the above view that speakers perceive the meanings of the two constructions as highly similar.

Table 4.9. Results from Bock and Loebell (Bock and Loebell 1990: Experiment 1)

Prime type	Proportion of target productions	
	Transfer double-object	<i>to</i> -dative
Double-object	75%	25%
<i>to</i> -dative	68%	32%
Locative caused-motion	65%	35%

Bock and Loebell's experiment is, however, subject to severe limitations, which cast some doubt on the reliability of the above interpretations. First, as mentioned above, the researchers tested locative caused-motion sentences with the preposition *to*, so their findings are only reflective of the degree of similarity between this specific subtype and *to*-datives, but they do not necessarily generalise to the fully abstract locative caused-motion construction. Second, their experiment did not contain a baseline condition; it is therefore at least theoretically possible that the priming effect was driven primarily by double-object primes, whereas *to*-dative and locative caused-motion primes may have had little effect on speakers' target productions. Third, there are some potential concerns about Bock and Loebell's stimuli. In some of the *to*-dative primes, the recipients denoted institutions that have to be interpreted metonymically (e.g., *the church* in (17b)); this could have potentially weakened the priming effect of these sentences compared with *to*-datives that contain prototypical animate referents. Moreover, as noted by Ziegler and Snedeker (2018: 222), some of the locative caused-motion primes in fact expressed transfer of possession events rather than change of location (e.g., *The hospital returned the bill to the patient by mistake*), thus leading to partial overlap with the *to*-dative condition.

A subsequent study by Potter and Lombardi (1998) suggests that these concerns about Bock and Loebell's results are indeed justified. In three sentence recall experiments, Potter and Lombardi tested, among other things, how often participants misrecalled a double-object target as a *to*-dative after having been primed with *to*-datives, locative caused-motion sentences (again, restricted to the preposition *to*) and intransitive baseline primes. In contrast to Bock and Loebell's stimuli, however, their *to*-dative examples contained prototypical animate recipients (e.g., *the manager*) and their locative caused-motion sentences expressed change of location events (e.g., *move the ashtray to another table*). Across all three experiments, Potter and Lombardi found that the proportion of misrecall was highest after *to*-dative primes (approximately 45% in Experiment 1), lower after locative caused-motion primes (approximately 29%) and lowest after baseline primes (approximately 14%).²³ The differences between all three conditions were statistically significant. This suggests that the locative caused-motion sentences did prime speakers' *to*-dative productions, but that the cross-constructural effect was smaller than within-constructural priming among the *to*-datives. As a result, speakers seem to encode similarities between *to*-datives and locative caused-motion sentences with the preposition *to*, but the two constructions are nevertheless functionally distinct enough to give rise to diverging priming patterns.

Finally, Ziegler and Snedeker (2018) conducted two event description experiments to test how strongly *to*-datives were primed by locative caused-motion sentences with *varying* prepositions. In contrast to the previous two studies, they thus targeted the similarity relation between the two fully abstract constructions, rather than restricting the locative caused-motion construction to the preposition *to*. In their Experiment 11, the authors compared the effect of double-object primes like (18a), *to*-dative primes like (18b) and locative caused-motion primes like (18c) on speakers' subsequent dative productions. Importantly, the locative caused-motion primes (which Ziegler and Snedeker call 'motion verb primes') featured a range of different prepositions, including *against*, *around*, *behind* and *under*.

- (18) a. *The woman threw the bird the ball.*
b. *The woman threw the ball to the bird.*

²³ The values for Potter and Lombardi's (1998) Experiment 1 are estimated based on visual inspection of their results plot; the authors do not report the exact values in the text.

c. *The woman raised the ball above the bird.*

(all from Ziegler and Snedeker 2018)

In addition, in their Experiment 4, Ziegler and Snedeker tested the effect of two further ‘locative’ constructions on speakers’ dative productions: theme-first locative primes as in (19a) and theme-second locative primes as in (19b). While these two patterns are typically regarded as the members of the ‘locative alternation’ (or *spray/load* alternation; see Sections 2.4.2 and 4.1.1), theme-first locatives can in fact also be classified as instances of the locative caused-motion construction (Goldberg 2002). Not only do theme-first locatives fulfil all the characteristics of the locative caused-motion construction as outlined in Section 2.4.4, but they can also contain varying prepositions (e.g., *in, on, around*). Ziegler and Snedeker’s theme-second locative stimuli, on the other hand, differ from the locative caused-motion construction in the order of their thematic roles (location–theme) and their non-locative preposition (*with*).

(19) a. *The boy sprayed the water on the plant.*

b. *The boy sprayed the plant with the water.*

(both from Ziegler and Snedeker 2018)

The results of Ziegler and Snedeker’s Experiments 4 and 11 can therefore be combined to examine priming between the locative caused-motion construction and the *to*-dative.²⁴ If the two constructions are highly similar, then the locative caused-motion primes in (18c) and (19a) should both facilitate *to*-dative productions, potentially to the same degree as *to*-dative primes (18b); meanwhile, they should behave differently from the theme-second locative primes in (19b). Table 4.10 provides a summary of Ziegler and Snedeker’s results.

²⁴ One potential concern is that Ziegler and Snedeker’s (2018) Experiment 4 only included a subset (namely, two thirds) of the target items that they tested in their Experiment 11. As a result, the target proportions might differ between the two experiments, thus making a cross-experimental comparison difficult. This concern seems unwarranted, however, given that the proportions of *to*-dative targets after double-object and *to*-dative primes in Experiment 1, which used the same target items as Experiment 4, were similar to the proportions after the same prime types in Experiment 11 (43% and 75% versus 49% and 73%; compare Table 4.8 and Table 4.10).

Table 4.10. Combined results from Ziegler and Snedeker (2018: Experiments 4 and 11)

Prime type	Proportion of target productions	
	Transfer double-object	<i>to</i> -dative
Double-object	51%	49%
<i>to</i> -dative	27%	73%
Locative caused-motion	38%	62%
Theme-first locatives	34%	66%
Theme-first locatives	35%	65%

Focusing first on the three top rows in Table 4.10 (from Ziegler and Snedeker’s Experiment 11), the proportion of *to*-dative targets after locative caused-motion primes (62%) was higher than after double-object primes (49%) but lower than after *to*-dative primes (73%). The differences between all three prime conditions were statistically significant. The fact that the locative caused-motion primes fell almost exactly in between the two other conditions raises the possibility that the locative caused-motion construction may not have had any priming effect on speakers’ dative productions. This is further supported by the two bottom rows of Table 4.10 (from Ziegler and Snedeker’s Experiment 4), which show that the proportion of *to*-dative targets was almost identical after both types of locative primes (66% and 65%), and also similar to the locative caused-motion primes from Experiment 11. The fact that the three conditions all patterned together suggests that none of these prime constructions affected speakers’ subsequent dative productions (for this reason, the two locatives from Experiment 4 were used as a neutral baseline in Section 4.3.1). These results do not support the view that *to*-dative and locative caused-motion sentences are highly similar to each other.

In sum, the structural priming evidence suggests that speakers’ representations of the *to*-dative construction and the locative caused-motion construction are distinct. Especially when the latter is considered in its more abstract form, containing different spatial prepositions, Ziegler and Snedeker’s (2018) results cast doubt on the view that speakers encode strong similarities between the two constructions. Cross-constructural priming between the patterns has only been found when the locative caused-motion construction is restricted to its specific subtype with the preposition *to*, thus creating additional overlap with the *to*-dative. But even then, Potter and Lombardi’s (1998) study, which avoids the limitations

of Bock and Lobell's (1990) design discussed above, suggests that the cross-constructural priming effect is less strong than within-constructural priming among *to*-datives.

As a result, the experimental findings indicate that speakers encode functional differences between *to*-datives and locative caused-motion sentences, in line with the view that the constructions differ in constructural meaning and thematic role structure (Rappaport Hovav and Levin 2008). In contrast, the results do not directly support Goldberg's (2002) view that the two constructions can be subsumed under an overall 'caused-motion' construction. This does not necessarily mean that speakers encode *no* partial formal and/or functional similarities between the constructions. The fact that locative caused motion sentences with *to* prime *to*-datives raises the possibility that speakers encode similarities between the constructions, even though it is unclear how much of the effect is simply driven by the identical prepositions (see Bock and Loebell [1990]; Ziegler et al. [2019] for discussion). Moreover, given that structural priming may only reflect strong, i.e., cognitively salient, similarities between constructions, it may still be possible to posit a higher-level, potentially weakly entrenched, 'caused-motion' schema that links the two patterns. As far as the above studies are concerned, however, there is no evidence that such an abstract schema forms a salient part of speakers' grammatical networks.

4.3.3 Interim summary

This section has illustrated that structural priming can shed light on the similarity relations between members of different constructural alternations (and even with a construction outside those alternations). In this way, the experimental results contribute further to the theoretical debate about the status of these alternations. Focusing on five specific argument structure constructions, the above analyses have demonstrated that the priming evidence supports several (but not all) aspects of Goldberg's (2002) Surface Generalisation Hypothesis.²⁵

²⁵ Apart from the constructions discussed here, cross-constructural priming has been tested between a few other alternating patterns. For example, some studies have found priming between the members of the dative alternation and the 'fulfilling' alternation (Cho-Reyes et al. 2016; Hare and Goldberg 1999; Ziegler and Snedeker 2018: Experiment 7; see also Section 3.2). The fulfilling alternation encompasses the theme-first fulfilling construction (e.g., *The boy presented the trophy to the athlete*) and the theme-second fulfilling (or 'provide-with') construction (e.g., *The boy presented the athlete with the trophy*; Ziegler and Snedeker 2018). In addition, Ziegler and Snedeker (2018: Experiment 10) tested priming between the fulfilling alternation and the locative alternation (see Section 4.3.2 for examples), but they did not find any cross-constructural effect.

As shown in Section 4.3.1, previous priming results suggests that speakers encode a strong similarity relation between the transfer and the benefactive double-object construction, while the link between *to*-datives and *for*-datives is weaker or potentially absent. These findings support Goldberg’s claim that speakers generalise across members of different alternations, and that these cross-constructural links depend on the individual constructions (with a stronger link between the double-object patterns and a weaker or no link between the prepositional patterns). Combining this with the evidence presented in Section 4.2 that the similarities that speakers encode between members of the *same* alternation may be weaker than often assumed, the results thus provide psycholinguistic support for Goldberg’s critique of the cognitive salience of alternations.

On the other hand, the priming results discussed in Section 4.3.2 do not corroborate Goldberg’s extended claim that *to*-datives are highly similar to locative caused-motion sentences and that the two patterns can therefore be subsumed under a single broadly construed caused-motion construction. The evidence suggests that cross-constructural priming from locative caused-motion sentences to *to*-datives is weaker or potentially absent compared with within-construction priming among *to*-datives. Even when the locative caused-motion construction is restricted to the preposition *to*, the priming results indicate that it still patterns differently from *to*-datives. This provides further evidence that structural priming can index some of the more fine-grained patterns of formal and functional similarity within speakers’ grammatical networks.

4.4 Summary: insights and open questions from priming among alternating constructions

The analyses in this chapter have illustrated the use of structural priming to study similarity relations within and between alternating argument structure constructions. For this purpose, previously unconnected results from a range of priming studies were linked up and reinterpreted in the context of a cognitive-linguistic network model of grammar. It was argued that priming provides an important source of psycholinguistic evidence that can inform theoretical models of the grammatical network and help address the four theory-related questions outlined in Chapter 2, as well as some of the methods-related concerns raised in Chapter 3.

First, it was demonstrated throughout the chapter that priming can index varying degrees of similarity among instances of the same and related constructions (Q_T 1). Second, Section 4.1 presented evidence from priming that speakers form generalisations at multiple levels of abstraction, including lexically specific lower-level schemas and abstract higher-level schemas (Q_T 2). Third, Sections 4.2 and 4.3 illustrated that priming supports the view – in some cases, at least tentatively – that speakers represent different types of similarity relations between argument structure constructions (Q_T 3). These include patterns that are both formally and functionally similar (e.g., the transfer and the benefactive double-object construction) as well as patterns that only share functional similarities but are formally distinct (e.g., the double-object and the *to*-dative construction). Fourth, the same findings were used to adjudicate between competing theoretical claims about the status of constructional alternations (Q_T 4). Overall, the structural priming evidence provides at least partial support for Goldberg’s (2002) Surface Generalisation Hypothesis, according to which alternations may be cognitively less salient than often assumed, and which highlights additional similarities between members of different alternations.

On the methodological side, a few innovative techniques have been applied to derive these interpretations. First, the analyses have highlighted the importance of baseline comparisons for the fine-grained interpretation of priming results. In Section 4.1.3, baselines were used to compare the strength of within-construction priming among different constructions; in Section 4.2.2, they were necessary to distinguish between within- and cross-constructional priming; and in Section 4.3.1, they were crucial for identifying the cross-constructional effects between individual pairs of constructions. Second, in Section 4.2, two novel strategies were applied to overcome the challenge of distinguishing between within-construction and cross-constructional priming when the two effects co-occur in the same experiment (Q_M 2 from Chapter 3). One strategy is to compare the observed target proportions with the proportions that would be expected if no cross-constructional priming occurred; this entails an analysis of participants’ ‘other’ responses (Section 4.2.2). The second strategy is to examine the effect that a third member of the alternation has on the two other members in a setting where only cross-constructional priming occurs (Section 4.2.3). These methods yielded a nuanced picture of the priming results, which partially differs from previous interpretations of the same data.

Besides these insights, the discussions have also highlighted some limitations of the existing priming literature, and desiderata for further research. First, comparing the analyses in Sections 4.1 with the ones in Sections 4.2 and 4.3, it is evident that the number of studies that have tested cross-constructural priming is considerably smaller than for within-construction priming. As a result, some of the discussions of cross-constructural priming have relied on a relatively small set of experiments, which sometimes yielded conflicting results. In a few instances, this has made it difficult to discriminate between theoretical accounts, for example regarding the question of whether speakers encode the transfer and the benefactive double-object construction as polysemous but distinguishable patterns, or as part of a single construction (see Section 4.3.1). Further studies of cross-constructural priming between these and other constructions would be needed in order to draw more reliable and fine-grained conclusions about the structure of speakers' grammatical networks.

Second, even though Section 4.2 outlined potential strategies for distinguishing between within-construction and cross-constructural priming in production settings, these techniques nevertheless had limitations. In particular, the analysis of 'other' target productions is based on the (idealised) assumption that these 'other' targets are directly reflective of activation levels in speakers' grammatical networks (see Section 4.2.1 for discussion). Given the tentative nature of these analyses, it is worth considering whether other priming methods could allow for a more straightforward distinction between within-construction and cross-constructural priming. As mentioned in Section 3.3, comprehension priming methods may be a promising candidate since most of these methods yield independent outcomes, such as response times.

Third, the discussion in this chapter has been restricted to a relatively small set of alternating argument structure constructions. The reason for this, it was noted, is that these constructions have been the focus of most previous priming studies, with a particularly strong bias towards the two dative constructions. In order to generalise the findings to the whole class of argument structure constructions, however, both within-construction and cross-constructural priming should also be tested among constructions that do not participate in alternations. Some of these non-alternating constructions may be related in ways that are distinct from the ones discussed in this chapter; for instance, relations that are based on (partial) formal overlap but functional differences. It remains to be seen whether structural priming can provide evidence of such similarity relations.

In Chapter 5, some steps will be taken to address the three research desiderata just outlined. The experiments reported in the chapter will extend priming to a previously understudied group of non-alternating constructions. Both within-construction and cross-constructional priming will be tested among these constructions to determine the strength of their respective similarities. To achieve this goal, the experiments will exploit the potential of comprehension priming methods.

5 Extending the scope of structural priming: comprehension experiments with non-alternating constructions

Having discussed priming among alternating constructions in the previous chapter, this chapter addresses the question to what extent priming can also shed light on the similarity relations between non-alternating constructions. As already noted in Section 3.3, most previous priming studies of argument structure constructions have focused on alternating patterns only, such as the members of the dative alternation. Little attention has been given to how the paradigm can be extended to investigate priming between non-alternating argument structure constructions.

To address this research gap, the present chapter outlines a methodological approach that uses comprehension methods – in particular, a version of self-paced reading known as the ‘maze task’ (Forster et al. 2009) – to investigate priming between previously understudied constructions. To motivate this approach, Section 5.1 explains first why the widely used production priming methods (which were the focus of Chapter 4) cannot be straightforwardly applied to non-alternating constructions. It is then argued that comprehension methods offer a more flexible alternative that may enable researchers to extend the scope of priming to new constructions. The specific advantages of the maze task for investigating constructions with (partial) formal overlap are outlined.

Sections 5.2 and 5.3 illustrate this approach with practical applications. Section 5.2 reports two novel comprehension priming experiments that examine the similarity relation between the resultative and the depictive construction. Given that these patterns have not been systematically tested in a priming setting, the experiments address both theoretical questions about the status of the constructions in speakers’ grammatical networks, and methodological questions about how the priming effects can be measured and interpreted. Section 5.3 discusses another experiment (first presented in Ungerer 2021) that applies the same methodological approach to a different phenomenon: the relation between the caused-motion and the resultative construction. The focus here is on whether the priming results support previous theoretical claims about an asymmetric metaphorical link between the constructions. Moreover, the discussion addresses an interesting methodological feature, namely the occurrence of inhibitory (rather than facilitatory) priming, which has so far been seldom reported in the structural priming literature.

In this way, the empirical analyses in this chapter provide further answers to both the theory-related and methods-related questions raised in Chapters 2 and 3. The theoretical focus is in particular on whether speakers encode a particular type of similarity relation – namely, between constructions that share aspects of their form but potentially differ in function (Q_T 3); and whether the priming evidence can thus help assess previous theoretical claims about these relations (Q_T 4). On the methodological side, the present chapter addresses the question of which priming methods can be used to study non-alternating argument structure constructions (Q_M 1) and whether these methods help differentiate between within-construction and cross-constructural priming (Q_M 2). Moreover, compared with Chapter 4, the discussion places special emphasis on the two final methods-related questions: which factors may determine the (a)symmetry of the priming effects (Q_M 3), and which conditions give rise to facilitatory and inhibitory priming (Q_M 4).

5.1 Using comprehension priming to test non-alternating constructions

As noted above, extending structural priming to non-alternating argument structure constructions requires certain methodological adjustments. The following discussion outlines these methodological preliminaries, which will form the basis for the experiments reported in Section 5.2. Section 5.1.1 explains why production priming methods cannot be easily applied to non-alternating patterns like the resultative, depictive and caused-motion construction, and why comprehension methods offer a more promising alternative. Section 5.1.2 outlines how self-paced reading methods can be used to study these specific constructions. Finally, Section 5.1.3 introduces a particular variant of self-paced reading known as the ‘maze task’ (Forster et al. 2009) and describes its advantages over more traditional comprehension techniques. The experiments in the remainder of the chapter will then provide practical examples of how the maze task can be applied to specific case studies.

In line with its methodological focus, this section addresses the first two methods-related questions outlined in Chapter 3: which priming methods can be used to study non-alternating argument structure constructions (Q_M 1), and how within-construction and cross-constructural priming can be distinguished in the respective experiments (Q_M 2).

5.1.1 The flexibility of comprehension priming

As briefly explained in Section 3.3, the main reason why production priming methods cannot usually be applied to non-alternation constructions is that these methods rely on what Branigan and Pickering (2017) call ‘structural alternatives’. In a picture description task, for instance, participants typically choose between two target constructions that express the depicted events in (roughly) equally felicitous ways. The same principle applies to sentence completion tasks and sentence recall tasks. Structural alternatives are, by definition, available for alternating constructions like the double-object and the *to*-dative construction. The same is not true, however, for non-alternating constructions like the (adjectival) resultative, the (object-oriented) depictive and the (prepositional) caused-motion construction (henceforth simply ‘resultative’, ‘depictive’ and ‘caused-motion’). Compare the examples in (1): in each case, there is no obvious alternative construction that speakers could use to encode the same event.

- (1) a. *Susan hammered the metal flat.*
b. *Richard ate the steak raw.*
c. *James rolled the ball down the hill.*

Besides this main challenge, there is a second reason why the most commonly used production priming methods are difficult to apply to the constructions in (1), especially to the ones in (1a) and (1b). These methods rely on the fact that speakers freely produce the target constructions. However, the resultative and the depictive are relatively rare constructions, so it may be difficult to elicit them from participants with the help of pictures or sentence fragments. In both cases, participants might often simply produce monotransitive structures (e.g., *Richard ate the steak*).

Both of these problems can be overcome by using comprehension priming methods. With respect to the first challenge, most comprehension methods (perhaps with the exception of ‘visual world’ eye-tracking) do not require structural alternatives that describe the same event. Instead of participants’ structure choices, these techniques yield outcome measures that do not depend on a comparison between alternatives, for example reading times or gaze durations. As for the second challenge, comprehension methods are well suited for testing rare constructions because experimenters can choose the exact stimuli that

participants encounter, rather than having to induce participants to produce the constructions themselves.

Two more advantages of comprehension priming methods deserve to be highlighted here. First, they allow for a straightforward distinction between within-construction and cross-constructional priming. This is in stark contrast to production methods, which make it difficult to separate the two types of priming effects when they occur in the same experiment (see Section 4.2). The difference between the methods is again due to the nature of their outcome measures. Comprehension measures such as reading times consist of mutually independent outcomes: i.e., speakers' responses to one target type are unaffected by their responses to the other target type. As a result, it can be clearly determined whether a particular prime construction affects participants' responses to targets of the same type (within-construction priming), targets of a different type (cross-constructional priming), or both. This is different from the structure choice proportions obtained in production experiments, where an increase in the proportion of one target construction automatically leads to a decrease in the proportion of the other target construction(s).

Second, compared with production methods, comprehension priming provides a more direct window into speakers' 'online', i.e. real-time, processing of constructions. While the structure choices obtained in production experiments only reflect the final outcome of a production process, comprehension measures such as reading times index the processing costs that speakers incur as they gradually encounter a sentence. This is particularly useful for determining the exact location at which speakers' processing differs depending on the experimental condition. In the context of priming, for example, this can help determine which elements of two constructions speakers perceive as similar, and at what point in the sentence they start treating the patterns as distinct (see Sections 5.2 and 5.3 for applications of this logic).

As illustrated by these points, comprehension priming affords researchers the crucial flexibility that is needed to extend priming to a more diverse range of constructions. As noted in Section 3.3, the proportion of priming studies examining comprehension has increased over the recent years, and it has been predicted that this trend is likely to continue (Branigan and Pickering 2017). The experiments reported in this chapter contribute to this ongoing trend. To lay out their methodological foundations, the next step is to identify which particular

comprehension method is suitable for testing non-alternating constructions such as the resultative and the depictive.

5.1.2 Extending comprehension methods to argument structure constructions

As was pointed out in the theoretical analyses in Section 2.4, the resultative, depictive and caused-motion construction display formal similarities. The resultative and the depictive are, in fact, identical in terms of their syntactic constituents, while the caused-motion and resultative construction only differ in their sentence-final constituent, which consists of a prepositional phrase in the caused-motion construction and an adjective phrase in the resultative. Due to these formal similarities, the constructions can occur in temporarily ambiguous sentences; compare the examples in (2) and (3). The resultative and depictive examples in (2) are perfectly ambiguous until the final adjective is reached. The caused-motion and resultative sentences in (3) are ambiguous up to the verb, and they are still structurally similar at the first postverbal noun phrase, even though they typically combine with different types of object nouns (see Section 5.3.2). On the other hand, they are fully disambiguated at the first word of their final phrase (preposition versus adjective).

- (2) a. *Max cooked the chicken tender.*
b. *Gary cooked the chicken whole.*
- (3) a. *Sarah swept the glass into the bin.*
b. *Nancy swept the floor clean.*

The temporary ambiguity of these sentences hints at a suitable comprehension method that can be used to test the constructions in a priming setting. As noted in Section 3.3, two methods that have been applied to priming among temporarily ambiguous structures are self-paced reading and eye-tracking. Traxler and Tooley (2008), for instance, employed these techniques to test speakers' processing of active main clauses such as (4a) and reduced passive relative clauses as in (4b). In their Experiment 1, which used eye tracking, participants read reduced relative targets while the researchers recorded their eye movements at the disambiguating region (e.g., *by the lawyer*). In their Experiment 4, which made use of self-paced reading, participants read these sentences word by word while the researchers

measured their reading times. Across both experiments, the authors found that participants' gaze durations and reading times at the critical region of the reduced relative targets were shorter when they had been primed with a reduced relative clause instead of a main clause (see also Tooley et al. 2019; Traxler et al. 2014).

- (4) a. *The defendant examined the glove but was unreliable.*
b. *The defendant examined by the lawyer was unreliable.*
(both from Traxler and Tooley 2008)

As pointed out in Section 3.3, self-paced reading and eye-tracking have usually been applied to test priming of garden-path phenomena like the reduced relative clause examples above, which give rise to temporary misinterpretations because a more frequent alternative structure is available. The methods have, however, been hardly applied to priming among argument structure constructions, let alone non-alternating argument structure constructions.¹ Comparing the examples in (4) with the resultative, depictive and caused-motion sentences in (2) and (3), however, it becomes apparent that they involve similar temporary ambiguities. As a result, it seems feasible to extend comprehension methods like self-paced reading beyond garden-path phenomena and apply them to the specific type of argument structure constructions examined here, namely pairs of constructions that share (partial) formal overlap. In particular, the following section will describe a specific variant of self-paced reading that can be used for this purpose and which provides additional advantages over the traditional version of the method.

5.1.3 A variant of self-paced reading: the 'maze task'

Forster et al. (2009) introduced the 'maze task' as a novel variant of self-paced reading that can potentially overcome some of the limitations of the traditional method (note that these limitations also largely apply to eye-tracking). In 'pure' self-paced reading, sentences are displayed word by word and participants press a button to continue to the next word. A first limitation of this method is that it provides little incentive for participants to read the

¹ Tooley and Bock (2014) used self-paced reading to test priming among the double-object and *to*-dative construction. Note, however, that they did not find a statistically reliable effect for these constructions (see their discussion for a potential item-based confound).

sentences carefully and pay attention to their meaning, let alone their subtler structural features. To ensure participants' in-depth processing, additional attention checks need to be added to the task. For example, self-paced reading experiments often include comprehension questions about the sentence contents after a subset of the stimuli.

A second challenge for pure self-paced reading is the occurrence of spillover effects: the influence a particular word has on participants' processing may only manifest itself several words later in the sentence, which makes it more difficult to pinpoint the exact location of the effect. This is a result of the time it takes participants to integrate words with their prior context during rapid incremental processing. Delayed manifestations of the effects are particularly problematic when the critical region falls on the last word in the sentence, as in the resultative and depictive examples above in (2).

Third, participants' reaction times in pure self-paced reading are typically very fast, of the order of a few hundred milliseconds per word. Differences in reading time between conditions may thus be numerically small, which can make it more difficult to detect statistically reliable effects. This may be less of an issue in studies of garden-path phenomena (see above), where participants' expectations are contradicted at the disambiguating region, thus leading to a more pronounced slowdown in reading time. For the resultative, depictive and caused-motion examples in (2) and (3) above, however, there may not be a clear asymmetry between the constructions such that participants would perceive one pattern as much more surprising than the other. Differences in reaction time depending on the prime construction may therefore be smaller.

The maze task aims at overcoming all three of these challenges. In this task, participants still read sentences word by word, but at every step they have to choose between a correct sentence continuation and an incorrect distractor word. This is illustrated in Figure 5.1, which shows a typical maze trial using a resultative stimulus from Experiment 1 reported in Section 5.2.2. With the exception of the first word, each correct word (e.g., *cooked*) is accompanied by a contextually inappropriate distractor (e.g., *sheets*); see below for how suitable distractors can be chosen.² The primary outcome measure in the maze task is the

² Witzel et al. (2012) call this version of the maze task the 'G(rammaticality)-maze' and contrast it with the 'L(exicality)-maze'. In the latter version, each correct word is accompanied by a non-word rather than a contextually inappropriate but existing word. Given Boyce et al.'s (2020) evidence that the G-maze yields larger and more reliable effects than the L-maze, only the G-maze is used in the present investigation.

time it takes participants to select between the alternatives (a secondary measure is their accuracy at choosing the correct option).

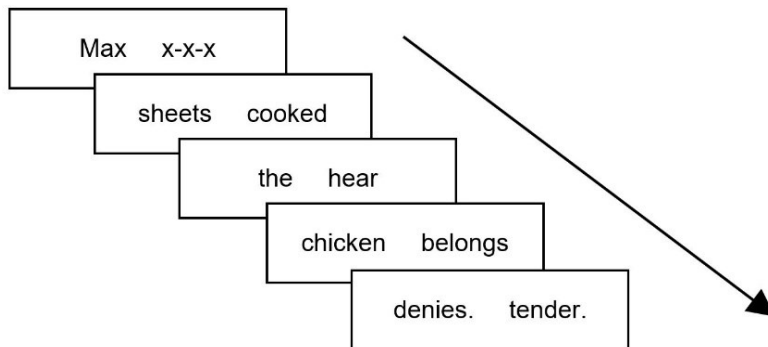


Figure 5.1. Sample trial in the standard maze task

The maze task has several advantages over pure self-paced reading (Forster et al. 2009; Forster 2010; Witzel et al. 2012). First, the task provides participants with an incentive to pay attention to the form and meaning of the stimuli in order to make an informed choice about the appropriate sentence continuation. As a result, additional comprehension questions are not needed to ensure participants' understanding of the experimental sentences. Second, the maze task avoids spillover effects because participants have to integrate each word with the preceding context before being able to choose between the competing options. Evidence for this comes from Boyce and Levy (2020), who found that the surprisal of a word in the maze task did not predict participants' response times at the following word, suggesting that the effects did not spill over to the following segment (see also Boyce et al. 2020). Finally, response times in the maze task are generally longer than in pure self-paced reading, ranging between 800 and 1,000 ms in Forster et al.'s (2009) original study. Consequently, differences in response time between experimental conditions tend to be numerically larger, which may make it easier to filter out confounding factors and isolate the critical effects in the statistical analysis.

These arguments are further supported by direct comparisons between the maze task and pure self-paced reading, which have found that maze experiments provide stronger and more reliable indications of several well-known sentence processing effects (Boyce et al. 2020; Witzel et al. 2012). In line with this, an increasing number of studies have used the maze task to investigate a variety of processing-related phenomena in languages like English,

German, Mandarin and Japanese. This includes studies of syntactic ambiguities and garden-path sentences (Boyce et al. 2020; Witzel et al. 2012), scrambled word order (Witzel and Witzel 2016), reflexive pronouns (Li et al. 2017), information structure (Sikos et al. 2017) and lexical effects in sentence contexts (Gallant and Libben 2020; Witzel and Forster 2014).

From a practical perspective, further applications of the maze task have been facilitated by the introduction of Boyce et al.'s (2020) 'A(uto)-maze'. This software package consists of code for running maze experiments online and for automatically creating the contextually inappropriate distractor words. The latter are generated using a natural language processing model. The model selects distractors that resemble the correct maze continuations in word length and overall corpus frequency, but which have a high surprisal value given the preceding words in the sentence. The A-maze software was also used for the experiments reported in this chapter (see Section 5.2).

The preceding comments illustrate why the maze task has become an increasingly popular tool in sentence processing research over the recent years. Despite this trend, however, the method has so far been rarely used in priming experiments. Notable exceptions are Gallant and Libben (2020) and Hilpert and Correia Saavedra (2018), but neither of these studies specifically investigate structural priming. Instead, Gallant and Libben used the maze task to test lexical priming, and Hilpert and Correia Saavedra focused on a special type of priming between lexical and grammatical uses of the same word (e.g., between *go (somewhere)* and *be going to*). The experiments described in Sections 5.2 and 5.3 are therefore among the first attempts to apply the maze task to structural priming. It will be assessed whether the maze task provides a suitable methodology for testing priming between previously understudied non-alternating constructions, and what insights the results can provide about the way in which speakers represent and process the respective patterns.

5.2 Priming between the resultative and the depictive construction

This section reports two novel experiments that make use of the above comprehension method – the maze task – to extend structural priming to a pair of non-alternating argument structure constructions. The specific example concerns the relationship between the (adjectival) resultative and the (object-oriented) depictive construction. As argued in Section 2.4.3, these patterns are usually subsumed under the label of 'secondary-predication constructions', but their exact degree of (functional) similarity remains an

empirical question. The experiments below assess to what extent priming among the two constructions can shed light on their relation within speakers' grammatical networks. To date, these investigations appear to constitute the first systematic attempt to study resultatives and depictives in a controlled priming setting.³

Beyond that, the experiments pursue several methodological objectives. They aim to illustrate that it is possible to extend structural priming to an understudied set of non-alternating argument structure constructions. Moreover, they explore the potential of a relatively new comprehension method – the maze task – for enabling such an extension of the paradigm. For this purpose, the experiments use two different versions of the method. Experiment 1 (in Section 5.2.2) employs the 'standard' version of the maze task, as described in Section 5.1.3. Meanwhile, Experiment 2 (in Section 5.2.3) uses a new 'modified' maze task in which participants choose directly between the two competing target constructions, thus introducing a production-oriented element into a comprehension setting.

Section 5.2.1 outlines the specific research questions for the experiments, linking them to the larger theory-related and methods-related questions raised in Chapters 2 and 3. Sections 5.2.2 and 5.2.3 describe the methods and results of the experiments, and address their theoretical and methodological implications. Section 5.2.4 provides a summary of the findings.

5.2.1 Research questions

Given the lack of previous research on priming between resultatives and depictives (and other non-alternating argument structure constructions), the following experiments address a number of theory- and methods-related research questions. On a theoretical level, the experiments test whether priming provides evidence of similarity relations among the resultative and the depictive construction. This includes within-construction priming among instances of the same construction as well as cross-constructional effects between the two

³ Resultatives and depictives have been investigated in one previous maze task study (De Souza and Oliveira 2017), but the researchers compared the overall processing difficulty of the patterns, rather than testing priming between them. They also investigated the constructions in Brazilian Portuguese rather than English. Moreover, Eddington and Ruiz de Mendoza (2010) conducted a structural priming experiment that included instances of the resultative and what can be called the 'predicative complement' construction (e.g., *Josh thought the treatment fair*; see also Himmelmann and Schultze-Berndt 2005). The two patterns, however, appeared alongside 10 other constructions in the study, whose goal was to assess differences in constructional meaning more generally, rather than testing the relation between specific patterns. Moreover, the study used relatively informal methods: the sample size was small, the experiment did not include baseline primes, and the statistical analysis was rudimentary.

distinct constructions. As outlined in the theoretical analysis in Section 2.4.3, resultatives and depictives are formally (near-)identical but they display characteristic differences in function. While resultatives express a change of state of the object argument as a result of the event, depictives encode a concomitant state that applies to the object argument during the event. Nevertheless, the fact that the two patterns are typically subsumed under the umbrella of ‘secondary predication’ constructions suggests that they may still share some aspects of their meaning.

Based on previous theoretical analyses, it is therefore unclear what degree of similarity speakers may perceive between the two constructions. Priming can inform this discussion by revealing whether processing one construction affects the activation level of the other construction in speakers’ grammatical networks. If cross-constructional priming between the resultative and the depictive is absent, this would suggest that speakers perceive the constructions as clearly distinct, and that their formal similarity is not sufficient for activation to spread between the patterns in real-time processing. If, on the other hand, cross-constructional priming occurs between the constructions, and if the effects are perhaps even similar in strength to within-construction priming, this would suggest that speakers represent the constructions not only as formally, but potentially also as functionally related. In this way, the experiments in the following sections inform two of the theory-related questions outlined in Chapter 2: whether structural priming can index the degree of similarity between argument structure constructions (Q_T 1), and whether it provides evidence that speakers encode a specific type of similarity relation – in this case, a similarity link between constructions with (near-)identical form that appear to be at least partially distinct in function (Q_T 3).

Besides these theoretical goals, the experiments examine several methodological aspects of structural priming, thus addressing all four methods-related questions raised in Chapter 3. First, they test whether a particular comprehension priming method – the maze task – can be used to study structural priming between non-alternating argument structure constructions such as the resultative and the depictive (Q_M 1). Section 5.1 outlined reasons for why such an extension of the structural priming paradigm seems feasible, but it remains to be seen how suitable the particular method chosen here is. Given that the maze task has scarcely been employed in a priming context before, the following experiments use two different versions of the task to explore their respective potentials (the ‘standard’ and a ‘modified’ version). One particular feature of these experiments is that they use stimuli that

are temporarily ambiguous between a resultative and a depictive interpretation (e.g., *Max cooked the chicken tender / whole*). This ensures that participants cannot predict which construction the targets instantiate before reaching the sentence-final adjective. It also avoids the confounding influence that different lexicalisations of the prime constructions could have on participants' response times. Moreover, using temporarily ambiguous sentences is a precondition for the modified maze task used in Experiment 2 (see Section 5.2.3): in this version of the task, participants choose between two legitimate endings for the ambiguous target sentences.

As a second methodological goal, the experiments explore whether within-construction and cross-constructional priming effects can be clearly distinguished when interpreting the results of the maze task ($Q_M 2$). As argued in Section 5.1.1, such a distinction should be straightforward due to the independent nature of the response times that are obtained in the maze task. This, it was argued, constitutes an advantage of comprehension priming techniques over production methods, where it can be difficult to distinguish between the two types of priming effects (see Section 4.2). The discussion of Experiment 1 (see Section 5.2.1) will illustrate whether within-construction and cross-constructional effects can be successfully separated.

Third, the experiments address a methodological aspect (with theoretical implications) that has only been briefly discussed in the analyses of Chapter 4. If cross-constructional priming occurs between resultatives and depictives, an additional question is whether the effects are symmetric (i.e., emerging equally strongly in both directions) or asymmetric (i.e., occurring more strongly in one direction than the other), and what factors may determine this (a)symmetry ($Q_M 3$). Most of the previous cross-constructional studies examined in Chapter 4 tested priming only in one direction and were therefore not able to shed light on the symmetry of the effects (see Section 4.3.1 for an exception). In contrast, the experiments in this section investigate priming between resultatives and depictives systematically in both directions. If the effects turn out to be asymmetric, the question will be whether this asymmetry can be explained by differences in the frequency of the constructions (as suggested in Section 3.5), or what other factors may play a role.

Finally, another methodological question that has gained little attention in previous structural priming research concerns the conditions under which facilitatory or inhibitory effects occur in priming, and how the respective effects can be interpreted ($Q_M 4$). As

suggested in Section 3.6, both effects could emerge in a comprehension setting because previous activation of a prime construction could either facilitate the same construction or inhibit a competing alternative. The following experiments examine whether priming between resultatives and depictives manifests itself as facilitation or inhibition. This will also allow for fruitful comparisons with another recent study that tested priming between caused-motion and resultative sentences (see Section 5.3).

5.2.2 Experiment 1: standard maze task

The first experiment addresses the research questions outlined in the previous section, using the standard version of the maze task as introduced in Section 5.1.3.

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. Multiple participation by the same worker was prevented with the help of the “Unique Turker” script (<https://uniqueturker.myleott.com/>). 150 participants were excluded because they made errors in more than 50% of trials in the maze task; these participants were replaced by 150 new participants. Participants’ mean age was 38.6 years (SD = 11.4, range 20-77, three unreported); 141 were right-handed and 16 left-handed (three unreported). The study was approved by the PPLS Research Ethics Committee at the University of Edinburgh (reference number 100-2021/3) and all participants gave informed consent before starting the experiment.

Materials

To create the critical stimuli, 20 verbs were chosen that are compatible with both the resultative and the depictive construction. For each verb, one resultative sentence and one depictive sentence were formed which contained the same object noun phrase. The critical items thus consisted of 20 resultative and 20 depictive sentences, all of which had the structure ‘animate subject [proper name] – verb – inanimate object [definite/possessive determiner + common noun] – adjective’. Examples of the items are provided in Table 5.1; the full list of the materials is included in Appendix A (Table A1). To minimise lexical overlap between the stimuli, each resultative-depictive pair used a different subject and a different

object; moreover, none of the sentence-final adjectives were used in more than four experimental items.

Table 5.1. Examples of primes and targets in Experiment 1

PRIMES		TARGETS	
Construction	Examples	Construction	Examples
Resultative	<i>Max cooked the chicken tender.</i>	Resultative	<i>Nancy cut the grass short.</i>
Depictive	<i>Gary cooked the chicken whole.</i>	Depictive	<i>John cut the grass wet.</i>
Unrelated	<i>Susan sang in the shower.</i>		

To assess the acceptability of the resultative and depictive stimuli, they were pretested with another 40 participants recruited via Amazon Mechanical Turk, who were asked to judge the acceptability of the sentences on a Likert scale from 1 to 7. Only items that received a median rating above the middle of the scale, i.e., a rating of 4 or higher, were included in the main experiment. This relatively lenient threshold was chosen because some of the depictive items, in particular, did not receive very high ratings. Across all items, acceptability ratings for the depictives (mean = 4.68; median = 5) were lower than for the resultatives (mean = 5.86; median = 6). This difference between the constructions is statistically significant, as was confirmed both with a linear mixed model (assuming that the Likert ratings constitute interval data; $\beta = 1.197$, $SE = 0.252$, $t = 4.746$, $p < 0.001$) and a cumulative link mixed model (assuming that the ratings constitute ordinal data; $\beta = 1.537$, $SE = 0.376$, $Z = 4.086$, $p < 0.001$).⁴ The influence that the acceptability of the constructions may have had on the priming results will be addressed again in the discussion below.

In addition to the critical items, the materials included 60 instances of unrelated constructions, whose purpose was twofold. They served as fillers between the critical pairs; and when directly preceding resultative or depictive sentences, they functioned as a baseline condition to test processing of those targets in the absence of priming. The sentences instantiated a variety of unrelated constructions: monotransitives, ditransitives, intransitives with locative adjuncts, verb + prepositional object constructions, and verb + *to*-infinitive

⁴ The models were fitted in R (R Core Team 2020), using the packages *lme4* (Bates et al. 2015) and *lmerTest* (Kuznetsova et al. 2017) for the linear mixed model, and the package *ordinal* (Christensen 2019) for the cumulative link mixed model. Both models included random intercepts for participants and items, and a random by-participant slope for the construction.

structures. An example of an unrelated item is shown in Table 5.1. In total, the experiment thus had six conditions which resulted from crossing the three prime constructions (resultative, depictive and unrelated) with the two target constructions (resultative and depictive).

For the purposes of the maze task (see 'Procedure' below), each word of each sentence (except for the first word) was associated with a distractor, i.e., an existing English word that did not form a sensible sentence continuation given the preceding words. Distractors were automatically created using Boyce et al.'s (2020) 'A(uto)-maze', which selects words from a natural language processing model (Gulordava et al. 2018) that match their correct counterparts in length and corpus frequency, but have low contextual probability. The automatically chosen distractors were then manually adjusted if they still formed legitimate sentence continuations, or were rare or register-specific (e.g., poetic, colloquial).

Items were pseudo-randomised to create eight different lists, each distributed to 20 participants. Every participant saw all 100 sentences once during the experiment. For each list, the resultative and depictive stimuli were 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 the first and in the second half of the experiment. The lists consisted of five blocks, each of which contained four resultative and/or depictive prime-target pairs in random order, interspersed with two to four unrelated sentences between every critical pair. The resultative and depictive stimuli that were lexically identical except for their subject and final adjective (see above) occurred in different halves of the experiment. In addition, the order of some items was manually adjusted to minimise the conceptual overlap between primes and targets (e.g., to prevent two resultative items with semantically similar adjectives from directly following each other).

Procedure

The experiment was hosted online on Ibex Farm (Drummond 2013). Participants completed five practice trials prior to the start of the experiment. During the experiment, the sentences were then presented one after the other using the 'maze' format; the procedure was identical for prime and target trials. In each maze trial, 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 5.1 in Section 5.1.3 for illustration). The position of the words was randomly determined. Participants pressed 'e' or 'i' to select the word on the left or on the right. 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 three filler trials.

Data analysis

Visual inspection revealed that the response times were right-skewed, so they were log-transformed (base 10) to render their distribution more normal (Baayen and Milin 2010). Only the response times at the sentence-final adjective of the resultative and depictive sentences were retained for the analysis. All trials that contained an error, i.e., in which participants had chosen an incorrect sentence continuation, were excluded.⁵ Moreover, the trials that immediately followed these trials were also discarded since participants had not been fully primed in those cases. This led to the exclusion of 22.2% of the data. For outlier removal, all response times below 200 ms and above 3000 ms were discarded (a further 1.2% 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 were removed (1.4% of the remaining data). In total, this left 4,812 data points for the analysis.

The statistical analysis was conducted in R (R Core Team 2020). A linear mixed model was fitted using the packages *lme4* (Bates et al. 2015) and *lmerTest* (Kuznetsova et al. 2017) to test the effect of the prime conditions on participants' response times at the adjective of the resultative and depictive sentences. The main variables of interest were target construction (resultative versus depictive), prime construction (resultative versus depictive versus unrelated) and their interaction. In order to factor out additional variance in the data, further predictors were chosen in a backward stepwise fashion, retaining only those that

⁵ An additional analysis was conducted to test whether participants' accuracy in the maze task, i.e., their likelihood of correctly completing a target trial, varied depending on the prime construction. According to a mixed-effects logistic regression model, however, participants' error rates did not differ significantly between prime conditions, nor depending on the interaction between prime and target constructions.

significantly improved the model fit (based on a likelihood ratio test and the AIC criterion). The ‘bobyqa’ optimiser was used to facilitate model convergence. As a result, the final model included trial number (centred around the mean), word length of the adjective (i.e., number of letters; centred around the mean) and position of the adjective on the screen (left or right). Age and handedness, however, did not significantly improve the model and were therefore excluded. The maximal random effects structure that led to model convergence consisted of intercepts for participants, target sentences and prime sentences as well as a by-participant slope for the target construction.⁶

Since the focus of the analysis is on the interaction between prime and target constructions (which was significant, see below), this interaction was further investigated via planned comparisons using the package *emmeans* (Lenth 2021). For each of the two target constructions, it was assessed whether participants’ response times differed between any of the three prime conditions (using the command `emmeans(model.lmer, pairwise ~ prime_cxn | target_cxn)`). The reported *p*-values were adjusted for multiple comparisons using the Tukey method; degrees of freedom were estimated asymptotically.

Results

If priming occurred in the experiment, it should manifest itself as a main effect of the prime constructions or as an interaction between the prime and target constructions. That this interaction had indeed an effect on participants’ response times was confirmed by comparing a model that included the interaction term with a model that only included main effects for the prime and target construction. The model that included the interaction was a significantly better fit for the data ($\chi^2(2) = 11.238, p = 0.004$). The discussion will therefore focus on the results of the pairwise comparisons that were used to further probe the nature of this interaction. Apart from that, the regression model also indicated that participants’ response times were influenced by three other predictors: trial number (responses became faster the further participants progressed with the experiment); screen position (participants’ responses were faster when the correct word was on the left, most likely as a result of left-

⁶ An additional model was constructed that contained a three-way interaction between prime construction, target construction and trial number, given that some comprehension studies have found priming effects to increase over the course of the experiment (Fine et al. 2013; Kim et al. 2014). Including this interaction, however, only marginally improved the model fit ($\chi^2(2) = 10.668, p = 0.058$). Moreover, the predictions for the effects of prime and target construction were almost identical in the models that included or excluded the three-way interaction; only the simpler model without the three-way interaction is therefore reported here.

to-right reading); and word length (participants' responses were faster the shorter the adjective was). None of these effects are surprising; their details can be gleaned from the full model output in Appendix B (Table B1).

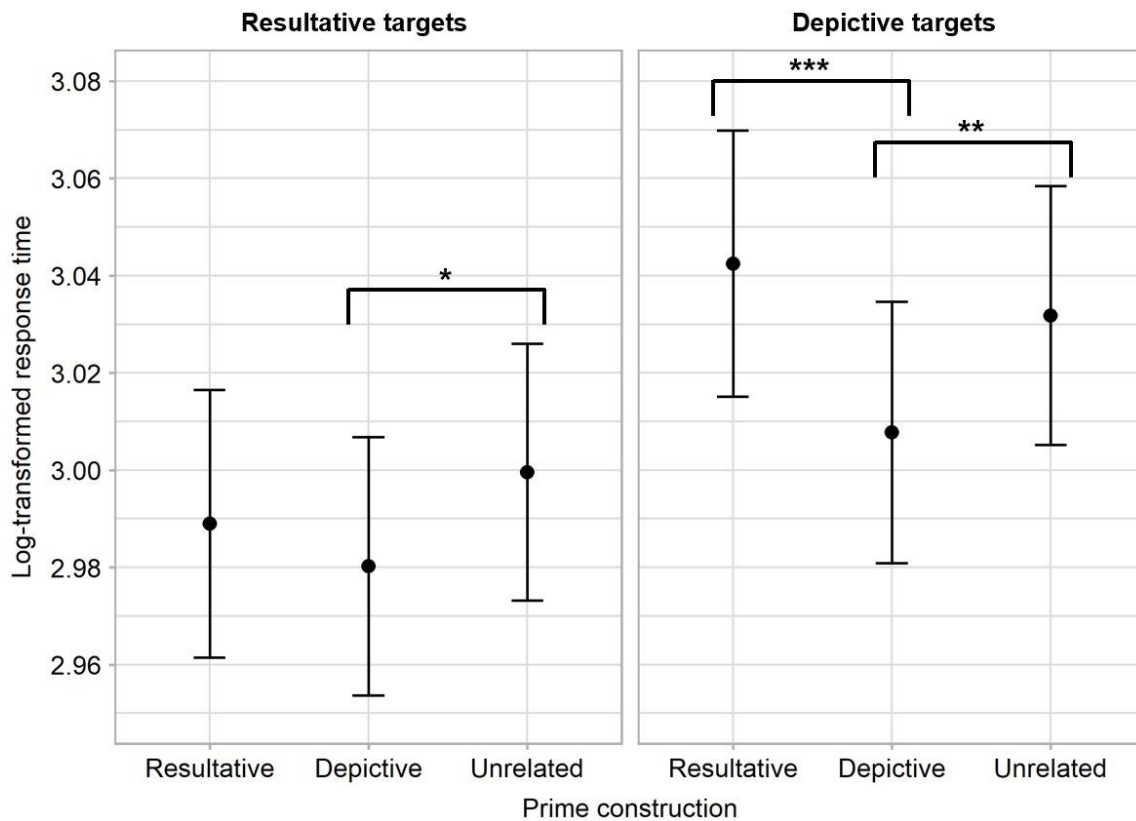
As far as the critical effect of the prime constructions on participants' response times is concerned, Table 5.2 provides the results of the pairwise comparisons between prime conditions for each target construction. In the two rightmost columns, the statistically significant results are back-transformed from logged into actual response times; both absolute estimates (in ms) and relative estimates of those differences (in %) are provided. Moreover, the model estimates are graphically represented in Figure 5.2, which also highlights the statistically significant differences.

Table 5.2. Pairwise comparisons of log10-transformed response times between resultative, depictive and unrelated primes for each target construction in Experiment 1

Target cxn	Diff. between prime cxns (A minus B)	Estimate	SE	Z	p (adjust.)	Sign.	Diff. in ms	Relative diff.
RES	RES - DEP	0.009	0.0076	1.156	0.480			
	RES - UNREL	-0.011	0.0071	-1.495	0.293			
	DEP - UNREL	-0.019	0.0070	-2.768	0.016	*	-44.0	-4.6%
DEP	RES - DEP	0.035	0.0075	4.597	<0.001	***	85.5	7.7%
	RES - UNREL	0.011	0.0071	1.498	0.292			
	DEP - UNREL	-0.024	0.0070	-3.427	0.002	**	-58.5	-5.7%

Sign. codes: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$; RES = resultative; DEP = depictive; UNREL = unrelated.

As Table 5.2 shows, participants responded faster to the sentence-final adjective of resultative targets after depictive primes than after unrelated primes (by an estimated margin of 44.0 ms). With respect to the depictive targets, participants responded faster to those targets after depictive primes than after both resultative primes (by 85.5 ms) and unrelated primes (by 58.5 ms). None of the other contrasts were statistically significant.



Sign. codes: '*' $p < 0.05$; '**' $p < 0.01$; '***' $p < 0.001$; whiskers represent 95% confidence intervals.

Figure 5.2. Model estimates of log₁₀-transformed response times for resultative targets (left) and depictive targets (right) depending on the prime construction in Experiment 1

In addition to illustrating the differences between the prime constructions, Figure 5.2 also suggests that participants generally responded faster to resultative targets than to depictive targets. In order to test whether this difference was reliable across all three prime types, a second set of pairwise comparisons was conducted, which contrasted participants' response times to the two target constructions after each prime construction (using the command `emmeans (model.lmer, pairwise ~ target_cxn | prime_cxn)`). The results confirm that participants' responses to resultative targets were faster than their responses to depictive targets after all three types of primes, with the estimated differences ranging between 62.6 ms and 127.7 ms (after resultative primes: $\beta = -0.053$, $p < 0.001$; after depictive primes: $\beta = -0.028$, $p = 0.014$; after unrelated primes: $\beta = -0.032$, $p = 0.003$).

Discussion

The results of Experiment 1 indicate that compared with the unrelated baseline, previous exposure to depictive primes speeded up participants' responses *both* to depictive targets and to resultative targets. This may, to date, constitute the first evidence that effects

of within-construction and cross-constructural priming can be observed among the English resultative and the depictive construction. The implications of these results are unpacked step by step below, following the research questions outlined in Section 5.2.1.

In terms of the similarity relations among speakers' constructional representations, the results suggest that speakers encode similarities both among different instances of the depictive construction (giving rise to within-construction priming) and between instances of the depictive and the resultative construction (giving rise to cross-constructural priming). As far as the cross-constructural effect is concerned, one interesting question is whether this effect was driven purely by the formal overlap between the two constructions, or whether participants additionally perceived their meanings as similar. The latter possibility appears feasible given the previous evidence that priming is sensitive to differences in constructional meaning (see Section 3.2 and Chapter 4). Under this view, if participants were to encode resultatives and depictives as fully functionally distinct (i.e., as 'homonymous' constructions; see Section 2.4.3), one would expect cross-constructural priming between the constructions to be weaker. In the present experiment, however, the effects of within-construction and cross-constructural priming were roughly equal in magnitude (58.5 ms and 44.0 ms). This suggests that speakers encode both formal and functional similarities between resultatives and depictives. The conclusion should, however, be regarded as tentative since the maze task has not been previously applied in structural priming and could potentially be more sensitive to certain (e.g., formal) characteristics than to other (e.g., functional) features.

Given that the depictives primed both depictives and resultatives to such similar degrees, another question is whether participants were at all aware of the difference between the two patterns, or whether they treated them as instances of a single 'secondary predication' construction. Some tentative evidence that participants were sensitive to the semantic difference between the constructions comes from the resultative prime conditions. Note that participants' responses to depictive targets were considerably slower after these resultative primes than after depictive primes, while their responses to resultative targets did not differ in statistically significant ways after resultative and depictive primes. Moreover, numerically at least (see Figure 5.2 above), responses to depictive targets after resultative primes were slower than in the baseline, while responses to resultative targets after resultative primes were faster than in the baseline. These results together suggest a potential trend such that resultative primes facilitated resultative targets but inhibited depictive targets

– even though the effects are too small to be statistically reliable. Tentatively, then, the data support the view that speakers encode the resultative and the depictive construction as similar but still distinct patterns in their grammatical networks.

Since the results thus suggest that the two patterns are neither homonymous, i.e., functionally unrelated, nor fully identical in their constructional meanings, they seem more akin to the concept of ‘polysemous’ constructions discussed in Section 2.4.3. On this view, the result state encoded by resultatives and the concomitant state expressed by depictives could be seen as extensions of a broader ‘secondary predication’ schema, which captures the fact that the sentence-final constituent predicates a state over the object argument but leaves the type of predicative relationship underspecified. It may, of course, still be possible to distinguish degrees of constructional polysemy between different phenomena: for example, the functional similarity between resultatives and depictives may be weaker than between the transfer and the benefactive double-object construction discussed in Section 4.3.1, which merely differ in the type of transfer of possession that they specify (‘actual’ versus ‘intended’ transfer). These gradual differences in the degree of functional similarity thus lend further support to the view that constructions are situated along a continuum between homonymy and polysemy, an idea that is widely accepted in the literature on lexical relations (Cowie 1982; Tuggy 1993).

On the methodological side, the results also have a number of relevant implications. First, the experiment provides evidence that the maze task can successfully capture within-construction and cross-constructional priming effects among non-alternating argument structure constructions. The method may thus provide an opportunity to extend the structural priming paradigm beyond its traditional focus on alternating patterns and use it to investigate a wider range of phenomena. Second, the above analysis of response times allowed for a clear distinction between within-construction and cross-constructional priming effects. This illustrates the advantages of measuring mutually independent outcomes such as response times in a comprehension priming setting, rather than obtaining complementary structure choice proportions as in most production priming experiments.

Third, the priming results in this experiment were strikingly asymmetric: while depictive primes led to a change in participants’ processing of both depictive and resultative targets, resultative primes did not affect participants’ responses in a statistically significant way (despite numerical tendencies). In this sense, both types of asymmetric priming

introduced in Section 3.5 occurred: asymmetric within-construction priming because instances of the depictive construction primed each other while instances of the resultative construction did not; and asymmetric cross-constructional priming because depictives primed resultatives but not vice versa.

Three possible factors suggest themselves that may contribute to these asymmetries. First, depictives are potentially less frequent than resultatives, thus giving rise to stronger priming in line with the inverse frequency effect (Ferreira and Bock 2006; see Sections 3.5 and 4.1.3). One explanation for this effect is that infrequent structures conflict more strongly with speakers' prior expectations and thus have a more significant influence on the connection weights and resulting activation patterns in their mental networks. Given the absence of large-scale corpus studies of English depictives and resultatives, it is difficult to compare their respective constructional frequencies. Nevertheless, an informal search of the ENCOW16A-NANO web corpus (Schäfer 2015; Schäfer and Bildhauer 2012) suggests that depictives are less frequent than resultatives, especially if 'lexical' resultatives (with verbs such as *make/turn/render*, which entail a change of state) are included among the latter (see also Section 5.2.3 for additional evidence of the frequency differences).⁷

A second factor for the occurrence of asymmetric priming may be the acceptability of the prime constructions: in the pretest (see 'Materials' above), the depictive stimuli received lower average acceptability ratings than the resultative stimuli. Applying a similar argument as for the inverse frequency effect, primes with lower acceptability may have induced stronger surprisal among participants in the main experiment and thus led to stronger priming. A third factor may be differences in the processing difficulty of the constructions, given the above result that participants' responses to depictives were generally slower than for resultatives, irrespective of the prime condition. Note that this construction-specific effect emerged independently of the word length of the sentence-final adjective, which was factored out by the statistical model. Since depictives were more difficult to process, it is possible that participants paid more attention to the depictive primes, which consequently had a larger effect on speakers' target responses.

⁷ The query used to search for resultative and depictive instances in ENCOW16A was: [tag = "DT|PP\$"] [tag = "N.*"] [tag = "V.*" & lemma != "be|have|do"] [tag = "DT|PP\$"] [tag = "N.*"] [tag = "JJ.*"]. One challenge that more in-depth corpus-based comparisons of the two constructions would need to overcome is that automatic POS-tagging may not be reliable for the sentence-final adjectives (e.g., *open* and *shut* may be incorrectly tagged as verbs in *push the door open/shut*).

Based on the present experiment, it is not possible to determine which of the three factors gave rise to the priming asymmetries. It is, of course, also feasible that the results emerged from a combination of these factors, which may be partially correlated: for instance, instances of infrequent constructions are likely to be less acceptable and induce a higher processing cost than frequent structures. Nevertheless, by highlighting that priming asymmetries may be influenced by other parameters besides frequency, the present discussion goes beyond previous accounts of priming asymmetries, which have focused mostly on frequency-based explanations. Further work could try to isolate the different factors and assess their respective modulatory effects on priming.

Finally, with respect to the distinction between facilitation and inhibition, all statistically significant effects in the present experiment were facilitatory. The occurrence of facilitatory cross-constructional priming suggests that speakers' representations of the resultative and the depictive construction are similar enough to enhance the retrieval of the related pattern. Even though there was, as noted above, a numerical tendency that resultative primes may have inhibited depictive targets relative to the unrelated baseline, this possible reflex of competition between the constructions was not statistically significant and therefore remains tentative. As will be discussed in Section 5.3, these results contrast in an interesting way with evidence from priming between the caused-motion and the resultative construction.

5.2.3 Experiment 2: modified maze task

The standard version of the maze task that was used in Experiment 1 is a comprehension method: rather than producing the target constructions themselves, participants merely have to recognise them by discriminating the correct sentence elements from contextually inappropriate distractor words. In this task, participants are only ever confronted with one of the constructions – either the resultative or the depictive – at a time, instead of having to choose directly between them. While the results of Experiment 1 thus provide evidence that participants' comprehension of resultatives and depictives is influenced by previous exposure to the constructions, they leave open the question of whether priming can also affect participants' *productions* of the two patterns. Experiment 2 tests this by using a novel modified version of the maze task in which the constructions are

presented simultaneously and participants have to actively choose between the competing options. Before discussing the experiment, the method will be described in more detail.

The modified maze task

The novel version of the maze task used in the experiment below exhibits one crucial difference from the standard task: at the final word of the target sentences, participants do not choose between a correct resultative or depictive adjective and an incorrect distractor, but they instead select between two adjectives that instantiate a legitimate resultative and depictive continuation, respectively. This is made possible by the fact that the critical items in the present experiments are ambiguous between a resultative and depictive interpretation until the sentence-final adjective is reached. A sample trial for this modified task (using a stimulus from Experiment 2) is depicted in Figure 5.3, which contrasts with the earlier illustration of the standard maze task in Figure 5.1 (see Section 5.1.3). In the example, participants choose between correct words and incorrect distractors at all points during the sentence except for the final word, where they select between a resultative adjective (*tender*) and a depictive adjective (*whole*).

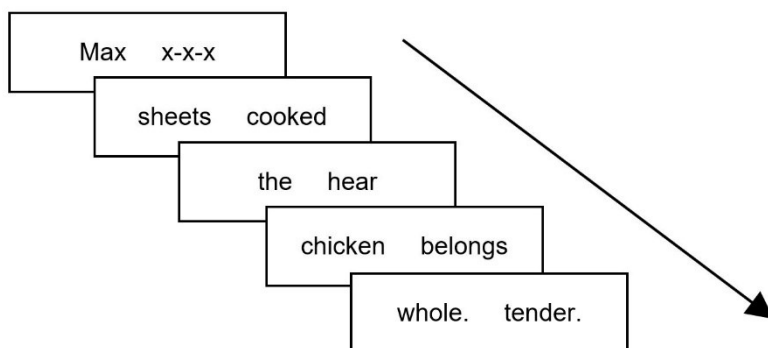


Figure 5.3. Sample trial in the modified maze task

This modified maze task combines the comprehension setting of the standard method with an additional element of forced choice between competitors. The latter can be regarded as a production-oriented element because participants have to actively choose the construction with which they complete the temporarily ambiguous sentences. In conventional forced choice experiments, participants are explicitly told to choose between the competing options. For example, Rosenbach (2003) asked participants to select between *s*-genitives and *of*-genitives in a cloze task, and Bresnan (2008) had participants choose

between a double-object and a *to*-dative continuation to continue a story fragment. In contrast, the modified maze task provides an opportunity to integrate the forced choice element *covertly* into a comprehension method that already requires continuous choices between two alternatives. Instead of explicitly telling participants that they may need to choose between two competing constructions, they are only instructed to select the word that “best continues the sentence” (see ‘Procedure’ below). Participants are therefore unlikely to be aware of the purpose of the task, especially given that the choice between two legitimate options only arises at the final word of the target sentences, while all the other maze choices in the targets, primes and filler items involve only one correct option and a distractor.

As a result, the modified maze task constitutes a hybrid method that combines a comprehension setting – which allows experimenters to design the stimulus sentences according to their wishes – with forced choice production. In line with its hybrid nature, the method yields two outcome measures: the primary measure is participants’ structure choice at the final target word (resultative versus depictive); a secondary measure is their response time when making the choice. Importantly, the complementary nature of the structure choice proportions, i.e., the fact that an increase in the proportion of one target construction automatically leads to a decrease in the proportion of the other construction, means that the modified maze task is subject to similar limitations as the ones discussed for production priming methods in Sections 3.4, 3.6 and 4.2. Specifically, structure choice proportions do not allow experimenters to distinguish between within-construction and cross-constructural priming (since one effect may overshadow the other) and between facilitatory and inhibitory priming (since the two types of effects cannot be assessed independently).

As a result, Experiment 2 cannot address all of the research questions outlined in Section 5.2.1. Rather, the focus is on the methodological question of whether the modified maze task presents a viable alternative to the standard maze task, and whether it thus allows researchers to test priming between resultatives and depictives in a more production-oriented setting (see Q_M 1 in Chapter 3). The potential of the method will be assessed in the discussion of the experimental results at the end of this section.

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 prohibit participants who had already participated in Experiment 1 from participating again, and to prevent multiple participation by the same worker. 99 participants were excluded because they made errors in more than 50% of trials in the maze task. One further participant was excluded because they identified as a non-native speaker. These participants were replaced by 100 new participants. Participants’ mean age was 37.0 years (SD = 10.0, range 19-72, five unreported); 145 were right-handed and 14 left-handed (one unreported). The study was approved by the PPLS Research Ethics Committee at the University of Edinburgh (reference number 100-2021/3) and all participants gave informed consent before starting the experiment.

Materials

The critical items were, in principle, identical with the ones from Experiment 1. They consisted of 20 pairs of resultatives and depictives; the sentences in each pair contained the same verb and object argument (and were therefore temporarily ambiguous). When these sentences occurred as primes, they were displayed in the exact same way as in Experiment 1, with each word being accompanied by a contextually inappropriate distractor. When the stimuli occurred as targets, however, they needed to be displayed differently as part of the modified maze task. For this purpose, a new target item was created for each pair of partially identical resultatives and depictives. In these targets, each word was paired with an incorrect distractor except for the final word, where the choice instead consisted of a resultative and a depictive adjective (see Figure 5.3 for illustration). Examples of the items are provided in Table 5.3; for the targets, the example in the rightmost column illustrates the choice between the resultative and the depictive continuation at the sentence-final adjective.

In addition to the critical items, the materials included 45 instances of unrelated constructions, which were selected from the unrelated sentences in Experiment 1. They served as fillers between the critical pairs; and when directly preceding the resultative/depictive targets, they functioned as a baseline condition to test processing of

those targets in the absence of priming. In total, the experiment thus had three conditions, which varied only in the prime construction (resultative, depictive and unrelated).

Table 5.3. Examples of primes and targets in Experiment 2

PRIMES		TARGETS	
Construction	Examples	Construction	Examples
Resultative	<i>Max cooked the chicken tender.</i>	Resultative / depictive	<i>Nancy cut the grass short / wet.</i>
Depictive	<i>Gary cooked the chicken whole.</i>		
Unrelated	<i>Susan sang in the shower.</i>		

Items were pseudo-randomised to create eight different lists, each distributed to 20 participants. In each experimental list, 15 of the resultative/depictive pairs were used as resultative/depictive targets (which combined both constructions in one item). The members of the other five pairs, i.e., the remaining 10 resultatives and depictives, were used as primes (which only instantiated one construction), alongside five unrelated primes. The resultative and depictive primes from the same pair (which were lexically identical except for their subject and sentence-final adjective) occurred in different halves of the experiment. This means that across all lists, each resultative or depictive sentence appeared three quarters of the time as part of a target (equally often after resultative, depictive and unrelated primes), and one quarter of the time as a prime. Each sentence also appeared equally often in the first and in the second half of the experiment. As in Experiment 1, the order of some items was manually adjusted to minimise the conceptual overlap between primes and targets. Every participant saw all 70 sentences once during the experiment. The lists consisted of five blocks, each of which contained three prime-target pairs in random order, interspersed with two to four unrelated sentences between every critical pair.

Procedure

The experiment was hosted online on Ibex Farm (Drummond 2013). The procedure was identical to Experiment 1, with two exceptions. First, the instructions at the beginning were slightly adapted for the purposes of the modified maze task. Instead of telling participants that there would only be one correct sentence continuation at each word, the instructions said merely that one option would “form a better continuation” than the other. In addition, participants were told that, if they thought both options made sense, they should

still select the word that intuitively seemed better to them. This was intended to prepare participants for the possibility that there could sometimes be two legitimate options, while still keeping the instructions intentionally vague. The second difference from Experiment 1 was that Experiment 2 was shorter, so there was only one break after roughly 60% of the experiment.

Data analysis

As for Experiment 1, all trials that contained an error, along with the trials that immediately followed them, were excluded (20.0% of the data).⁸ The analysis was restricted to the sentence-final adjective of the target sentences. Visual inspection revealed that the response times at the adjective were right-skewed, so they were log-transformed (base 10). For outlier removal, all response times below 200 ms and above 3000 ms were discarded (a further 5.0% of the data). Moreover, all logged response times that were more than 2.5 standard deviations above or below each participant's mean were removed (0.3% of the remaining data). In total, this left 1,793 data points for the analysis.

To analyse the two outcome measures – participants' structure choices and their response times – two separate mixed-effects models were fitted using the R packages *lme4* (Bates et al. 2015) and *lmerTest* (Kuznetsova et al. 2017). Participants' structure choices were analysed with a logistic mixed-effects model; response times were analysed with a linear mixed model. In both cases, the variable of interest was the prime construction. Additional predictors were chosen in a backward stepwise fashion; this only led to the inclusion of trial number (centred around the mean).⁹ Age, handedness, screen position (of the resultative and the depictive adjective relative to each other) and word length difference (between the resultative and the depictive adjective) did not significantly improve the model fits and were therefore excluded. The random effects structures were kept maximal as long as they led to

⁸ An additional analysis was conducted to test whether participants' accuracy in the maze task varied depending on the prime construction. Interestingly, a mixed-effects logistic regression model revealed that participants' made slightly more errors in target sentences that were preceded by resultative or depictive primes compared with unrelated primes (unrelated versus resultative primes: $\beta = -0.678$, $p = 0.008$; unrelated versus depictive primes: $\beta = -0.754$, $p = 0.003$). This seems initially surprising, but can potentially be explained by the fact that participants responded faster after resultative and depictive primes (see 'Results' below), thus perhaps responding less carefully. Nevertheless, given that the errors could occur anywhere in the sentence, not necessarily at the critical adjective, they are not further discussed here.

⁹ The interaction between prime construction and trial number was also tested in case the priming effects accumulated over the course of the experiment (see note 6 above); but this interaction did not improve the model fits.

model convergence (using the ‘bobyqa’ optimiser). Both models contained random intercepts for participants, target sentences and prime sentences (by-participant slopes for the prime construction could not be included because they produced singular fits).

Results

Focusing first on participants’ structure choice proportions, Table 5.4 summarises the output of the logistic mixed model (see Table B2 in Appendix B for the full regression table). First, the negative intercept indicates that participants generally produced more resultative than depictive responses in the experiment. Transforming the estimate back into percentages, the model estimates that participants selected an average of 78.4% resultatives and 21.6% depictives after unrelated baseline primes. Second, the variable of interest – the prime construction – did not have a statistically significant effect on participants’ target responses. As the second and third row of Table 5.4 illustrate, the proportion of participants’ resultative and depictive responses did not vary after resultative, depictive and unrelated primes. Finally, there was a statistically significant effect of trial number, suggesting that the further participants progressed in the experiment, the more often they chose a depictive over a resultative continuation. According to the model estimate, the proportion of depictive responses (after unrelated primes) increased from around 17.7% at the beginning of the experiment to around 25.9% at the end of the experiment.

Table 5.4. Effects of prime constructions and trial number on the proportion of depictive responses in Experiment 2

Fixed effects	Estimate	SE	Z	p	Sign.
(Intercept)	-1.287	0.266	-4.842	<0.001	***
prime_cxn = “RES” (reference level = “UNREL”)	0.112	0.165	0.681	0.496	
prime_cxn = “DEP” (reference level = “UNREL”)	0.049	0.167	0.294	0.769	
trial_number_centred	0.007	0.003	2.232	0.026	*

Sign. codes: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$; RES = resultative; DEP = depictive; UNREL = unrelated.

The fact that participants produced considerably more resultative than depictive responses suggests that they might not have perceived both constructions as equally feasible candidates for the targets. One reason for this may be that several of the depictive items

received only medium acceptability ratings in the pretest conducted for Experiment 1 (see Section 5.2.2, ‘Materials’). It seems possible that these less acceptable items are less amenable to priming and therefore obscure a potential effect of the prime constructions. To test this, an additional analysis of participants’ structure choice proportions was conducted including only target items which, in their depictive form, had received median ratings of 6 or higher (out of 7) in the pretest for Experiment 1. The new logistic mixed model had a similar structure to the one for the entire dataset, but it did not include trial number as a predictor (because the factor did not improve the model fit) nor the random intercept for prime sentences (which led to a singular fit). The model estimates are summarised in Table 5.5 (see Table B3 in Appendix B for the full regression table).

Table 5.5. Effects of prime constructions on the proportion of depictive responses for a subset of highly acceptable targets in Experiment 2

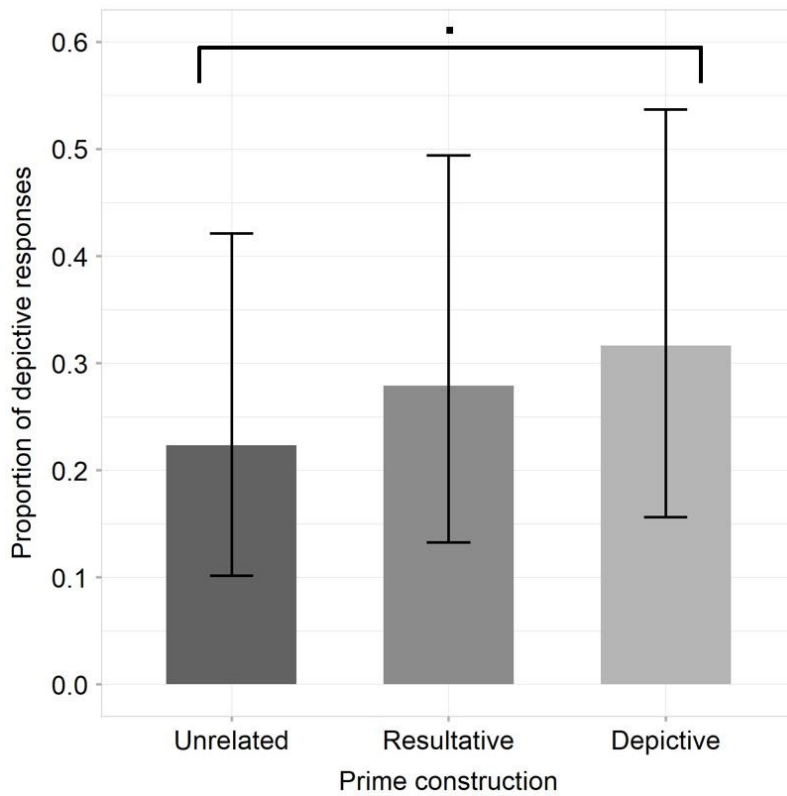
Fixed effects	Estimate	SE	Z	p	Sign.
(Intercept)	-1.248	0.475	-2.628	0.009	**
prime_cxn = “RES” (reference level = “UNREL”)	0.298	0.274	1.089	0.276	
prime_cxn = “DEP” (reference level = “UNREL”)	0.478	0.259	1.846	0.065	.

Sign. codes: ‘.’ $p < 0.1$; ‘*’ $p < 0.05$; ‘**’ $p < 0.01$; ‘***’ $p < 0.001$; RES = resultative; DEP = depictive; UNREL = unrelated.

The model for the subset of highly acceptable targets yielded a marginally significant effect suggesting that participants selected more depictive responses after depictive primes than after unrelated primes. This corresponds to a 9.4% increase in the proportion of depictive targets after depictive primes. Meanwhile, there was no statistically significant difference between target proportions after resultative and unrelated primes. The results are visualised in Figure 5.4, which highlights the marginally significant difference between depictive and unrelated primes for highly acceptable targets.

Finally, Table 5.6 summarises the outcomes of the linear mixed model that was used to analyse participants’ response times, i.e., the speed with which they chose between the resultative and the depictive adjective in the targets (see Table B4 in Appendix B for the full regression table). The results indicate statistically significant effects of the prime constructions suggesting that compared with unrelated primes, participants’ responses were

faster after resultative primes (by an estimated 66.1 ms) and after depictive primes (by 83.8 ms). Moreover, there was a significant effect of the trial number, indicating that participants responded faster the further they progressed in the experiment.



Sign. codes: ‘.’ $p < 0.1$; whiskers represent 95% confidence intervals.

Figure 5.4. Model estimates for the proportion of depictive responses after resultative, depictive and unrelated primes in Experiment 2

Table 5.6. Effects of prime constructions and trial number on log10-transformed response times in Experiment 2

Fixed effects	Estimate	SE	<i>t</i>	<i>p</i>	Sign.
(Intercept)	3.115	0.015	204.458	<0.001	***
prime_cxn = “RES” (reference level = “UNREL”)	-0.023	0.010	-2.223	0.042	*
prime_cxn = “DEP” (reference level = “UNREL”)	-0.029	0.010	-2.844	0.012	*
trial_number_centred	-0.0008	0.0002	-4.441	<0.001	***

Sign. codes: ‘*’ $p < 0.05$; ‘**’ $p < 0.01$; ‘***’ $p < 0.001$; RES = resultative; DEP = depictive; UNREL = unrelated.

Discussion

The goal of Experiment 2 was to assess whether the modified maze task can be used to detect priming effects among the resultative and the depictive construction in a more production-oriented setting. The results are mixed: while the experiment produced some relevant findings, it also points to limitations of the method, at least in this specific application. First, no priming effect emerged among participants' structure choices in the overall analysis. This means that previous exposure to resultative and depictive primes did not affect how often participants chose a resultative as opposed to a depictive continuation for the subsequent targets. However, when the targets were restricted to a subset of highly acceptable instances, a marginally significant effect emerged, indicating that participants selected more depictive responses after depictive primes than after unrelated baseline primes. This provides some evidence that the modified maze task can potentially reflect changes in participants' structure choices due to priming.

The fact that only depictive primes differed from the unrelated condition while the resultative primes did not is in line with the priming asymmetry observed in Experiment 1. As discussed there, depictives are less frequent, less acceptable and potentially more difficult to process than resultatives. They may thus conflict more strongly with speakers' prior expectations and give rise to larger priming effects. The claim that depictives are less frequent than resultatives receives additional support from Experiment 2, in which participants produced considerably more resultative than depictive responses overall (78% versus 22% after unrelated primes).

Two potential reasons may explain the absence of statistically robust priming effects among participants' structure choices in Experiment 2. One possibility is that participants' preferences for one construction over the other when confronted with specific target items were too strong to be affected by priming. In other words, participants may sometimes not have perceived the resultative and the depictive continuation as two equally felicitous options, but one option may have seemed clearly more appropriate for the given target. This argument draws support from the fact that participants' structure choice proportions varied strongly depending on the individual target sentence: for example, one target yielded around 29% resultative continuations while others yielded up to 96% resultative responses. The strong influence of idiosyncratic lexical-conceptual factors may have thus overshadowed any more subtle effects that the prime sentences had on participants' constructional choices.

A second possible reason is that priming *may* have occurred, but that the effects of within-construction and cross-constructural priming cancelled each other out and thus remained undetected. For example, Experiment 1 in the previous section provided evidence that depictive primes facilitated speakers' processing of *both* depictive and resultative targets. A similar effect might have occurred in Experiment 2, but given the complementary nature of structure choice proportions, the relative proportions of resultative and depictive responses would have remained constant since both constructions were primed. Compare Section 4.2.3, where a similar situation was discussed: the fact that 'shifted' *to*-dative primes facilitated both double-object and regular *to*-dative targets did not affect the binary proportions of the target constructions because the two facilitatory effects cancelled each other out. Only when 'other' targets were included as a third outcome in the analysis, which therefore comprised non-binary rather than binary proportions, did the priming effects by shifted *to*-datives become apparent. In the present experiment, however, a third category of such 'other' targets is not available because participants were forced to select either the resultative or the depictive continuation. As a result, it is possible that the limitations of the outcome measure obscured priming effects that could potentially be detected with other methods.

So far, the discussion has focused on the immediate effect of each prime sentence on its subsequent target, but besides these trial-by-trial effects, the experiment provides evidence of another kind of priming effect. The fact that the proportion of depictive responses increased over the course of the experiment indicates that speakers were subject to 'cumulative' priming, i.e., priming that results from repeated exposure to the same construction over a series of trials. This aligns with previous studies that have reported cumulative effects, especially among the dative constructions (Kaschak 2007; Kaschak, Kutta and Jones 2011; Kutta et al. 2017; see also Section 3.1). The present result demonstrates that a similar effect of cumulative priming can also be detected for a much less frequently studied construction such as the depictive. The fact that the effect is asymmetric, i.e., that statistically significant cumulative priming only emerged after depictive primes but not after resultative primes, again fits in with the above discussion of frequency- and other processing-related differences between the constructions.

Finally, the analysis of the response times provides evidence of a facilitatory priming effect suggesting that participants were faster to select the final word of the target sentences

when they were preceded by either resultative or depictive primes. This illustrates that even when no clear priming effect emerges among participants' structure choices, the modified maze task can still provide informative results via its secondary response time measure. It also supports the use of response times as a relatively robust measure not only in the standard version of the maze task, but also in the modified maze task. This being said, one limitation of the response time analysis in Experiment 2 is that it cannot clearly distinguish between within-construction and cross-constructural priming. Since participants were presented with a resultative and a depictive continuation at the same time, it is not clear whether they chose more quickly between them because the prime facilitated both options or only the option that instantiated the same construction as the prime.

5.2.4 Interim summary

In this section, two novel experiments have been reported that employed different versions of the maze task to investigate priming between the resultative and the depictive construction. Using the standard maze task, Experiment 1 provided evidence of both within-construction and cross-constructural priming. The results indicated that previous exposure to depictive primes can facilitate speakers' processing of both depictive and resultative sentences. This was interpreted as evidence that speakers encode strong formal and functional similarities between resultatives and depictives, but that they also recognise differences between the constructions. Experiment 2 tested priming between the two constructions in a more production-oriented setting, using a modified version of the maze task in which participants choose directly between a resultative and a depictive continuation. While the evidence remains somewhat tentative, signs of facilitatory priming emerged both among participants' structure choices and their response times. Moreover, both Experiments 1 and 2 provided evidence of asymmetric priming, with the effects being primarily driven by the depictives. Three factors were suggested that could contribute to the observed asymmetries: differences in the frequency, acceptability and processing cost of the constructions.

Overall, the experiments illustrate the potential of using comprehension methods like the maze task to extend structural priming to previously understudied phenomena, such as non-alternating argument structure constructions. With respect to the specific phenomenon,

the present study seems to be the first to report within-construction and cross-constructional priming effects among resultative and depictive sentences.

At the same time, the experiments are also subject to several methodological limitations. First, a general criticism of the maze task has been that it creates a relatively artificial setting, requiring participants to make stepwise choices between competing words in a way that differs considerably from their normal reading mode (Forster et al. 2009; Forster 2010). This lack of naturalness is traded for the specific advantages of the maze task (see Section 5.1.3): namely, the increased ability to localise effects in the sentence (by avoiding spillovers to the following words), the stronger incentive for participants to pay attention to the sentence contents, and the ease with which the method can be applied. In the present approach, the latter advantages arguably outweigh the limitations because the goal is to study subtle real-time processing effects in order to gain insights about speakers' grammatical representations. If, in contrast, the research aim was to examine the specific processes implicated during speakers' normal mode of reading, a more naturalistic method such as eye-tracking should be preferred (Witzel et al. 2012).

Second, and specifically with respect to the modified maze task used in Experiment 2, the method did not indicate priming effects among resultatives and depictives as reliably as had been expected. Compared with the within-construction and cross-constructional effects observed in Experiment 1, the more production-oriented measure of structure choices in Experiment 2 only provided some tentative evidence of within-construction priming among depictives. It may, however, be premature to conclude from this that the modified maze task is an ineffective method. As suggested in Section 5.2.3, participants may have had lexically mediated preferences for specific resultative or depictive targets that were too strong to be overcome by priming. It remains to be seen whether the modified maze task can produce more informative results when applied to a pair of constructions that resemble each other more closely in frequency and acceptability, and may thus be competing on a more equal footing. In this sense, the experiments in the present section have illustrated methodological options that could be applied to other constructions and research questions beyond the immediate focus of this study.

5.3 Priming between the caused-motion and the resultative construction

Having explored the relationship between the resultative and the depictive construction in the previous section, the discussion will now move on to a differently related pair of constructions: the (locative) caused-motion and the (adjectival) resultative construction. As discussed in Section 2.4.5, a special type of similarity relation has been posited between these patterns, namely an asymmetric metaphorical link. According to Goldberg's (1995) analysis, the 'change of location' meaning of the caused-motion construction forms the metaphorical source for the 'change of state' semantics of the resultative. The present section discusses whether this hypothesis is supported by psycholinguistic evidence from structural priming; or more specifically, whether there is evidence of asymmetric priming that would reflect a metaphorical asymmetry between the constructions.

The discussion focuses on a recent structural priming study (reported in detail in Ungerer [2021]) that used the standard maze task (as described in Section 5.1.3) to test priming between caused-motion and resultative sentences (referred to as the 'CMR study' in the following). Section 5.3.1 discusses the experimental evidence regarding the degree of similarity between the constructions, and specifically the question of whether priming was symmetric or asymmetric. Section 5.3.2 focuses on the methodological implications of one particular feature of the study: namely, that priming manifested itself as inhibition rather than facilitation. Given that inhibitory effects have seldom been reported in previous structural priming research (see Section 3.6), the section outlines an innovative account of why the effects might arise and how they can be interpreted. In this way, the discussion addresses the theory-related questions Q_T 3 and Q_T 4 outlined in Chapter 2 (concerning the potential of priming to assess different types of similarity relations and previous theoretical claims about them), as well as the methods-related questions Q_M 3 and Q_M 4 raised in Chapter 3 (about the factors that give rise to (a)symmetric priming and facilitatory versus inhibitory priming).

5.3.1 Using priming to test for metaphorical asymmetries

Priming between metaphorically related concepts has so far been studied primarily on the lexical level. A number of studies have found that words or pictures that describe a putative source domain (e.g., space) prime lexical expressions that encode a target domain (e.g., time) more strongly than the other way round (Boroditsky 2000; Casasanto et al. 2010;

see Casasanto and Boroditsky [2008] for similar effects in extra-linguistic contexts; but see Cai and Connell [2015] for potential counter-evidence). Most of the findings concern the ‘time is space’ metaphor (Lakoff and Johnson 1980), but similar asymmetries have also been found for other metaphors, such as ‘similarity is closeness’ (Boot and Pecher 2010). Together, these results support the view that the relationship between metaphorical sources and targets is inherently asymmetric (Glucksberg 2001; Lakoff and Johnson 1980), and that the directionality of the relation is reflected by asymmetric priming.

Going beyond lexical expressions, however, little experimental work has so far targeted metaphorical relations between clause-level constructions. As far as structural metaphors are concerned, they have been posited largely on theoretical grounds, as illustrated by Goldberg’s analysis of the caused-motion construction as a metaphorical source for the resultative construction (see Section 2.4.5). Similar to the resultative and the depictive construction discussed in Section 5.2, hardly any attempts have been made to test the link between caused-motion and resultative sentences in a priming paradigm. One important exception is Johnson and Goldberg’s (2013) study, which included the two patterns alongside other target constructions. However, as the following discussion will show, the authors tested a special kind of priming that differs from conventional structural priming; and their results do not provide conclusive evidence about the (a)symmetry of the relation between the caused-motion and the resultative construction.

Johnson and Goldberg’s experiment differs from conventional priming studies in two important ways. First, they used Jabberwocky sentences like the ones in (5) as primes, in which all content words are replaced by nonce words. Example (5a) illustrates the caused-motion schema, while (5b) instantiates the resultative construction (note that the experiment also included double-object and ‘removal’ sentences, but they only occurred in separate prime-target pairs). The use of Jabberwocky primes is an interesting strategy, since it arguably ensures that the priming effects are driven by the formal and functional characteristics of the constructional schemas, rather than by any lexical features of the specific instances.

- (5) a. *He lorped it on the molp.*
b. *She jorped it miggy.*

(both from Johnson and Goldberg 2013)

Second, the target items that participants saw in Johnson and Goldberg's experiment were not full sentences, but only single verbs. These target verbs either occurred regularly in the constructions (e.g., *put* for the caused-motion construction; *gave* for the resultative) or they were at least semantically related to the constructional meanings (e.g., *decorated* for the caused-motion construction; *transformed* for the resultative). Testing lexical rather than sentential targets allowed the researchers to use a familiar method from lexical priming: a lexical decision task, which measures the time it takes participants to recognise the target as a correct English word (as opposed to a nonword distractor).

Johnson and Goldberg compared participants' response times for caused-motion and resultative verbs after prime instances of the corresponding and of the other construction. It is important to note that the authors did not compare these constructions because they regarded them as similar, but rather because they treated them as distinct and predicted that the two prime patterns would affect the target verbs differently. The focus of their study was to show that each argument structure construction has a distinct meaning that gives rise to within-construction priming. Interestingly, however, the researchers found that only caused-motion targets were recognised faster after caused-motion targets than after resultative targets (note also that the effect was only statistically significant in the by-subjects analysis, not in the by-items analysis). On the other hand, participants' response times for resultative targets were roughly equal after resultative primes and caused-motion primes.

Could an asymmetric metaphorical link between the constructions have given rise to this result? Johnson and Goldberg appeal to this argument at least implicitly (p. 1449) by observing that the absence of a priming effect for the resultative targets may be due to the fact that these verbs were primed by *both* resultative and caused-motion primes. This would mean that resultative targets were subject to both within-construction and cross-constructional priming. The fact that an equivalent cross-constructional effect was not observed for the caused-motion targets would point to asymmetric priming from caused-motion sentences to resultatives, thus supporting the existence of a metaphorical link between them.

One limitation of this interpretation, however, is that Johnson and Goldberg's study did not include a neutral baseline condition. Without comparison to such a baseline, it is not clear whether participants' responses to resultative verbs were speeded up after resultative and caused-motion primes, or whether they were merely unaffected by those prime

constructions. Given the relatively small number of items in the study, it seems possible that priming for the resultative targets was too weak to reach statistical significance. A second caveat that applies to Johnson and Goldberg’s study is that it remains somewhat unclear what exact type of priming their experiment was testing. The specific combination of sentential primes and lexical targets may lead to a hybrid version between lexical and structural priming, which makes it harder to compare the results with other findings in the structural priming literature. Given these considerations, Johnson and Goldberg’s study leaves room for further priming investigations of the (potentially asymmetric) relationship between the caused-motion and the resultative construction.

5.3.2 (A)symmetric priming between caused-motion and resultative sentences

Choosing a more conventional setting of natural language examples, Johnson and Goldberg’s (2013) research issue has been taken up in a recent experiment (reported in Ungerer [2021] and henceforth called the ‘CMR study’). This study employed the maze task to test structural priming among the caused-motion and the resultative construction, using full sentences as targets (rather than lexical verbs, as in Johnson and Goldberg’s experiment). While the study pursued multiple goals – including an analysis of whether priming differed when primes and targets contained the same or different verbs (a ‘lexical boost’ effect; see Section 4.1.2) – the discussion here focuses on the evidence that emerged concerning the symmetry of the priming effects.

The experiment used the same version of the maze task that was described in Section 5.1.3 and applied in the first resultative-depictive priming experiment reported above (see Section 5.2.2). 160 self-reported English native speakers read three different types of prime sentences while choosing the correct continuation at every word: (prepositional) caused-motion primes as in (6a), (adjectival) resultative primes such as (6b), and unrelated primes like (6c). These primes were followed either by a caused-motion target like (7a), or a resultative target like (7b).

- (6) a. *Edward knocked the ball over the fence.*
 b. *Daniel squeezed the tube flat.*
 c. *Amy practiced speaking in public.*

- (7) a. *Nancy swept the glass into the bin.*
b. *Sarah swept the floor clean.*
(all from Ungerer 2021)

Comparing the target examples in (7) with the resultative and depictive stimuli tested in the experiments in Section 5.2, it is evident that the caused-motion and resultative sentences in the CMR study did not overlap quite as closely with each other. Whereas the resultatives and depictives in the earlier experiments were perfectly ambiguous until the sentence-final adjective was reached (e.g., *Max cooked the chicken tender / whole*), the caused-motion and resultative sentences in the CMR study displayed lexical differences already at the object noun (*glass* versus *floor*). This is because the latter constructions tend to combine with different semantic types of objects. In the above examples, the *glass* in the caused-motion sentence can be regarded as the ‘figure’ (in Langacker’s [1987] sense) which is moved relative to an unspecified ‘ground’, while the *floor* in the resultative example denotes the ‘ground’ which is affected by the removal of an unspecified figure. As a result of these semantic differences, the participants may have already recognised the target construction when they reached the object noun, which was therefore the first critical word at which response times in the maze task were measured.

Nevertheless, the caused-motion and resultative targets in the CMR study were still formally indistinguishable at the object noun. They were only fully disambiguated at the sentence-final complement phrase, which differed between a prepositional phrase in the caused-motion construction and a bare adjective in the resultative. The first word of the complement was therefore used as a second critical region for the response time measure.

The results of the CMR study indicate that participants’ responses were slowed down when the targets were preceded by primes of the *other* construction compared with both primes of the same construction and unrelated baseline primes. In other words, participants responded more slowly to caused-motion targets when they were preceded by resultative primes (compared with the other two prime conditions), and they responded more slowly to resultative targets when they were preceded by caused-motion primes. The results were largely similar at the object noun and at the first word of the complement, even though the differences from the baseline primes were statistically significant only at the former sentence region.

These results give rise to several interesting conclusions. First, the observed priming effects were inhibitory: participants' target responses after prime instances of the other construction were *slower* than after unrelated baseline primes. On the other hand, there was hardly any sign of facilitatory priming: participants' responses to targets after prime instances of the same construction were not faster than in the baseline (but see Section 5.3.3 for one exception). This is an intriguing finding since, as pointed out in Section 3.6, inhibitory effects have hardly been reported in the structural priming literature. Given that the mechanisms of facilitatory and inhibitory priming are one of the methods-related concerns of the present investigation (Q_M 4), the inhibitory effects will be discussed in more detail in Section 5.3.3.

Second, and importantly for the present context, there was no evidence of an asymmetry among the cross-constructional priming effects. In fact, it was striking how similar the effect of caused-motion primes on resultative targets was to the effect of resultative primes on caused-motion targets. In this way, the results of the CMR study do not provide evidence of an asymmetric metaphorical link between the constructions, as proposed by Goldberg (1995). Instead, they seem to support a view under which speakers encode a *symmetric* similarity relation between the two constructions. At the same time, the fact that the constructions primed differently from each other demonstrates that speakers also perceived them as clearly distinct. These results suggest that the resultative construction is a fully 'emancipated' construction whose conceptualisation is not asymmetrically dependent on the caused-motion construction as a potential metaphorical source. The view that the two constructions share a partial symmetric similarity seems to be in line with Jackendoff's position, mentioned in passing by Goldberg and Jackendoff (2004: 542, note 13), according to which the two patterns can be regarded as "parallel instantiations of thematic structure".

Of course, the absence of evidence for metaphorical priming in the CMR study does not preclude the possibility that a metaphorical link may still exist between the caused-motion and the resultative construction. It is possible that the specific processes implicated by the maze task – for example, the resolution of temporary ambiguities – is less sensitive to some of the more subtle conceptual relations between the constructions. The results of the CMR study will therefore have to be evaluated in the context of further research, including applications of the maze task to other priming phenomena, as well as studies of the caused-motion and the resultative construction that use alternative priming methods.

5.3.3 Interpreting inhibitory priming effects

From a methodological standpoint, a particularly interesting aspect of the CMR study is that the priming effects manifested themselves primarily as inhibition rather than facilitation. This fact was only briefly discussed in the original study. Given the wider methodological concerns of the present investigation, however, the following discussion addresses the possible origins of the inhibitory effects, as well as their interpretation, in more detail (see Q_M 4 in Chapter 3). Since the role of inhibition has been hardly discussed in previous structural priming studies, the suggested explanations are necessarily somewhat tentative. Nevertheless, it will be argued at the end of the section that the present account aligns naturally with other findings from lexical and structural priming (some of which were introduced in the earlier Section 3.6).

In order to explain the occurrence of inhibitory priming in the CMR study, consider the stepwise process that the participants might have undergone when encountering the primes and the following temporarily ambiguous targets. For example, while reading a caused-motion prime like (8), repeated from above, participants would have presumably activated their representation for the caused-motion construction. When they subsequently encountered the caused-motion target in (9a), the unfolding sentence matched the pre-activated prime construction, which could have potentially speeded up participants' processing of the targets.

(8) *Edward knocked the ball over the fence.*

(9) a. *Nancy swept the glass into the bin.*

b. *Sarah swept the floor clean.*

(all from Ungerer 2021)

While the CMR study provided hardly any evidence of such a facilitatory effect, it could be the case that the effect was too small to be detectable. For example, given that the caused-motion construction is a reasonably frequent and probably well-entrenched pattern, the caused-motion targets may have already been easy enough to process for participants and may have thus not benefitted from additional prime pre-activation. The same argument could be made for the resultative targets after resultative primes: compare Experiment 1 from

Section 5.2.2, in which facilitatory priming only emerged among instances of the less frequent depictive construction, not among resultatives. This being said, there was one tentative sign of facilitatory priming in the CMR study, too: participants' responses to resultative targets following resultative primes were faster when primes and targets contained the same rather than different verbs (note that the effect only reached marginal statistical significance). This suggests that, at least in the presence of lexical overlap, the pre-activated resultative primes may have facilitated speakers' subsequent processing of resultative targets.

Compare this to the crucial conditions in which inhibitory priming emerged, for example when participants encountered resultative targets like (9b) after caused-motion primes like (8). In this case, the first few words of the target item – before participants reached the object noun – matched the pre-activated caused-motion schema. In Section 3.6, it was suggested that this temporary overlap may additionally strengthen the activation of the prime construction. However, when participants encountered the object noun, for example *floor* in (9b), this word may have induced a conflict with the semantics of the caused-motion construction (since it is implausible that the floor would be moved somewhere by sweeping it). Even more so, the following adjective *clean* conflicts both formally (in terms of the type of syntactic constituent) and functionally (by expressing a state rather than a location) with the prime construction. At both these sentence regions, participants may have therefore had to 'recover' from their initial analysis of the target (similar to recovering from an initial misinterpretation of a garden-path sentence), which would naturally slow down their response.

In this sense, the inhibitory effects in the CMR study can be understood as reflexes of both the partial similarity and the partial difference between the caused-motion and the resultative construction. On the one hand, if speakers did not perceive the target sentences as temporarily ambiguous between the two constructions, their responses to resultative sentences after caused-motion primes should not have differed from their responses after unrelated baseline primes. Moreover, the fact that inhibitory effects emerged at the object noun, but also *still* did so at the sentence-final complement, suggests that participants had not fully disambiguated the constructions at the earlier critical word. This provides evidence that participants still perceived the constructions as partially similar at the object noun. It was only at the first word of the complement that the constructions differed significantly enough to be fully disambiguated.

It is instructive to compare this to the priming effects between the resultative and the depictive construction observed in Experiment 1 from Section 5.2.2: there, facilitatory priming was found at the sentence-final adjective of resultative targets after depictive primes. This suggests that speakers encode a stronger similarity relation between resultatives and depictives than between caused-motion and resultative sentences. The question remains to what extent this difference is due to formal (dis)similarity – the fact that resultatives and depictives both contain an adjective, while caused-motion instances end in a prepositional phrase – or whether it also reflects a stronger functional similarity between the former constructions than between the latter. While it seems likely that formal and functional factors conspire to bring about the priming effects (see also the discussion in Section 5.2.2 for further support), it will remain a task for further studies to distinguish between the different dimensions of constructional similarity.

Finally, it is worth pointing out how the above explanation of the inhibitory effects in the CMR study aligns both with the (rare) reports of inhibition in previous structural priming studies, and with the much more established accounts of the phenomenon in the lexical priming literature. As noted in Section 3.6, inhibitory effects have emerged in a few structural priming experiments with garden-path sentences. The example given in the earlier discussion was Traxler (2008), who found that prime sentences with a single locative adverbial, such as (10a), slowed down participants' processing of subsequent garden-path targets like (10b), in which the first prepositional phrase is a modifier of the object noun and only the second one is an adverbial. As in the CMR study, the slowdown occurred at the disambiguating region, i.e., the locative adverbial *into the crowd* in (10b).

- (10) a. *The girl tossed the blanket into the laundry this morning.*
b. *The vendor tossed the peanuts in the box into the crowd during the game.*
(both from Traxler 2008)

Inhibitory effects also seem to have occurred in two cumulative structural priming studies, i.e., studies in which participants saw several instances of the prime construction in a row. Fine et al. (2013: Experiment 2) observed that repeated exposure to reduced passive relative clauses as in (11a) slowed down participants' reading times for main clauses that can be temporarily interpreted as reduced relative clauses, such as (11b). Interestingly, this result

suggests that with enough exposure, participants come to expect less frequent garden-path structures like (11a), thus inhibiting their processing of more frequent structures like (11b). A similar finding is apparent among Myslín and Levy's (2016: Experiment 2) results, which indicate that repeated exposure to prime sentences with clausal complements (without *that*-complementiser), as in (12a), slowed down participants' processing of sentences with direct objects that could be temporarily interpreted as clausal complements, such as (12b). Myslín and Levy additionally present a computational model that simulates participants' reading times, and which also predicts a processing disadvantage for direct object targets that increases the more clausal complement primes participants have seen.¹⁰

- (11) a. *The experienced soldiers warned about the dangers conducted the midnight raid.*
b. *The cotton farmers warned about bad floods just before harvest time.*
(both from Fine et al. 2013)

- (12) a. *She had forgotten the procedure had called for adding water.*
b. *He remembered the robbery very vividly and in great detail.*
(both from Myslín and Levy 2016)

Interestingly, none of the above structural priming studies explicitly use the term 'inhibition', or discuss in more detail what factors lead to this specific manifestation of priming. In contrast, the present discussion highlights the fact that inhibitory priming has been a common feature of several previous structural priming experiments. The above explanation for the inhibitory effects in the CMR study can be generalised to these other investigations. It provides an account of why inhibitory priming can be expected to occur systematically in comprehension experiments that test temporarily ambiguous target sentences. Moreover, it links up the effects with similar phenomena in the lexical priming literature, where the role of inhibition has been discussed more explicitly. For example, Section 3.6 addressed the results of Schriefers et al.'s (1990) semantic priming experiment, in

¹⁰ In Myslín and Levy's (2016) study, the priming effects are operationalised in a specific way, namely as the difference between a group of participants who received 'clustered' training (in which clausal complement primes always occurred in pairs and participants thus came to predict their co-occurrence) and another group who received 'anti-clustered' training (in which clausal complement primes did not occur in a regular pattern and were thus less predictable).

which participants were slower to name a target picture of a 'sack' when it had been preceded by a semantically related prime such as *bag*. In line with the researchers' original interpretation, it was argued that this inhibitory effect is likely due to the fact that participants temporarily considered the prime word as a possible descriptor for the target picture, due to the featural similarity between the two. This is comparable to the structural priming studies reported above, in which participants may have temporarily interpreted the target as an instance of the prime construction, before discarding this initial analysis.

The parallels between structural and lexical priming become even more clear when considering the results of Monsell and Hirsh's (1998) phonological priming study, and especially the interpretation of their findings offered by Luce et al. (2000). In a series of lexical decision experiments, Monsell and Hirsh found that participants responded more slowly to target words that shared their initial phonological segments with the primes (e.g., *bruise* – *broom*), while participants responded faster to targets that shared their final segments with the primes (e.g., *gem* – *hem*). As Luce et al. suggest, the inhibitory effect in the former condition can be explained by assuming that participants initially reactivated the primes when encountering the formally identical onset of the targets, thus leading to competition when participants later noticed the differences between primes and targets. Such competition did not arise in the condition in which primes and targets shared final segments because participants did not entertain a temporary incorrect analysis of the targets. These interpretations provide further support for the above account of inhibitory priming in the CMR study and other structural priming experiments. The designs of these studies are comparable to Monsell and Hirsh's condition in which primes and targets share word-initial formal overlap and in which inhibition is likely to occur.

5.3.4 Interim summary

This section has provided another illustration of how comprehension priming studies, in particular maze task experiments, can inform theoretical questions about similarity relations in speakers' grammatical networks. The analysis of the CMR study in Section 5.3.2 provided no support for Goldberg's (1995) claim that the caused-motion and the resultative construction are related via an asymmetric metaphor. Instead, the presence of bidirectional cross-constructural priming effects suggest that speakers encode a symmetric relation between the constructions, which is based on their partial formal and functional overlap.

Moreover, the CMR study indicates that, compared with priming between resultatives and depictives (see Section 5.2), speakers perceive the caused-motion and the resultative construction as less similar at the sentence-final regions, thus leading to inhibitory rather than facilitatory priming effects.

Section 5.3.3 presented an explanation for the occurrence of inhibitory priming in the CMR study, thus addressing a methodological question that has so far gained little attention in the structural priming literature. It was argued that the inhibitory effects result from the specific processes implicated by the experimental task. In a paradigm in which participants read temporarily ambiguous target sentences, inhibitory priming can be expected to emerge at the disambiguating region of the targets when these have been preceded by a partially similar prime construction. This, it was suggested, is because prior pre-activation of the prime has led participants to form an initial incorrect analysis of the target, from which they later need to recover. The explanation allowed for the findings of the CMR study to be linked up with the results of other structural priming studies, in which inhibitory effects have been observed but not explicitly discussed, as well as with the literature on lexical priming, where comparable effects of inhibition are more commonly reported.

The discussions in this section also point to a number of open research problems that merit further investigation. As suggested in Section 5.3.2, the question remains whether the absence of evidence for asymmetric priming in the CMR study could be a result of the specific processes implicated by the maze task, such as ambiguity resolution. Follow-up studies could investigate whether other experimental tasks potentially yield asymmetric priming effects that would support a metaphorical link between the constructions. Moreover, it was argued in Section 5.3.3 that within-construction priming could manifest itself both via the facilitation of targets that instantiate the same construction as the primes, or via the inhibition of targets that instantiate the competing construction. The fact, however, that primarily the latter effect was observed in the CMR study (besides some marginal evidence for facilitatory priming) raises the question of whether inhibitory effects tend to be stronger than facilitatory effects, and whether the former may thus function as more reliable indicators of priming in certain comprehension paradigms. Together, these comments suggest that both the (a)symmetry of priming effects, and their manifestation via facilitation or inhibition, remain fertile areas for further research.

5.4 Summary: insights and open questions from priming among non-alternating constructions

This chapter has explored ways in which structural priming can be extended to non-alternating argument structure constructions, which have so far hardly been investigated. The goal of this approach is to study a larger variety of similarity relations in the grammatical network, instead of focusing on the relatively small set of argument structure constructions that have been the focus of previous studies (see Chapter 4). The chapter has not only outlined methodological arguments for how such an extension of the structural priming paradigm could be achieved, but it has also illustrated the approach with the help of two case studies. Section 5.2 reported two novel priming experiments that tested priming within and between the resultative and the depictive construction, while Section 5.3 summarised evidence from a recent experiment that examined priming between the caused-motion and the resultative construction.

The preceding sections have thus contributed to several of the theory- and methods-related research questions outlined in Chapters 2 and 3. On the theoretical side, the experiments in Sections 5.2 and 5.3 have provided evidence that speakers represent a type of similarity relation that had not yet been illustrated in Chapter 4, namely the relation between constructions that are (partially) similar in form but which arguably differ in function (Q_T 3). Moreover, the results have complemented the evidence from the previous chapters by suggesting that priming indexes differences in the degree of similarity (Q_T 1). The fact that priming between resultatives and depictives was facilitatory while priming between caused-motion sentences and resultatives was inhibitory suggests that speakers encode stronger similarities between the former pair of constructions than between the latter. Finally, the priming evidence has helped address previous theoretical accounts such as Goldberg's (1995) claim that the caused-motion and the resultative construction are related via an asymmetric metaphor (Q_T 4). This claim was not supported by the results of the CMR study, in which symmetric priming effects emerged between the two constructions.

On the methodological side, Section 5.1 outlined which methods can be used to extend structural priming to non-alternating argument structure constructions (Q_M 1). It was argued that comprehension priming methods can overcome the limitation of production techniques and thus offer researchers the crucial flexibility needed to study a wider range of

phenomena. The maze task was chosen as a particularly suitable comprehension method for the constructions in this chapter. The experiments in Section 5.2 explored both the standard version of the maze task and a modified production-oriented version of the task in which participants choose directly between the competing constructions. Both experiments provided evidence of priming – as reflected by participants’ response times, and tentatively also by their structure choices – even though the discussion also addressed potential limitations of the methods.

Moreover, for the experiments in Section 5.2, possible reasons were outlined for why asymmetric cross-constructural priming emerged from depictives to resultatives but not in the opposite direction (Q_M 3). Three reasons were suggested, which may possibly complement each other: differences in the frequency, acceptability and processing difficulty of the constructions. The discussion has thus widened the view beyond purely frequency-based explanations of priming asymmetries, which have been the focus of previous discussions. Finally, Section 5.3 provided a detailed account of why priming manifested itself as inhibition rather than as facilitation in the CMR study (Q_M 4). While inhibitory effects have been seldom reported in the structural priming literature, it was argued that they are an expected outcome of competition effects that arise when speakers process temporarily ambiguous sentences in a comprehension setting.

Finally, the present chapter has raised a number of open questions for further research. First, the experiments presented here only illustrate a small set of non-alternating argument structure constructions that can be investigated with the help of structural priming. Further experiments should extend the paradigm to a range of other constructions, in English and in other languages. A growing amount of evidence about similarity relations between diverse constructions will be necessary to refine current models of the grammatical network. Meanwhile, it is worth noting that not all non-alternating constructions can be investigated using the maze task. At least in its present application, the method is tailored towards formally similar constructions that can occur in temporarily ambiguous sentences. Experimenters may need to resort to alternative priming methods when testing other types of non-alternating constructions.

Second, the maze task is still a relatively new method which has only recently come to be used more widely. Researchers yet have to gain a detailed understanding of what linguistic or extra-linguistic features the task is sensitive to (e.g., semantic, syntactic or general

processing-related factors), and what mechanisms give rise to specific patterns among the results (e.g., facilitatory versus inhibitory effects). Moreover, the modified version of the maze task proposed in Section 5.2.3 joins other recent attempts to extend the method and adapt it for specific experimental purposes (e.g., Boyce et al. 2020; Gallant and Libben 2020). While the modified task was applied with mixed success in the present chapter, it may provide an effective tool in other cases in which researchers wish to integrate a forced-choice element into a reading task. It remains to be seen whether the maze task will over time develop into a family of more specialised techniques.

Third, the present chapter has highlighted two particularly intriguing features of priming effects – their (a)symmetry, and the way in which they manifest themselves as facilitation or inhibition. Possible factors were suggested that may contribute to each of these effects, but their respective roles have yet to be better understood. For example, experimenters could individually manipulate the frequency, acceptability and processing difficulty of constructions to determine what influence they have on the symmetry of priming effects. Similarly, the mechanisms that underlie facilitatory and inhibitory priming will have to be examined against a larger sample of comprehension studies in which the two types of effects are attested.

6 Conclusion and further implications

This study has explored the fertile ground that lies between cognitive-linguistic theory and the psycholinguistic paradigm of structural priming. On the theoretical side, elements from several cognitive-linguistic frameworks were combined into an account of grammar as a mental network of similarity relations. Focusing on argument structure constructions, it was suggested that speakers store these patterns via multi-dimensional formal and functional similarities that exist at different levels of abstraction. On the empirical side, evidence from structural priming was used to explore the nature and strength of the similarities between a range of constructions. Previous experimental findings were reinterpreted in the context of a network model of grammar, and new experiments were reported that extend structural priming research to previously understudied constructions.

The concluding discussion is structured as follows: Section 6.1 summarises the key findings of this investigation, addressing the overarching theory-related and methods-related questions raised in Chapters 2 and 3. Section 6.2 highlights the fruitful ways in which cognitive-linguistic theory and structural priming research can inform each other. Finally, Section 6.3 presents three implications of the present work that merit further investigation.

6.1 Summary of key findings

The previous chapters have assembled a range of evidence to address the four theory-related and the four methods-related questions outlined in Chapters 2 and 3. These questions are repeated in Table 6.1 for the reader's convenience.

Table 6.1. Research questions addressed in this study

Theory-related questions
Q _T 1: Can structural priming provide evidence about the degree of similarity between argument structure constructions?
Q _T 2: Can structural priming help determine at what level of schematicity speakers form constructional generalisations?
Q _T 3: Does structural priming provide evidence that speakers encode different types of similarity relations? (for example, between constructions with similar function and constructions with similar form)
Q _T 4: Can the structural priming evidence adjudicate between different theoretical accounts of particular similarity relations? (for example, between alternation-based views and Goldberg's [2002] Surface Generalisation Hypothesis)

Methods-related questions

Q_M 1: Which methods can be used to study structural priming between non-alternating argument structure constructions?

Q_M 2: How can within-construction and cross-constructional priming be distinguished when they co-occur in the same experiment?

Q_M 3: What factors determine the symmetry of cross-constructional priming effects?

Q_M 4: Under what conditions does priming manifest itself as facilitation and inhibition, and how can the effects be interpreted?

Starting with the first theory-related question (Q_T 1), the investigation has provided substantial support for the view that structural priming can reflect the degree of similarity between argument structure constructions. The priming results not only index whether or not two constructions are related, but they allow for more fine-grained evaluations of the relative strength of these similarities. For example, by comparing the effect sizes of production priming effects in Chapter 4, it was shown that instances of the same construction (e.g., two double-object sentences) prime each other more strongly than different members of the same alternation (e.g., the double-object and the *to*-dative construction). Meanwhile, priming seems to be largely absent between other pairs of constructions (e.g., the *to*-dative and the *for*-dative), suggesting that these constructions display little similarity. In Chapter 5, it was argued that the manifestation of priming effects in comprehension can also be reflective of the degree of constructional similarity. While facilitatory priming emerged between resultatives and object-oriented depictives (suggesting that speakers encode strong similarities between the patterns), inhibitory priming was observed between caused-motion sentences and resultatives (indicating that speakers treat the constructions as more distinct).

Regarding Q_T 2, Section 4.1 presented priming evidence suggesting that speakers represent similarity relations at different levels of abstraction. Differences in the strength of the priming effects indicate that stronger similarities exist between instances of the same lexically specific pattern (e.g., double-object sentences with the same verb) than between instances of the same abstract schema (e.g., the double-object construction). With respect to Q_T 3, Chapters 4 and 5 illustrated priming between constructions that are related by different types of similarities. This includes functionally similar but formally distinct constructions (e.g., the double-object and the *to*-dative construction), formally and functionally similar constructions (e.g., the transfer and the benefactive double-object construction) and formally

similar but functionally distinct constructions (e.g., the resultative, the depictive and the caused-motion construction).

Finally, the same analyses also informed Q_T 4, showing that structural priming can help adjudicate between existing theoretical accounts of similarity relations. Chapter 4 presented evidence suggesting that speakers may encode relatively weak similarities between members of the same alternation, thus casting some doubt on approaches that treat alternations as central generalisations within speakers' grammatical knowledge. Instead, the empirical results are broadly in line with Goldberg's (2002) Surface Generalisation Hypothesis, which highlights similarities between members of different alternations (e.g., between the transfer and the benefactive double-object construction). Nevertheless, some specific predictions of this hypothesis (e.g., regarding the strength of the similarity between *to*-datives and locative caused-motion sentences) are not supported by the priming evidence.

Moving on to the methodological questions, Q_M 1 was addressed in Chapter 5, where it was suggested that comprehension priming methods such as the 'maze task' can be used to extend structural priming to non-alternating argument structure constructions. Three experiments were discussed that apply the maze task to priming between resultatives and depictives and between the caused-motion and the resultative construction. In response to Q_M 2, it was argued in Section 4.2 that it can be difficult to distinguish between within-construction priming (between instances of the same construction) and cross-constructural priming (between instances of different constructions) in production experiments in which both types of effects occur in parallel (typically, in experiments with alternating constructions). Strategies to overcome this challenge were suggested; one of them involves a comparison of the observed target proportions (including 'other' targets) with the proportions that would be expected if no cross-constructural priming occurred. In contrast to production settings, it was argued in Chapter 5 that comprehension priming methods, due to the non-complementary nature of their outcome measures, allow for a straightforward distinction between within-construction and cross-constructural priming. It was also emphasised, however, that both production and comprehension experiments need to include a neutral baseline condition that allows researchers to differentiate between the two types of effects.

Q_M 3 was mostly addressed in Chapter 5, which reported asymmetric priming effects between resultatives and depictives, with only the latter giving rise to priming. Several

possible factors were suggested that may contribute to this asymmetry: besides differences in the constructional frequency (which have so far gained most of the attention in the literature), the effects might also be modulated by differences in the acceptability and the processing difficulty of the constructions (or a combination of these factors). By contrast, priming between the caused-motion and resultative construction (Section 5.3) and between the transfer and the benefactive double-object construction (Section 4.3) was found to be symmetric. The results thus do not provide evidence of metaphorical relations as another potential source of asymmetric priming, in contrast to previous theoretical claims.

Finally, the experiment with the caused-motion and resultative construction in Section 5.3 also shed light on Q_M 4, given that priming between the constructions manifested itself as inhibition rather than facilitation. Inhibitory effects have seldom been reported in the structural priming literature, but an account was presented that explains these effects as a natural outcome of the processes implicated by specific comprehension tasks. According to this account, when speakers process target sentences that are temporarily ambiguous between the prime construction and a related alternative, their processing is impeded when they reach the disambiguating region and have to revise their initial interpretation of the sentence. It was shown how this explanation can also account for other structural priming findings, and link them up with discussions of inhibition in the lexical priming literature.

6.2 Cognitive linguistics and structural priming – a symbiosis

Following this summary of key findings, the relationship between cognitive-linguistic network models of grammar and the structural priming paradigm can be evaluated at a more global level. It was suggested at the outset of this investigation that the two research areas may be able to inform each other in fruitful ways. Indeed, the preceding chapters have highlighted a variety of respects in which researchers in one field can benefit from the insights provided by work in the other area.

Starting with the ways in which cognitive-linguistic theory can advance structural priming research, the present discussions have illustrated that a network model of grammar can provide a unified interpretative framework for the analysis of various structural priming effects. Cognitive-linguistic theories emphasise several important features of this network. First, they highlight that the grammatical network consists of units that bear not only formal-syntactic, but also semantic, pragmatic and discourse-functional properties. As a

consequence, similarities between these units are also expected to encompass these different levels. Such a view offers a natural interpretation for a range of structural priming effects, which can depend both on formal and functional factors and are often best explained by a combination of these (see the discussion of ‘additive’ priming effects in Section 3.2). The concept of ‘constructions’, which Construction Grammarians use to describe the multi-dimensional units of grammatical analysis, is particularly useful in this context since it avoids a syntactocentric view of grammar as an array of meaningless forms (compare the label ‘syntactic priming’, which is here eschewed).

A second aspect highlighted by cognitive-linguistic theories is the role of similarity relations in the grammatical network. The view that similarities at higher levels of abstraction emerge from lower-level similarities between more specific units (see Section 2.3) allows for a unified treatment of abstract and verb-specific priming effects as instances of a single mechanism applied at different levels of abstraction (see Section 4.1). It can thus account for ‘lexical boost’ and ‘inverse frequency’ effects without having to posit, for instance, distinct types of network units such as ‘combinatorial nodes’ and ‘lemma nodes’ (Pickering and Branigan 1998; see Section 4.1.2).

Moreover, placing similarity relations centre stage sharpens the view of the factors that may underlie priming effects of varying strength between specific constructions. From a practical perspective, this motivates more fine-grained analyses of priming effects than have sometimes been conducted. If the goal of an investigation is not merely to determine whether or not priming occurs in an experiment, but how large the effect is, which prime construction it is driven by, which target construction it affects, and whether it is symmetric or asymmetric, then the priming results have to be interpreted more carefully. The present investigation illustrated this in several ways, for example by highlighting the importance of baselines (which many previous studies have not included) for identifying which prime and target constructions are affected by priming. In Section 4.2, the question of whether cross-constructional priming between the dative constructions occurred alongside the stronger effects of within-construction priming led to a partial reinterpretation of previous experimental results. Moreover, in Section 4.3, several studies of the dative and benefactive alternations as well as of the *to*-dative and the locative caused-motion construction were compared in innovative ways to determine which constructions primed each other and to what degree.

Finally, another way in which cognitive-linguistic research can inform structural priming is that, as a flourishing area of grammatical study, the former has produced detailed linguistic analyses of a broad range of phenomena. These analyses not only highlight the subtle similarities and differences between constructions that can be used to generate predictions for priming experiments and motivate nuanced interpretations of their results. They also raise awareness of patterns that have so far not received much attention in the structural priming literature, but which arguably make up significant parts of speakers' grammatical knowledge. Most prominently in the present context, Chapter 5 highlighted that little priming research has targeted non-alternating argument structure constructions. The experiments presented in the chapter illustrate that structural priming can be extended to previously understudied constructions such as the resultative, depictive and caused-motion construction. Given that cognitive linguists, in contrast to proponents of other frameworks (such as mainstream generative grammar), tend to include more 'marginal', idiosyncratic constructions in their analyses, the ongoing research in this area is likely to highlight many further phenomena that can be investigated with the help of priming.

Turning to the other side of the symbiotic relationship, structural priming can make several important contributions to cognitive-linguistic theory. First and foremost, priming has been heralded as one of the main sources of empirical evidence for the network relations proposed by cognitive linguists. The present investigation has provided numerous examples of how previous theoretical claims about the structure of the network, the degree of similarity between constructions and the directionality of their mutual influence can be assessed in the light of relevant priming results. It was argued that priming can inform long-standing theoretical debates, for example about the status of alternations in the grammatical network (see Sections 4.2 and 4.3) or about putative metaphorical links between constructions (see Section 5.3). While it remains to be seen whether structural priming indeed provides "the best evidence for constructional relations" (Diessel 2019: 204) compared with alternative empirical methods, the present work illustrates at least that priming constitutes a rich source of evidence which continues to be extended to new phenomena and research questions.

Second, and in contrast to other experimental or corpus-based methods (see Section 2.5), priming provides a rather unique window into the ways in which activation patterns within speakers' grammatical networks influence their processing in real time. It thus provides crucial evidence for cognitive-linguistic accounts, which emphasise the role of spreading

activation in (re)shaping the structure of the grammatical network during concrete usage events. Structural priming not only provides evidence for the view that an activation-based network model of grammar is psychologically plausible, but it also illustrates how similarity relations between constructions lead to specific observable processing effects. For example, the discussion of facilitatory and inhibitory priming in Chapter 5 highlighted ways in which the pre-activation of a prime construction can either enhance speakers' processing when the prime and target construction are closely related, or lead to competition and thus impede processing when they are more distinct from each other.

Structural priming can also reveal further properties of the grammatical network that were less foregrounded in the present investigation. The persistence of priming effects, for instance, can shed light on the time course of activation processes, even though previous findings on this issue display some variation. Some studies have found priming to decay rapidly, suggesting that activation by a single prime is short-lived (Branigan et al. 1999; see Gries [2005] for corpus evidence), while other studies have observed priming effects that persisted at least across several intervening sentences (Bock and Griffin 2000; Bock et al. 2007; Hartsuiker et al. 2008). Even longer-lasting priming effects can arise when speakers are exposed to multiple primes of the same type, potentially pointing to an implicit learning mechanism that adjusts speakers' long-term expectations for the upcoming input (Fine et al. 2013; Jaeger and Snider 2013; Kaschak, Kutta and Jones 2011). These findings have implications for theoretical models of how repeated short-term activation of grammatical units may lead to long-term changes in their resting activation level and thus result in reconfigurations of the network structure.

Finally, a thorough understanding of the structural priming literature also helps theoreticians to stay 'in touch' with the reality, and the limitations, of conducting empirical research on the grammatical network. The latter is a complex psychological structure that can so far only be coarsely approximated with the help of psycholinguistic methods. As one of the key sources of empirical evidence, priming illustrates particularly clearly the challenges that researchers face when testing hypotheses about the grammatical network in the lab. Several of these challenges were discussed here, including: the distinction between overlapping effects of within-construction and cross-constructural priming (see Section 4.2); the difficulty of avoiding lexical confounds when testing priming among abstract constructions (see, for instance, the selection of experimental materials in Section 5.2); and the identification of the

specific formal and/or functional factors that contribute to a given priming effect (see the ‘further implications’ below). While these obstacles can potentially be overcome through carefully controlled experimentation, they nevertheless caution against a naïve view of the challenges involved in translating theoretical claims about the network structure into empirically testable predictions.

6.3 Three further implications

Beyond the key findings summarised above, the present investigation has several broader implications that may motivate follow-up research on priming in the grammatical network. The first of these concerns the nature of structural priming, and in particular the question of what aspects of speakers’ grammatical representations are primed in a given situation. The preceding chapters have illustrated how, based on careful theoretical argumentation and experimental manipulation, researchers can often construct a plausible account of what functional and/or formal factors may have given rise to an observed effect. Nevertheless, a certain amount of what Hofmeister et al. (2013) call ‘source ambiguity’ always remains: given that priming may be influenced by a range of syntactic, semantic, pragmatic, discourse-functional and lexical factors at the same time, it is difficult to decide which combination of these parameters can accurately and fully account for the experimental results (see also Meyer 2017).

One particular question, for instance, is to what extent priming can be explained by ‘coarse’ surface-structural properties of constructions, such as the number or the order of their syntactic constituents, and how far the effects are driven by subtler features, such as fine-grained differences between constructional meanings in terms of their degree of compositionality. A number of findings suggest that priming is sensitive to characteristics of the latter type: for example, Ziegler et al. (2018) found that speakers’ dative productions are primed more strongly by regular (i.e., fully compositional) datives than by light verb and idiomatic datives, even though the constructions are semantically similar and contain identical syntactic constituents (see Section 3.2). Similarly, the evidence presented in Section 4.3.2 suggests that *to*-datives are primed more strongly by *to*-datives than by formally identical locative caused-motion sentences with the preposition *to*. For other examples, however, it is less clear to what degree formal and functional factors interact: the facilitatory priming observed between resultatives and depictives (Section 5.2), for instance, could be

due to their overlapping syntactic constituents, their partially similar semantics, or a combination of both. It will remain a task for future research to differentiate clearly between these interpretations, for example by introducing additional formal or functional differences into the stimuli and testing how this affects priming, or by drawing systematic comparisons with priming among other groups of constructions.

A second issue raised by the present work concerns the potential insights that priming can provide about other types of relations in the grammatical network. The focus in this study has been on (paradigmatic) similarity relations, which feature prominently in all cognitive-linguistic frameworks and which naturally align with a view of priming as an index of representational similarity. Cognitive-linguistic models of the grammatical network, however, also feature other types of links (see Section 2.3.1). Two of the most widely discussed mechanisms are ‘symbolic’ relations, which link up the formal and functional poles of constructions (Croft 2007; Diessel 2019; Langacker 1987; Schmid 2020), and ‘syntagmatic’ relations, which connect linearly co-occurring elements in a sentence (Budts and Petré 2020; Schmid 2020; compare Diessel’s [2019] ‘sequential’ relations; Barðdal and Gildea’s [2015] ‘meronymic’ links; and Langacker’s [1987] relations of ‘integration’ and ‘composition’).

It is not clear how priming could be used to probe symbolic relations, given that these links form an intrinsic part of the concept of ‘constructions’ (as pairings of form and meaning) and are thus presupposed rather than tested by priming experiments. With respect to syntagmatic relations, however, there is extensive experimental evidence available suggesting that speakers predict the upcoming elements of sentences based on the preceding words (for reviews, see Kuperberg and Jaeger 2016; Kutas et al. 2011; Pickering and Gambi 2018). Speakers establish connections between co-occurring units at multiple formal and functional levels: for example, speakers predict the phonological onset of the next word after *a/an* (DeLong et al. 2005; but see Nieuwland et al. [2018] for replicability issues); they predict the grammatical gender of nouns based on the preceding adjective (Bates et al. 1996); and they predict object nouns based on the semantics of the preceding verb (e.g., *eat – cake*; Altmann and Kamide 1999). Such ‘prediction’ of syntagmatic links resembles the ‘priming’ of similarity relations that was the focus of the previous chapters.

Nevertheless, the exact relationship between priming and syntagmatic prediction remains a matter of debate. First, on a mechanistic level, some researchers seem to regard the two processes as equivalent: compare Bates et al. (1996), who describe the above

prediction from adjectives to nouns as an instance of ‘gender priming’. Others regard the two processes as similar but distinct, arguing that predictive pre-activation is only one of several mechanisms that give rise to priming (Kuperberg and Jaeger 2016: 49, note 8). Second, on a more conceptual level, there are reasons to keep paradigmatic and syntagmatic links clearly apart: while the former rely on featural similarity between units (e.g., between *cat* and *dog*, or between the double-object and the *to*-dative construction), the latter rely on contextual association or ‘contiguity’ (Jakobson 1971) of units that are not necessarily similar (e.g., a verb and its object). Meanwhile, the distinction between the two levels is also somewhat blurred, considering that semantically similar units often appear together in the same phrase or sentence (e.g., *boys and girls*). The question in these cases is whether it would be possible to tease apart how much of the association is due to the similarity of the units, and how much it is driven by their routinised linear order (see Huettig et al. [2021], who make the same argument for the phrase *salt and pepper*). Together, these comments illustrate that the relationship between prediction, priming, similarity and syntagmatic association remains a fruitful topic for theoretical and empirical research on the grammatical network.

A third and final implication of the present study is that it highlights a particular aspect of the concept of ‘constructions’ that has not always gained enough attention in the cognitive-linguistic literature. Especially in Construction Grammar, the distinction between what constitutes a construction and what does not is usually regarded as a clear categorical divide: in simple words, speakers are assumed to either ‘have’ a construction or to ‘not have’ a construction. The same logic is apparent in attempts to ‘count’ the number of constructions that form part of the grammatical network, which presupposes that the network consists of discretely separable units. Compare, for instance, Goldberg (2019: 145), who comments that “[t]here are hundreds of grammatical constructions, thousands of idioms, [...]”. Similarly, in the diachronic literature, researchers usually take a clear stand on what can be regarded as the creation of a ‘new’ construction or a ‘new’ form-meaning pairing, thus constituting an instance of ‘constructionalisation’, and what is merely a variation of an ‘old’ construction, thus qualifying only as an instance of ‘constructional change’ (Traugott and Trousdale 2013). In terms of the network model, constructionalisation is conceived of either as the addition of a new network node (or construction) or as a series of ‘node-external’ changes, i.e., changes to the links between distinct constructions. In contrast, constructional change is assumed to

consists of ‘node-internal’ changes, i.e., changes to the links that connect instances of the same construction (Smirnova and Sommerer 2020).

These simple categorical distinctions between what is and what is not a construction, and what is a ‘construction-internal’ or a ‘construction-external’ link, are potentially at odds with the view of the grammatical network outlined in the previous chapters. There, it was emphasised repeatedly that the similarity relations between distinct constructions – i.e., ‘node-external’ links in the above terminology – and similarity relations among instances of the same construction – i.e., ‘node-internal’ links – are not *qualitatively* different from each other, but that they only differ *in terms of degree* (i.e., in the strength of the similarity). Priming provides perhaps the clearest empirical evidence for such a gradient view of similarities: as illustrated in Chapters 4 and 5, the difference between within-construction and cross-constructional priming effects is only a matter of degree. The same applies to priming between instances of the same abstract construction and instances of the same verb-specific pattern (see Section 4.1): again, the latter effects are stronger than the former, but they do not appear to involve a distinct mechanism.

What may seem like an obvious point has important consequences for the conceptualisation of ‘constructions’. If the difference between constructions and their subtypes is only a matter of degree, this suggests that ‘constructionhood’ itself may be a gradient, rather than a categorical, property of grammatical units. Under this view, the status of a generalisation as a construction can be regarded in probabilistic terms: the more similar the instances of the generalisation, the more likely it is to qualify as a construction. This would offer a means of comparing the constructionhood of different patterns, for example to decide whether it is more feasible to posit an abstract construction or rather several lower-level, for instance verb-specific, constructions (see Section 2.3.3 for discussion). At the same time, this perspective implies that patterns vary in terms of how clearly they qualify as a construction in their own right, forming a scale on which some patterns are stronger contenders for construction status and others are weaker candidates (with many intermediate candidates in between). Construing the constructionhood of grammatical units as a gradient property that can be quantified with methods like structural priming would thus seem to mark a significant step away from previous categorical judgments about what is and what is not a construction.

Similarly, from a diachronic perspective, the more different a newly emerging pattern is from already existing units, the more feasible it would be to treat the new pattern as a

distinct construction. In this light, the distinction between constructionalisation and constructional change (see above) might need to be reinterpreted as a continuum of changes that lead to larger or smaller modifications of the grammatical network (see Hilpert [2015]; Hilpert [2021] for compatible perspectives). Generally, a gradient view of constructionhood is not unique to the present framework, but it closely aligns with Schmid's (2020: 234) account, who posits that the 'likelihood' with which speakers form schematic representations depends on several factors (one of them being similarity). It is also compatible with Langacker's (1987; 2016) approach, in which the 'unit' status of a pattern is determined by its degree of entrenchment, which itself is clearly a continuous rather than a categorical property.¹

In summary, structural priming has not only provided a range of insights about the structure of speakers' grammatical networks, but it also continues to raise new puzzles, questions and opportunities for follow-up inquiry. These issues are situated firmly at the intersection between (cognitive-)linguistic theory and psychology; consequently, they are best addressed when researchers from the two disciplines work together. The present study has been an attempt to lay some of the groundwork necessary to enable such collaboration.

¹ Even if constructionhood is regarded as gradient, it may still be possible to define threshold values along this continuum such that any unit that scores above the threshold is regarded as a 'construction'. This approach would nevertheless differ in several respects from the 'naïve' categorical view described above: first, the threshold would be understood as an analytical construct rather than as a real psychological property; second, researchers would need to make the criteria explicit that underlie their choice of threshold; and third, the threshold is likely to vary depending on the specific purposes of the analysis.

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Appendix A. List of experimental materials

Materials for Experiments 1 and 2 (Sections 5.2.2 and 5.2.3)

In Experiment 1, the stimuli below occurred both as primes and as targets. In Experiment 2, the stimuli occurred in the form below only as primes; in target trials, the resultative and depictive sentences in each row were combined into a single target that could be continued either as a resultative or depictive at the sentence-final adjective (e.g., *Max cooked the chicken tender / whole*).

Table A1. Resultative and depictive stimuli for Experiments 1 and 2

Verb	Resultative construction	Depictive construction
BOIL	Emma boiled the carrots soft.	Peter boiled the carrots raw.
COMB	Judy combed her hair straight.	Sheila combed her hair wet.
COOK	Max cooked the chicken tender.	Gary cooked the chicken whole.
CUT	Nancy cut the grass short.	John cut the grass wet.
FOLD	Jenny folded her clothes flat.	Ellen folded her clothes unwashed.
FORGET	Matthew forged the iron flat.	Bob forged the iron hot.
FRY	Frank fried the vegetables crispy.	Maria fried the vegetables unwashed.
FREEZE	Eric froze the mixture solid.	Charles froze the mixture fresh.
GRILL	Cindy grilled the salmon crispy.	Jacob grilled the salmon whole.
GRIND	Sally ground the spices fine.	George ground the spices fresh.
IRON	Steve ironed his shirt dry.	Joe ironed his shirt wet.
KNEAD	Terry kneaded the dough smooth.	Jean kneaded the dough cold.
PAINT	Lisa painted the wood orange.	Joan painted the wood unvarnished.
POUND	Vivian pounded the fillet thin.	Kevin pounded the fillet raw.
ROAST	Bill roasted the potatoes golden.	Leslie roasted the potatoes whole.
SHAPE	Sam shaped the clay round.	Linda shaped the clay wet.
SHAVE	Michael shaved his chin smooth.	Mark shaved his chin dry.
SLICE	Julia sliced the cheese thin.	Mary sliced the cheese cold.
SPREAD	Sandra spread the butter thin.	Michelle spread the butter cold.
SQUEEZE	Ben squeezed the lemon dry.	Patrick squeezed the lemon fresh.

Appendix B. Regression tables

Regression table for Experiment 1 (Section 5.2.2)

Model of log10-transformed reaction times at the sentence-final adjective:

```
rt_log10 ~ target_cxn * prime_cxn + trial_number_centred +
  screen_position + word_length_centred +
  (1+target_cxn|participant) + (1|prime_sentence) +
  (1|target_sentence)
```

Table B1. Output of the linear mixed model of log10-transformed response times in Experiment 1

Fixed effects	Estimate	SE	t	p	Sign.
(Intercept)	2.989	0.0140	212.871	<0.001	***
target_cxn = "DEP" (reference level = "RES")	0.053	0.0113	4.726	<0.001	***
prime_cxn = "DEP" (reference level = "RES")	-0.009	0.0076	-1.156	0.250	
prime_cxn = "UNREL" (reference level = "RES")	0.011	0.0071	1.495	0.139	
trial_number_centred	-0.001	0.0001	-21.033	<0.001	***
screen_position = "right" (reference level = "left")	-0.011	0.0047	-2.397	0.017	*
word_length_centred	0.012	0.0030	4.008	<0.001	***
target_cxn : prime_cxn "DEP" : "DEP"	-0.026	0.0083	-3.131	0.002	**
target_cxn : prime_cxn "DEP" : "UNREL"	-0.021	0.0078	-2.730	0.006	**
Random effects	Var	SD			
(1 participant)	0.0164	0.1281			
(1+target_cxn participant)	0.0001	0.0088			
(1 prime_sentence)	0.0002	0.0146			
(1 target_sentence)	0.0009	0.0303			
Measures of model quality					
N	4812				
AIC	-7570.4				
marginal R ²	0.058				
conditional R ²	0.656				

Sign. codes: '*' $p < 0.05$; '**' $p < 0.01$; '***' $p < 0.001$; RES = resultative; DEP = depictive; UNREL = unrelated.

Regression tables for Experiment 2 (Section 5.2.3)

Model of depictive responses at the sentence-final adjective (for all targets):

$$\text{response_DEP} \sim \text{prime_cxn} + \text{trial_number_centred} + \\ (1|\text{participant}) + (1|\text{prime_sentence}) + \\ (1|\text{target_sentence})$$

Table B2. Output of the logistic mixed model of depictive responses in Experiment 2

Fixed effects	Estimate	SE	t	p	Sign.
(Intercept)	-1.287	0.266	-4.842	0	***
prime_cxn = "RES" (reference level = "UNREL")	0.112	0.165	0.681	0.496	
prime_cxn = "DEP" (reference level = "UNREL")	0.049	0.167	0.294	0.769	
trial_number_centred	0.007	0.003	2.232	0.026	*
Random effects	Var	SD			
(1 participant)	0.354	0.595			
(1 prime_sentence)	0.024	0.154			
(1 target_sentence)	1.035	1.017			
Measures of model quality					
N	1793				
AIC	1867.8				
marginal R ² (delta method)	0.004				
conditional R ² (delta method)	0.224				

Sign. codes: '*' $p < 0.05$; '**' $p < 0.01$; '***' $p < 0.001$; RES = resultative; DEP = depictive; UNREL = unrelated.

Model of depictive responses at the sentence-final adjective (only highly acceptable targets):

$$\text{response_DEP} \sim \text{prime_cxn} + (1|\text{participant}) + (1|\text{target_sentence})$$

Table B3. Output of the logistic mixed model of depictive responses for a subset of highly acceptable targets in Experiment 2

Fixed effects	Estimate	SE	t	p	Sign.
(Intercept)	-1.248	0.475	-2.628	0.009	***
prime_cxn = "RES" (reference level = "UNREL")	0.298	0.274	1.089	0.276	
prime_cxn = "DEP" (reference level = "UNREL")	0.478	0.259	1.846	0.065	.
Random effects	Var	SD			
(1 participant)	0.416	0.645			
(1 target_sentence)	1.095	1.047			
Measures of model quality					
N	564				
AIC	638.3				
marginal R ² (delta method)	0.006				
conditional R ² (delta method)	0.252				

Sign. codes: '.' $p < 0.1$; '*' $p < 0.05$; '**' $p < 0.01$; '***' $p < 0.001$; RES = resultative; DEP = depictive; UNREL = unrelated.

Model of log10-transformed reaction times at the sentence-final adjective:

```
rt_log10 ~ prime_cxn + trial_number_centred +
          (1|participant) + (1|prime_sentence) +
          (1|target_sentence)
```

Table B4. Output of the linear mixed model of log10-transformed response times in Experiment 2

Fixed effects	Estimate	SE	t	p	Sign.
(Intercept)	3.115	0.0152	204.458	<0.001	***
target_cxn = "RES" (reference level = "UNREL")	-0.023	0.0102	-2.223	0.042	*
prime_cxn = "DEP" (reference level = "UNREL")	-0.029	0.0102	-2.844	0.012	*
trial_number_centred	-0.001	0.0002	-4.441	<0.001	***
Random effects	Var	SD			
(1 participant)	0.0155	0.1244			
(1 prime_sentence)	0.0001	0.0115			
(1 target_sentence)	0.0014	0.0380			
Measures of model quality					
N	1793				
AIC	-1482.1				
marginal R ²	0.011				
conditional R ²	0.462				

Sign. codes: '**' $p < 0.05$; '***' $p < 0.01$; '****' $p < 0.001$; RES = resultative; DEP = depictive; UNREL = unrelated.